The Emergence of Clusters in Societal Transition

A Coevolutionary Perspective on the TCM Cluster at Tonghua/China

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Dekan: Prof. Dr. Dr. hc. Gerhard Brey

1. Gutachter: Prof. Dr. Eike W. Schamp
2. Gutachter: Prof. Dr. Christian Berndt

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In Memory of My Dearest Father (10.1950-4.2007)
who lives in my heart for good.

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Abstract

New industries are recognized as new impetus to national wealth. At the same time, they are increasingly becoming geographically concentrated in some well defined areas. But current studies on the emergence of industrial clusters tend to analyze favorable driving factors. This dissertation takes the example of a Chinese endogenous industrial cluster, the traditional Chinese medicine (TCM) cluster at Tonghua, a small peripheral city in Northeastern China, to contribute to the theoretical understanding of the emergence of industrial cluster as a co-evolutionary process of organizations, institutions and firms, or, to put it more broadly, as economic evolution embedded in complex socio-economic contexts.

The recent advance in evolutionary and co-evolutionary economics which considers the economy and economic landscape as dynamic process instead of equilibrium can be regarded as a part of broader and more intellectual turn of quest for history in social sciences. Although the principle of “history matters” is widely acknowledged, it tends to be reduced to a quite simple concept of “path dependence”. However, path dependence cannot offer space for new path creation, except from an external shock. Accordingly, the role of human conscious action or Schumpeterian innovation should be added to path analysis through the concept of path creation. Furthermore，and more importantly, history should be understood as context, and historical context can be explored through the understanding of multi-paths and interaction among them over time. So path inter-dependence (co-evolution between paths) would be useful to better understand the complexity of real history. Since the industrial cluster is composed of interconnected firms and is also subject to changes in institution and technology, I will focus on the multi-way causal relationship between firm, institution and technology. The theorizing is not entirely new, but most of the theoretical and empirical discussions are at the national or industrial level, not regional or local one. A competitive cluster can be regarded as a co-evolutionary hotspot in which multiple populations actively interact and are interconnected. Co-evolution itself is a dynamic and evolutionary process. So I will adopt a dynamic and evolutionary view to examine co-evolutionary degree or co-evolutionary effects in the Tonghua pharmaceutical cluster through time.

After a brief introduction which deals with the national institutional changes that are highly associated with new venture creation, entrepreneurship, and innovation, with registrations on drug and healthcare system, and with changes in market demand of China’s pharmaceutical industry and geographical distribution, I will collect evidences

from three aspects based upon field survey and second hand data, i.e., the history of the enterprises, the origin of entrepreneurship, and the knowledge of evolution, linking their respective generative relationships through the genealogical method. In this volume, the evolution of the Tonghua pharmaceutical firm organization, the formation of local entrepreneurship, historical accumulation of knowledge, and particular knowledge of transfer among generations of firms will be discussed, then I will probe into co-adaption and co-evolution between local formal and informal institutions and organizations in Tonghua's TCM industry. In addition, I will try to understand the co-evolutionary process at different geographical levels (namely, national and local).

In summary, my main findings include the following several points. Firstly, in the course of the emergence of Tonghua's pharmaceutical industry, local social networks and the traditional alliance between enterprises and government have played important roles. Secondly, the most important factor that influences the evolution of endogenous industrial clusters such as the Tonghua pharmaceutical industry in transitional countries is not the change in technology, but the change in fundamental national institutions. Thirdly, the success of the Tonghua pharmaceutical industry can be ascribed to the creation of multiple paths largely based on initial conditions, which implies that economic policy should have historical consciousness, namely, new economic innovation should make full use of both historical legacies and existing assets. Finally, it is co-adaption and co-selection of firm organization, institution, and technology that have jointly made Tonghua's pharmaceutical industry become highly competitive, which means that whether one region can grasp new opportunities partially depends on its capabilities to coordinate a varity of development agents.

Key words: industrial cluster, institution and technology, China, transitional society

Abbreviations

CCP	Chinese Communist Party
CCPCC	Chinese Communist Party Central Congress
S&T	Science and technology
PRIs	public research institutes
R&D	research and development
SOEs	state-owned industrial enterprises
COEs	collective-owned enterprises
POEs	publicly owned enterprises
TVEs	township-village enterprises
SMEs	small and medium-sized enterprises
RCEs	red cap enterprises
TCM	Traditional Chinese medicine
PCM	Prepared Chinese Medicine
GMP	Good Manufacturing Practice
GCP	Good Clinical Practice
GSP	Good Supply Practice
USA	United States of America
n/a	non-available
HFM	history-friendly models
FDI	foreign direct investment
FIEs	foreign-invested enterprises

Chapter 1 Introduction

1.1 Research Background

1.1.1 Industrial Clusters and China's Economic Growth

Industry Cluster in a World Perspective

Over the last two decades, no concept has been more intensely scrutinized than the industrial cluster by academics and policy makers across the world. Since the 1980s, industrial clusters have been conceived as drivers of innovation and carriers of economic, even social development. The recent popularity of the industrial cluster approach in international academic community and amongst policy makers partly results from the clear recognizing of the importance of small and medium-sized enterprises (SMEs) in economic growth in the global context. At the same time, it is connected to a long theoretical debate of "whether or not geography matters" (e.g. Krugman, 1991a; Feldman, 1994; Martin and Sunley, 1996; Morgan, 2001). Although globalization and telecommunications revolution have made communication across regions easier and more economical, knowledge is generated and transmitted more efficiently via local proximity, and information sharing is more convenient, economic activity based on new knowledge has a high propensity to cluster within a geographic region. Hence, the research issue of geographical concentration of industries has again received mounting attention from a variety of fields, when the new knowledge-based society is considered.

Although it has been already recognized by theoretical and empirical studies that industrial clustering becomes potentially mortal (see, for example, Schamp, 2005; Grabher, 1993), it is evident that industrial clustering is a regional development strategy which can potentially promote innovation and economic competitiveness (Martin and Sunley, 2003). This has been wildly proved by a great number of successful stories of industrial clusters in the developed world, such as the Third Italy (e.g. Piore and Sabel, 1984, Garofoli, 1992; Goodman and Bamford, 1989; Pyke, Becattini and Sengenberger, 1990; Pyke and Sengenberger, 1992), Silicon Valley (Saxenian, 1994, Cohen and Fields 1999) and Hollywood (Scott, 1998) in the USA, and Fukuoka (Kuchiki and Tsuji, 2005) in Japan, and even in developing countries, including software industry in Bangalore (Parthasarathy, 2004), the Jepara furniture cluster in Indonesia (Loebis and Schmitz, 2005), new-tech industries in Beijing (Wang and Wang, 1998), agro- industry and salmon aquaculture industry clusters in Chile (Perez-Aleman, 2005). International organizations, such as the United Nations Industrial Development Organization (UNIDO, 2001), OECD (2001, 2007) and the World Bank (2000), national governments, such as in US, the UK, Germany, France, Italy, Portugal, the Netherlands, New Zealand, former Eastern European socialist countries such as Czech Republic, oriental countries, including Japan, Korea, PRC, and even African countries like Kenya and Ghana[1], and regional development agencies like, to name but a few, the Northwest Regional Development Agency in the UK, Bio-Gen-Tec-NRW in the BioRegio Rheinland in Germany and Western Development Office in China, as well as uncountable local governments, were all involved in industrial cluster projects.

The Geographical Myth of China's Blooming Economy

An impressive Chinese phenomenon of an above 8% annual growth rate after the economic reform and opening-up (for an international comparison of world economic growth rates from 1960 to 2005, see Table 1.1) has recently received much attention. Some scholars owe recent steady and constant economic growth after 1978 mainly to the low-cost advantage, and abundant labour resources. But this explanation is not sufficient to illuminate the Chinese economic success. Firstly, low labour costs themselves are not necessarily transformed to real competitive advantage of low product prices. In fact there are many countries which possess lower labour cost and can't offer lower prices than China for the same product in the global market. Secondly, high technology-based production occupies an important position in the Chinese economy, which reflects that technology is also an important driving force in China, at least in some knowledge-intensive industries like information and biotechnology sectors. Thirdly, there are a lot of other factors that contribute to economic growth in China, including the presence of a multiplicity of companies (Arvanitis, et al., 2003), particularly the resurgence of privately managed enterprises and entrepreneurship, new emerging high technology industries, and a shift towards a foreign capital-oriented economy which is export-driven and relies heavily on foreign direct investment (FDI)[2]. However, I do not, by any means, deny the existing arguments which attribute China's

[1] For an overview of clusters with high competitiveness, most of which in developed countries, see OECD (2007); For a review of industrial clusters in developing countries, see (Nadvi and Schmitz, 1994) clusters in Africa, see Oyelaran-Oyeyinka and Lal (2006).

2 China's foreign direct investment in actual use reached 63.021 billion US dollars in 2006 and was ranked the fourth largest country in the World (but the first one in the developing countries), after the United States (177.3 billion US dollars), the United Kingdom (169.8 billion US dollars) and France (88.4 billion US dollars). In 1994, China's direct foreign capital in actual use shared as high as 13.45 percent of the global transnational investment. After 2000, that percentage started to decline, but, in general, kept the increase of above 5percent per year.

economic achievements mainly to the labour cost advantage, but I would highlight that economic growth has a territorial texture (Rullani, 2002). Namely, the growth in human material wealth is not geographically even, there is a very evident trend that economic development is localized and organized in territorial clusters.

Table 1.1 International comparison of world economic growth rate from 1960 to 2005

Unit: %

	1960-1970	1970-1980	1980-1990	1990-2000	2000-2005
China	2.9	3.7	8.8	9.3	8.3
India	1.1	2.3	3.6	4.2	5.3
South Korea	6.0	8.4	7.7	4.7	3.9
Brazil	2.6	6.5	0.7	1.3	1.0
USSR/Russia	4.0	4.7	1.3	-4.7	6.6
Low-income economies (excluding China & India)	2.0	1.8	2.2	1.2	4.2
Middle-income economies	3.5	2.1	1.2	2.2	3.9
Low- & middle-income economies			1.3	1.8	3.7
East Asia and Pacific			5.9	5.7	6.9
Europe and Central Asia			1.2	-1.7	5.2
Latin America & Caribbean			-0.3	1.7	0.9
Middle East & North Africa			-1.1	0.7	2.2
South Asia			3.4	3.7	4.8
Sub Saharan Africa			-1.3	-0.1	2.0
High-income economies			2.7	2.2	1.5

Sources: World Bank, *World Development Report* and *World Development Indicators*, various years.
Note: Figures are average annual real growth rate of per capita GDP (%).

In the process of national wealth growth, industrial clustering plays a significant role in regional development and contributes to the national competitiveness in both developed and developing countries, without exception of China. In today's China, a variety of products, from information and communication products, home appliances, to clothing and family day-to-day supplies, are manufactured assumedly in places with such clusters, proliferating not only in the coastal provinces, but also in inland provinces. It is reported that there are more than 160 specialized industry towns[3] in Guangdong province (the richest province with the highest total GDP among all

[3] 'Specialized Industrial Town' is a nickname of an industrial cluster used by local scholars and policymakers in Guangdong province, China. Each of these towns is specialized in making a particular industrial product. Most of the towns are so successful that they earn a reputation as a leading manufacturer in their own pillar industries. "One Industry in One Town" has become a unique economic feature in Guangdong province.

provinces, its nominal GDP increased to US$265 billion in 2005, about the same size as Denmark) creating approximately one third of the total industrial output value of Guangdong (Wang, 2004). In some industrial towns specialized on IT and electronics in the Pearl River Delta Region, one can purchase 90% of the computer components, 80% of the mobile components, and nearly 100% of the color TV components procurement in one day within the scope of 100 km (Liu, 2003). According to the survey by Zhejiang Provincial Economic and Trade Commission in 2003, about RMB 1 trillion Yuan, a half of the province's total industrial output value, was produced in 149 industrial clusters in Zhejiang province, which have crossed the marketing income level of 1 billion RMB Yuan (Dong, 2005). In Jiangsu province, there were about 110 industrial clusters in 2002, which created sales income of RMB 532 billion Yuan, equivalent to nearly 40% of the province's total sales of industrial enterprises above designated size (the enterprises with an annual income over 5 million Yuan[4], Gu and Wang, 2003). These evidences strongly support the argument that industrial clusters in China have become a comfortable home to SMEs and important manufacturing base and export base, and a powerful "engine" for the rapid development of industrial areas, and an effective instrument for building regional economic capacity to compete in the global increasingly cut-throat markets, despite of the current lack of a unified statistical standards for measuring the economic contribution of industrial clusters to the national economy of China. At the same time, just like in other countries, the industrial cluster is considered as a potentially successful way of organizing industrial activities in China and has been zealously adopted by all levels of Chinese governments (Wang, 2007).

The Importance of Endogenous Economic Growth

There is a variety of formation types of industrial clusters in China. Taking the biotechnology and pharmaceutical sectors as examples, there are mainly two: one is the exogenous industrial cluster which is government-led and mainly comes in existence in the form of recently developed high technology development areas such as Zhangjiang Bio-Pharmaceutical based in Shanghai, similar to Bangalore's software cluster in India. The other is endogenous. The Tonghua pharmaceutical cluster is a good representative for this type, in which local entrepreneurship is the first and main initiator of its emergence and growth. The former is linked to exogenous investments, especially foreign direct investment (FDI), while the latter is mostly related to endogenous factors

[4] Industrial enterprises above designated size contain all state-owned enterprises and non-state-owned enterprises with an annual income over RMB 5 million Yuan.

and indigenous innovativeness. Different from the Western World, China has a special form of industrial clustering, i.e. some clusters origin from large state firms established during the planning period. The development of (Chemical) pharmaceutical industry in Shijiazhuang can be classified into this category.

Associated to the typology of industrial clusters, there is a long-lasting debate on the importance of FDI in developing countries. In the 1990s, it was wildly accepted that vast introduction of FDI helped to stimulate industrial development, especially through industrial export zones, creating job opportunities, as well as consequently enhancing social wealth. For transitional economies, FDI might play a catalytic role in supporting the process of economic transition to a market-oriented system, and act as a conduit for revitalizing the private sector. This view is not wrong but very narrow (Huang, 2002). More evidence has emerged that such FDI-driven clusters are not "sticky places in slippery space", in the term of Markusen (1996). This argument could be proven by the recent large-scale withdrawal of FDI from China. Since the new Labour Contract Law in China took effect in the first months of 2008, providing protection to employees from layoffs, as well as ensuring that they will be well compensated in the event of being made redundant by their employers, a lot of foreign firms, specially the labour-intensive Taiwan and Hong Kong funded enterprises, have stampeded from China to Vietnam, other Southeast Asian countries as well. The current financial crisis that broke out in September is or will be exacerbating this situation. This clearly manifests that FDI tends to seek profits throughout the world, and is more subject to any changes in the host countries, and that FDI has a high-level mobility across the international markets. However, indigenous enterprises are profoundly rooted in local socioeconomic contexts. Moreover, the fact that the vast FDI in the former Soviet Union did not bring such a successful economy as China, at least until today, clearly shows that it is very essential for the safety of a national economy to mobilize indigenously all kinds of resources, in particular through cultivating local entrepreneurship and innovation culture. This is why public attention transfers to the endogenous model of economic development.

1.1.2 The Theoretical Puzzle Relevant to Cluster Emergence

The large number of recently coined theoretical concepts explaining the competitive advantages from geographical clustering arises around the family of territorial innovation models (Moulaert and Sekia, 2003). The common focus of these territorial innovation models is the origin and development of innovation and the significance of industrial organization and inter-firm linkages for regional competitiveness and regional innovation processes, so the core argument of these explanations is that the spatial co-localization or ‘clustering’ of firms and other organizations in related industrial sectors has a potential for economic and innovation benefits (Hassink, 2007).

Now, the research thread, both in theoretical discussion and empirical research, has already been transferred from the empirical assessment of the relevance and importance of industrial clustering to the understanding of trajectories that lead to success or failure. For example, Humphrey (1995) calls for a shift “from models to trajectories”. During the research shift, we can clearly find that there are two research camps which make an attempt to address the issues of which factors determine the rise and fall of the industrial clusters, and how they drive the geographical clustering of industries: social constructionism versus technological determinism (Kenney and von Burg, 1999). There is an additional theoretical line, institutional determinism especially for the emergence of industrial clusters in China’s transitional context. It is necessary to note that though both social constructionism and institutional determinism emphasize the role of institution in industrial clustering, institution in the latter refers to the regulation on enterprise ownership, which is very meaningful in understanding the economic evolution of transitional nations from a centrally planned economy to a free market.

(1) Social Constructionism

On the base of empirical investigations, some key factors were recognized, such as the local accumulated human capital (Camagni, 1995), labour mobility (Angel, 1990; Saxenian, 1994), close proximity to research universities (Storper and Walker 1989; Storper and Salais, 1997) , supplier networks (Saxenian, 1994), local competition (Porter 1990), location economies and agglomeration economies（Doeringer and Terkla, 1995), face-to-face interaction (Doeringer and Terkla, 1995; Rosenfeld, 1997), and social capital (Cohen and Fields, 1999), abundance of venture capital (Teubal and Avnimelech, 2004), and entrepreneurship (Bouwman and Hulsink, 2002). At the same time, particular emphasis was placed on the local synergy between firms and the resulting collective efficiency (Schmitz, 1999). However, this research has been repeatedly accused, for instance, of “less rigorous case study evidence” by Markusen (1999). More seriously, it adopts an isolated world view, without taking the complex and co-evolutionary nature of various social factors during the process of emergence and development of spatial clustering into consideration (Liu, 2006). In other words, it is social interaction and the creation of social capital (or "social network", in Chinese, *guanxi*) that co-constitute an emerging cluster. Further, the embryogenesis of industrial clustering is, both in the developing and developed countries, also a synchronous process of the presence of supportive institutions, containing the launch of local research universities, the availability of venture capital, the cultivation of a culture of risk taking, and creation of strong local informational and business development networks (Feldman, 2001, p: 861). This argument is in accord with the recently developed theory of co-evolution of industry, technology, and institutions (see Nelson, 1995; Murmann, 2003).

(2) Technological Determinism

On the contrary, there is another philosophical line, that of technological determinism. The fundamental building block of this theorizing is the cutting-edge technology which is vital for the fates of regional industries, high-tech industries in particular, so this research line attached more importance to the birth of cutting-edge technology and knowledge diffusion in local community. At the same time, the theory of technological/industrial lifecycle (adapted from the concept of product cycle, see Vernon, 1966; Abernathy and Utterback, 1975) is often used in this research stream (for example, Klepper, 1996; Dalum et.al. 2005; Storper, 1988; Walker, 1985; for an overview on this point, see Audretsch and Feldman, 1996). As Klepper (1996) pointed out, among the most heavily studied aspects of the life cycle is the evolution of the number of firms. At this point, the "evolutionary" model (or its family of models) states that new startups, especially spinoffs (employees leaving incumbent firms to start their own firms in the same industry), play a crucial role in the application of new technology and technology proliferation among firm generations (see, for example, Klepper, 2002; Zhang, 2003), since new spinoffs are the embodiment of innovation, especially for radical new technologies that are not easily absorbed into existing firms (Audretsch, 1995). The value-added of technological determinism is that the importance of technology is acknowledged, but it is silent on the social factors of production and diffusion of new technology. In fact, economic development results not only from technological advances but also from the simultaneous socio-cultural and institutional factors. Similarly, technology is not an exclusive factor which contributes to the formation and growth of an industrial cluster. A variety of techno-economic changes in the context of transitional countries tend to be accompanied by other non-technological factors, such as the increased importance of scale economies, easier access to capital, increasingly fierce competition market competititon and the market-oriented institutional framework. Moreover, in extremely turbulent environment in the transitional countries, institution, which "wake up" and activate the actually existing but not working technology, is more important than technology itself, as Wang and Wang (1998) discovered in the case of new-technology industry in Beijing.

(3) Institutional Determinism

Moreover, in the literature on the emergence and performance of China's industrial clusters, the institutional determinism has been too much prevailed, which follows the framework of the new institutional economics inseminated by Coase (1937) and recently advanced by North (1990). The institutional determinism assumes that since the privatization of collective and state-run enterprises was earlier carried out in some southern coastal regions, such as Guangdong and Zhejiang, industrial clusters have developed and are developing better there. This viewpoint seems to be justified when we try to understand why the southern coastal region as a whole is more energetic than other parts in China. It is estimated that 149 industrial clusters in Zhejiang province produced half of this province's total industrial output value in 2003 (Dong, 2005). However, the static and ahistorical analyses neglected an undeniable fact that property rights have not been clear-cut even at the very beginning in today's relatively advanced economic regions in China, namely, the reform of property rights in these regions was not finished overnight like "the shock therapy" adopted by the former Soviet Union. As regards my case area, Tonghua, a peripheral city in the Old Industrial Base of Northeast China, the ownership reform there was relatively later implemented than in South China in general. Hence, the theory of property rights is too narrow and simplistic, and failes to explain why Chinese industrial clusters formed and still remain highly competitive even when property rights have been fuzzy for a long time. My argument is that the institutional reform of property rights in China took place in the process of co-adaptation between property rights institutions and other national policies. That means that there is interaction between institution and technology. We can not well understand the achievements of the Chinese recent economic reform without the perspective of co-evolution between firm organization, institution and technology.

1.1.3 Review on Evolutionary Economic Geography and Coevolutionary Study

(1) Evolutionary Approach and Linear Historical Determinism

Recent years have seen the emergence of a new wave of interest in the "evolutionary" concept in the field of economics, and economic geography as well. The distinct evidences are the increasing number of books and articles which delineated by so-called "evolutionary", "Schumpeterian"' or "new/post Schumpeterian" approaches, and the establishment of new professional societies and journals labeled "evolutionary"[5]. Some leading neoclassical economists have turned away from mechanics to biological metaphors (Anderson, 1995; Arrow, 1995; Hahn, 1991). Meanwhile, in the realm of economic geography, apart from the traditional purely economic analysis, economic geographers have drawn freely on different sources, from social, cultural to political sciences, for theoretical and conceptual insights, which resulted in the emergence of some significant 'turns', such as the 'cultural turn' (Amin and Thrift, 2000; Barnes, 1999, 2001)[6], 'institutional turn'(Martin, 1994, 2000 and Hayter, 2004) or 'relational turn' (see Amin, 1998; Dicken et, al. 2001; Ettlinger, 2001,2003; Bathelt and Glückler, 2003; Boggs and Rantisi, 2003)[7], and the recent 'evolutionary turn' (Storper and Walker, 1989; Cooke and Morgan, 1998; Martin, 1999; Scott, 2004; Rigby and Essletzbichler, 1997; Boschma and Lambooy, 1999; Essletzbichler and Rigby, 2005; Boschma and Frenken, 2006a; Cooke, Roper and Wylie, 2003). Such conjunction between economic geography and evolutionary economic analysis offers powerful and insightful theoretical and conceptual underpinnings in emergences and development of clusters and the like.

In the hot wave of evolutionary studies, economists and economic geographers are increasingly aware of the importance of "history" in understanding the ways in which industry (clusters) arise(s). For example, Arthur (1986, 1990), Nelson (1994) and Zysman (1994), among others, all suggest that understanding industrial development requires tracing the nature, origin and dynamics of historically rooted institutions. Unfortunately, the concept of "history matters" with richer and more extensive

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[5] The European Association for Evolutionary Political Economy and the International Joseph Schumpeter Association were already founded in the late 1980s. Moreover, the Journal of Evolutionary Economics commenced publication in 1991.Other international recognized journals which paid special attentions to the evolutionary concept are Journal of Economic Behaviour and Organization, Journal of Economic Issues, Journal of Structural Change and Dynamics, Cambridge Journal of Economics, Economic Journal, Journal of Economic Geography, and Industry and Corporate Change.

[6] For an in-depth review on the cultural turn in economic geography, see Barnett (1998).

[7] For a review literature on the relational turn in economic geography, see Yeung (2005).

meanings was reduced to some oversimplified concepts, such as "initial condition" (Feldman and Schreuder, 1996), and "path dependence" (Britton, 2007; Essletzbichler and Winther, 1999; Belussi, 1999) . These concepts seem to follow a linear historical determinism, while the influence of history on the rise of spatial clustering of industries is far more complicated than it had been envisioned. Although these concepts might be a bit helpful for understanding industrial evolution in the USA and the mature and advanced market economies of Europe where industrial history is continuous, they are totally inadequate to address the same issues in transitional countries, in which momentous institutional changes made the preceding development paths disconnected: i.e. history was discontinuous. In other words, the powerful influence of initial conditions could probably be reflected well in the uninterrupted history, but the dynamics of the development trajectory of discontinuous history is more complicated. More seriously, the concepts dominated by the philosophy of linear historical determinism risk losing the rich contents of real history, since the trajectories of entities is locked in by their own history on the one hand, and the path dependence may bifurcate due to sudden external shocks or deliberate human actions, on the other hand. Meanwhile, the trajectory of a single entity is subject to its own history, as well as the changing history of the environment, in which it operates and exists. This means that we need an alternative theoretical concept for understanding the complexity of evolutionary history of industrial clusters. The integrated conceptual framework of path dependence, path creation, and coevolution (which we might call the non- linear historical determinism) appears to be a good choice, since it accommodates the need for the study on change (through the concept of path creation) and non-change (stasis, through the concept of path dependence), and the interconnectedness of the changes of entities (through the concept of path interdependence or coevolution between paths) in understanding the dynamics of industrial spatial evolution.

There is no place for path creation owing to endogenous factors in the traditional path dependence study developed by Paul David and Brian Arthur. Arthur (1994a) extended the concept of path dependence to geography, and explained the location of new industries as a path dependent process. Despite of being insightful, one of his seminal works also receives challenges from geographers (for an extensive review, Boschma, 2007). I want to especially stress that Arthur, like other economists (for example, Krugman), abstracts from space, treating it as being flat and neutral before a new industry starts; namely, his models are silent on how geography may feedback on this process (also see Boschma, 2007, p: 42). Martin (1999) and Martin and Sunley (2006) tried to fill this gap and state that path dependence should not only produce space (industries creating space) but places impact on path dependence (place dependence, for this concept, also see Berndt, 1998, 2001). Their arguments are akin to the concept of *Windows of Locational Opportunity*, which was coined by the so called Californian School of Economic Geography in the late 1980s (Scott and Storper, 1987; Storper and Walker, 1989, p: 75), and extended and refined by Boschma and his colleagues (e.g. Boschma, 1997; Boschma and Van der Knaap, 1999; Boschma and Lambooy, 1999; for a review on WLO, see Boschma, 2007). The key viewpoint of windows of locational opportunity is that new industries have the capacity of "*generating their own conditions of growth in place by making factors of production come to them or causing factors supplies to come into being where they did not exist before*" (Storper and Walker 1989, p: 71). There is another question related to this aspect, namely, whether it is realistic to assume that (local) new industries start from scratch. If not, where are their roots? In their own history? Or in related industries or other location-specific assets? Boschma (2007) states that why Coventry/Birmingham became a center of the British automobile industry was because it was well endowed with related industries like coach and cycle making in the late nineteenth century before the automobile sector started to expand. This means that the formation of local new industries benefits a lot from the existence of technically related industries. Are there other ways in which "new" industries don't start from scratch? How to make use of old and existing resources in creating new industrial paths?

(2) Co-evolutionary Study and Untouched Questions

Co-evolution is a concept from biology, refers to the mutual evolutionary influence between two species, namely each population in a co-evolutionary relationship exerts selective pressure on the others, thereby affects one another's evolution. The selective pressure on each other forces co-evolving parties to co-evolve and co-adapt to each other. Classic economics was coevolutionary, namely, the coupled cause-effect processes of technology and institutions, despite the term of "coevolution" was never used, for example, Adam Smith, Karl Marx, and Max Weber, Joseph Schumpeter, all explored the determinants of economic growth and the the intertwined influence of technology and institution (for a detailed explanation, see Nelson, 2002). However, economics has forgetten this good tradition for a long time. After this long forgetting, coevolution finally comes back again to economics and other social sciences.

Recently, some evolutionary economic scholars, such as Nelson (1994), Coriat and Dosi (1997), and Murmann (2003), have highlighted the necessity of developing co-evolutionary models for better understanding the dynamics of economic change. Coevolutionary models can help us to understand the interaction between technological change, institutions, and industry structure (Lewin et al., 1999; Nelson 1995; Ziman 2000). Recent work on co-evolution has called for analysis of both directions of causality (Pelikan, 2003) and rigid definitions of co-evolution (Murmann, 2003). Most literatures on the industrial evolution and industrial leadership concentrates on the national level, and has helped us to understand how these factors drive the rate, path and character of technical change – and thereby, economic growth, is shaped over time by the co-evolution of industries, technologies, and supporting institutions (Nelson, 1994; Tucker, 2003). Good examples of empirical research on the co-evolution of new emerging industries and institutions are, besides Murmann's book noted above that discusses the rise of the synthetic dye industry in the second half of the nineteenth century in Germany (Murmann 2003), the latest Consoli's publication with the purpose of elaborating an evolutionary perspective on the process of structural change which has characterized retail financial services in the United Kingdom (UK) from the 1840s to the 1990s (Consoli, 2005). But there are a few coevolutionary studies, both theoretical and empirical, on the meso-level of geography, i.e. subnational (regional) or so called industrial cluster level. According to my literature survey, there are merely two papers. One is a paper of Lee and Saxenian (2008), which tries to grasp the multi-faceted nature of coevolution of technological, organizational and territorial change, using the Taiwanese information technology industry as an example. Another is a working paper by Sotarauta and Srinivas (2005), in which they compared various cases of regions in Finland, India, and the USA to show heterogeneity in development, specifically technologically innovative development, and attempted to provide us with a co-evolutionary framework for a more comprehensive view of regional development processes. Therefore, many questions have been left. For example, can coevolutionary study at the national level be applied to the subnational levels? If yes, how to link local coevolution mechanism to macro-coevolutionary mechanism?

1.2 Research Questions

I try to contribute to our understanding of a basic research question: why do new industries develop in some regions, and not in others? So, the main task of this thesis is *to contribute to our understanding of the process and dynamics of the formation and growth of industrial clusters, with a motivation to theoretically contribute to evolutionary economic geography, in particular to the small subfield of 'coevolution'*. In order to fulfill the objective, the thesis will *build upon a consistent system, from the methodological or philosophical foundation of the concepts I will use, to the conceptual framework itself and policy suggestion, all of them in a coevolutionary perspective for understanding and promoting industrial clusters.* In addition, it will be proved that the emergence of successful industrial clusters results from the coupled interconnection of institutions, technology and firms at the national industry level. This dissertation will reinforce this viewpoint by empirically studying the Traditional Chinese Medicine (TCM) cluster in Tonghua, a small peripheral city in the Northeast of China, and will figure out *when and in which situations the coevolutionary processes occur.* Before starting to study the coevolutionary process on technology, institution, and firms, I will discuss the following two questions, which are relevant to the main topic of this dissertation.

1.2.1 Uncover 'How History Matters'

A "historical turn" has recently begun to emerge in the social sciences as a whole (McDonald, 1996; Pierson, 2004). An evidence of this growing interest is that concepts and terminologies such as "path dependence", "process", "sequence", "dynamics", and "mechanism", are increasingly often employed in literature. Some recently developed historizing theories, for example, regulation theory, institutional economics, and last but not least, evolutionary economics, try to contribute to understanding the relationship of current changes and what happened in the past, and view current changes as transition from one historical stage to another and attribute some explanatory power to historical events (Schamp, 1996). Evolutionary economic geography is a historical school in economic geography in the sense that it contributes to a basic evolutionary or historical issue, "*the processes by which the economic landscape – the spatial organization of economic production, distribution and consumption – is transformed over time*."(Boschma and Martin, 2007, p: 539).

The formation and development of evolutionary economic geography benefits from a marriage between economic geography and evolutionary economics, and offers alternatively better theoretical and conceptual underpinnings for understanding the economic landscape or geographical development (Boschma and Lambooy 1999; Boschma and Frenken, 2006a). Its research issues cover almost all fields of traditional economic geography, in particular, spatial evolution of industries and regional differences (e.g. Boschma and Weterings, 2005; Weterings, 2005), the decline of old industrial areas (e.g. Schamp, 2005; Hassink, 2007); the formation of local industries (e.g.Boschma and Wenting, 2007; Klepper, 2002) and spatial dimension of innovation (e.g. Cooke et al., 1998). At the same time, some important concepts of evolutionary economics have begun to be reflected when they are applied to economic geography. For example, Martin and Sunley (2006) construct the concepts of “place dependence” through reflection on the concept of “path dependence”, and Schamp (2009) develops the connotation of economic geography of the “coevolution” concept. Yet, this body of writing often contributes little to the foundation of theoretical questions, for example, what kind of history do we evolutionary scholars need for better understanding ‘evolution’ in economy and economic geography.

(1) What Kind of History Does Evolutionary Economic Geography Need

Although a series of concrete techniques of gathering and processing data, such as demographical techniques, social network, and spatial econometric techniques, were applied in the field of evolutionary economic geography (see Frenken, 2007), all of these methods, which I will call the “research methods”, don’t say any word about the researchers’ ontological or epistemological views, namely, for what these concrete research methods are used. The first task of this dissertation is to make sound methodological construction by bringing history into evolutionary economics, namely elevating history to the methodological foundation of evolutionary economic geography, by which we can identify the evolutionary study from a-evolutionary or a-historical ones. The term “methodology” here refers to the rational and philosophical assumptions underlying the logics of theoretical exploration and the usage of research methods. All concrete research methods to be used should be based on it to understand the real history through the lens of evolutionary concepts. This section serve as the philosophical foundation for the later discussion on path interdependence or coevolution between paths.

(2) Path Dependence Enough for Understanding History?

The second task of this thesis, related to the first one, is to figure out how to understand history. In the history-oriented research, all historical effects tend to be reduced to a too oversimplified term, 'path dependence', which runs the risk of losing the rich contents of history. As Martin and Sunley (2009) state, it is the interrelated process of path creation and path dependence that shapes geographies of economic development and transformation. But there are few theoretical and empirical studies on this aspect. Accordingly, I will build up a new framework to understand the complexity of history, and then develop the concrete historical method for the empirical study. As to the empirical study, I will take an industrial cluster of traditional Chinese medicine (TCM) as an example.

For the theoretical framework to be employed in this Ph.D. thesis, I will explore how to understand evolution in economic geography by placing history in historical time and historical contexts. Accordingly, the concepts of path creation and path dependence should be used together in the historical study. More importantly, the concept of path interdependence, which stresses the importance of the circumstances under which processes and events are likely to occur, opens a new window on the temporal aspects of the world and is also important to regional industrial policy.

1.2.2 The Coevolutionary Process at Industrial Cluster Level

The term "coevolution" is firstly used in biology and refers to successive changes among (two or more) ecologically interdependent but unique species so that their evolutionary trajectories interlace over time, adapting to each other. This results in an ecosystem of partially interdependent species that adapt together (Eisenhardt and Galunic, 2000). Norgaard (1984, 1994) first introduced coevolution in a socio-economic context to reflect long-term feedbacks that occur between five main subsystems: knowledge, values, organization, technology and environment.

According to the rigid definition of coevolution, "*two evolving populations co-evolve if and only if they both have a significant causal impact on each other's ability to persist*" (Murmann 2003, p: 210), we can find that there are two different coevolutionary approaches to industrial evolution in existing coevolutionary literature. First, some literature contributes to understanding the co-evolution of industry (or firms) and external environments, for example, industry and technology, industry structure, and institution (Nelson, 1994, 1995; Fatas-Villafranca et al., 2008). Murmann

(2003) empirically studies the interaction of industry, institution, and technology, using the case of the synthetic dye industry in the second half of the nineteenth century in Germany. I would like to call this type of coevolutionary approach to industrial evolution as 'the coevolutionary model of industry-environment'. Second, other literature has studied the coevolution of two or more industries, which we might call 'the coevolutionary model of industry- industry'. For example, Malerba, Nelson, Orsenigo and Winter (2007, 2008a,b) study the co-evolution of the computer and component industries from their inceptions to the 1980s. Recently evolutionary economic geographers (for example, Boschma, 2007) are also concerned about the 'industry-industry' coevolutionary mechanism in industrial cluster analysis.

In fact, these two coevolutionary models are interrelated, in the sense that it is impossible to well understand 'industry- industry' coevolutionary mechanisms without probing into the 'industry-environment' coevolutionary dynamics. As we know, an industry consists of a group of companies that operate in the same segment of the economy or share a similar business type. Considering that institutions and technology are always the main study topics both in economics and geography, and, in addition, they are the most important factors that have influence on industry or firms, I choose firms, institution, and technology as populations of my model. The coevolution of firms, institution, and technology is not an entirely new issue, even in evolutionary literature. Before the path-breaking book of Nelson and Winter (1982), some scholars (e.g. Penrose, 1959; Chandler, 1962) had emphasized that firm organizations should match the underlying technology and have the capacity for adapting to changing environments. Evolutionary theorists also consider the abilities of firms to adapt to and change the external environments (for example, of institution). Recently, prominent evolutionary scholars both in economists (e.g. Nelson, 2002; Pelikan, 2003) and in economic geography (e.g. Schamp, 2000, 2002, 2005; Boschma and Frenken, 2009) have begun to attach great importance to institutions (Nelson, 2002; Pelikan 2003). Nelson (2002) and other evolutionary scholars as well, recently called for a coevolutionary study of institution and technology during the process of industrial evolution. But almost all existing literatures on industrial evolution in coevolutionary perspective do not focus on the local industrial level, but on the national level; for example, the Mumann's study object is German synthetic dyestuffs industry.

I want to carefully examine the coevolutionary process of institution, technology and firm in an industrial cluster. Hence, it is necessary to answer the following questions: firstly, why and how a coevolutionary model can be applied to the sub-national level? Secondly, how to link different geographical scales of coevolution? The existing coevolutionary studies see coevolution as given, either implicitly or explicitly; while my argument is that coevolution itself is not given or fixed, but a changing process, in which the coevolutionary degree and effect change over time. Hence, we should adopt a dynamic view to study coevolution itself. In order to theoretically and empirically investigate the coevolutionary process in industrial clusters, I will develop two standards or criteria, the degree of the interaction (weak or strong) and the effects of the coevolution (positive or negative), to examine the coevolutionary process of firms, institution, and technology.

Theoretically, coevolution has intertwined geographical scales. Just as Lewin and Volberda (1999, p: 526) pointed out that multilevel coevolutionary thinking requires scholars to consider the interactions between multiple levels of coevolution. As I have said, my coevolution is in industry cluster, a meso-level, but its evolution is necessarily related to the higher geographic scales of institutions and technology (for example, global and national). This issue is of importance in the era of globalization of economy and technology in the sense that multiple geographic scales of institutions and technology interplay to an unprecedented degree. But Tonghua's pharmaceutical industry has been mainly specialized in TCM, which is different from chemical drugs in technology, and the global technology and market had little direct influence on Tonghua's pharmaceutical industry particularly before 1990s. I concentrate not on the global dimension of institutions and pharmaceutical technology, but on their national dimension. In addition, considering that the pharmaceutical enterprises in Tonghua are not so strong that they play an important role in national policy-making, I will concentrate in this dissertation on the top-down way of multi-scalar coevolution, by which national institutions and technologies affect the evolution of Tonghua's pharmaceutical industry.

1.3 Why Coevolution of Firms, Institution and Technology

In this section, I will answer the questions of what is the evolutionary unit and why I choose these three populations of firms, institution, and technology as my coevolutionary units. There is no general consensus on what the possible units of analysis of evolutionary economics are or how the units relate to each other. For example, in the work of Nelson and Witter (1982), the unit of selection is routine, while following Veblen (1899), Hodgson (1993) treats "habits" and "institutions" as the units of selection (Corning, 1995). In general, the typical and often discussed units in biology are genes, individual organisms and species; correspondingly, the units of analysis in the social sciences at large are individuals, groups, and societies. In economics, firms, markets, institutions and technologies usually are chosen as the units of analysis but it is still unclear how they are causally related. Perhaps the multi-level selection theory and group selection (Sober and Wilson, 1998; Vromen, 2001) help to establish explanatory links between the different layers in the ontology of evolutionary economics (Essletzbichler and Rigby, 2007). My main task here is not to theoretically discuss this dilemma, but to explain why I use these entities in studying coevolution in regional industries.

1.3.1 Why Firm

(1) The Working Definitions of Firm and Industrial Cluster

A firm may be defined as an entity for organizing production or services. In my empirical study, I define the legally registered investment entities, state-owned, collective, or private, as firms. Considering the special nature of the transition to a market economy, entities which were not legally registered but nevertheless operated for profit for themselves like separate firms, for example the contracted workshop during the transitional period, are also included. This kind of entities falsely tends to appear as affiliate subunits of a legally separate firm (state-owned enterprises).

The definition of industrial cluster is fuzzy both in the industrial cluster literature and in practice (Martin and Sunley, 2003). Porter (1998, p: 199) defines an industrial cluster as "*a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities*". However, other researchers emphasize the interconnectedness of firms within a cluster, for example, Rosenfeld's (1996, p: 13) definition is "*a geographically bounded concentration of similar, related, or complementary businesses with active channels for business transactions, communications, and dialogue, that share specialized infrastructure, labor markets, and services and that are faced with common opportunities and threats*". The interconnectedness of clustered firms and the sequent result of innovation are the essence of an industrial cluster. My argument is that the firms in the same industry are the kernel component of an industrial cluster, though it is impossible for an industrial cluster to exist and grow without related, supporting and complementary firms and other institutions like education, and government agencies. Therefore, pharmaceutical manufacturing firms will be the core units to be studied in the empirical research part of this dissertation.

(2) The Reasons for Selecting the Firm as Basic Unit of Evolution

The units of selection that found an evolutionary account (of economic landscape) could be firms, workers, routines, or even regions themselves (see also Essletzbichler and Rigby, 2007), which represents that firms are the most appropriate unit of selection within the (regional industrial) economy, and that other units of selection besides firms are equally useful for an evolutionary account. Why I choose firms as basic unit of analysis is based on the following three reasons. Firstly, my study objective is evolution in industrial cluster; meanwhile industrial clusters consist of firms in the same and related industries, located in relatively close proximity. Secondly, the firm (or in the words of Essletzbichler and Rigby, business establishment or plant)[8] is the often chosen unit of selection in economics and economic geography as well (Essletzbichler and Rigby, 2007, p: 23). The dynamics of evolution in a region as well as the evolution of regions which are research focuses of evolutionary economic geographies originate from variety creation and retention/transmission at the micro-level of firms. Finally and most importantly, selecting the firm is consistent with my research method. Through the usage of research method of business history, I will track the development trajectory of individual business organizations, based on the histories and stories of business themselves and entrepreneurs. The individual firms-based research method, together with others, enables us to find out detailed historical information on the micro-level of firms and makes possible a long-range observation of change at the meso-level of firm agglomeration.

1.3.2 Why Institution and Technology

(1) The Definitions of Institution and Technology

It is a widely accepted definition that institutions are the rules of the game devised by human beings in order to create order, constrain political, economic and social interaction and reduce uncertainty in exchange. Institutions include formal or informal

[8] Strictly speaking, there are some fine differences between the kinds of selection unit. For instance, both business establishments and plants can be not legally independent economic entities, which the films such as state-owned, collective-owned and privatized enterprises are independent economic unit. In addition, either establishment or plant operates in a single location, mainly engaged in a single productive activity, but a firm is an economic unit under single management consisting of one or more than one establishment, inside or/and across regions. The selection unit of Essletzbichler and Rigby (2007), the business establishment and plant, places more emphasis on technological change than my evolutionary unit of firms.

institutions. The formal institution is officially codified in written documents (as constitutions or laws, regulations), and easy to be changed, while the informal institution is not formally codified in official documents and is difficult to be changed in a short time (for example, norms, routines, and operating). The creation of formal institutions related to regional and industrial development is sanctioned by the state or regional agencies, and the enforcement or effectiveness of informal institutions are based mainly on auto-licensing (i.e. self-enactment and subsequent self-assertion) and the extent of public acceptance of uncoded practices or habits.

Sometimes, organizations like firms and markets are viewed as institutions, but it is meaningful to distinguish between general social rules (the institutional environment) and particular organizational forms (sometimes called institutional arrangements). However, I will adopt a narrow definition of institution in the sense that the institution I employ refers to coded policies and rules, and informal forms like social capital, but excludes organization. In addition, I want to bring a multi-level perspective to institutional study, namely I will make a difference between local institution and higher level institutions. In the case of Tonghua, the city and counties are local levels, while the province and the state are higher levels. Since Saxenian (1994) argues that regional institutions determine the ability of a region-industry to adapt to changes in markets and technology, I will focus on local dimensions of institutions.

This leads to another question, what kinds of institutions and organizations would be included in my empirical study. I will take the local institutions, including the industrial policies and local social capital, social connections (*guanxi)* as endogenous variables and the national institutions as the external variables. Since the institutions vary widely across China and the importance of institutions varies across industries, I will limit the scope of the national institutions to those which are highly relevant to China’s pharmaceutical industry or enterprises. It is very important to keep in mind that external conditions can be transformed into internal variables, namely, as the growth of local enterprises, local entrepreneurs have the ability to influence on the nation-level policymaking institutions. I will explain this in the last chapter. Firm is viewed as an organizational form in my dissertation, since the work definition of firms here is a legally independent economic unit which can operate across regions to produce goods or provide services. I view a firm with multiple plants as one entity. So just as I have already mentioned, I limit the scope of pharmaceutical firms (or enterprises) to the manufacturing organization, excluding the commercial organization in the field of the pharmaceutical sector (e.g. wholesale drug stations or companies), in my empirical study on Tonghua city.

Generally speaking, there are mainly two types of technology for firms: (1) technologies of production (technological innovation), which focus on improving a product or service and innovation on new production, producing process and quality; (2) technologies of operational management (organizational innovation), which focus on improving internal business, for example, new business process innovation or redistribution of management powers. Because firm organizational innovation that happed in the past 60 years in China is subject to changes of macro national institutions in the context of China's transitional period, I will take in account changes in macro national institutions (see Chapter 3) in China in studying organizational innovation (see Chapter 6). In the Chapter 8, I will focus on technological innovation. According to the innovative degree and the way of innovation, we can differentiate radical innovation and incremental innovation. The former — associated with high uncertainties — explores a new (technological or organizational) change and is highly uncertain, while the latter is to exploit an existing technology or organization, with low levels of uncertainties. In studying both technological innovation and organizational innovation, I will examine whether their respective change dynamics originates from radical innovation or incremental innovation.

(2) The Reasons of Focusing on Institution and Technology

Before going to explain why I focus on institution and technology, I have to say that there are other factors, for example market, which also coevolve with firms or industries. But these factors could be created through collaboration between firm, institution and technology. Therefore, I will focus on institution and technology, besides firms, based on the following reasons. Firstly, both institution and technology are very important for economic development. Secondly, both institution and technology are at the center of evolutionary economics and evolutionary economic geography. Since this first reason has been explained in the literature on economic growth, institutional economics and technological economics, I will turn to the second point.

The dialogue between institutional economics and contemporary evolutionary economics has recently emerged (for an overview on this point, see Brette, 2006 and Liu, 2006). In Nelson and Winter's evolutionary approach to economy, they first emphasized the role of technology in economic evolution[9] but subsequently, some prominent economic 'evolutionists' (including Nelson himself) have increasingly been aware that it is necessary to bring economic institutions to evolutionary theory (Nelson, 2002; Pelikan, 2003). In the realm of institutional economics, the evolutionary approach

[9] Different from Nelson and Winter, Freeman paid more attention to instutitions at the very beginning of his studying the catch-up efforts of East Asian (for example, Freeman, 1987, 1988).

has received a welcome. For example Geoffrey M. Hodgson, a commonly recognized prominent scholar of old institutional economics has some highly cited publications on evolutionary economics; at the same time, another elite scholar of new institutional economics, Douglass C. North also is expressly concerned with the historical-evolutionary character of institutions (for example, North 1990). Though North never explicitly used the principle of evolutionary economics, his outstanding research on institutional change is very helpful for a potentially fruitful conversation between institutional economics and evolutionary thinking.

The co-evolution of institution and technology has recentlybecome one of the hot topics in the realm of (evolutionary) economics, as I discussed above. Economic geographers, on the one hand, take advantage of the evolutionary approach to better understand the dynamics of regional development (for example, Boschma and Lambooy, 1999; Boschma and Frenken, 2003; Boschma and Frenken, 2006a), and on the other hand, make use of the core ideas and concepts such as the concepts of "lock-ins", "embeddness" and "social network" from institutional economics or so-called institutional sociology to reveal a complexity of temporalities and spatialities in the development path of enterprises, industries and regions (for example, Schamp, 2000, 2002, 2005; Boschma and Frenken, 2009). They argue that the territorial difference in economic performance is highly associated with the differences in institutions in the forms of humanly devised formal law, informal social norms and socially connected networks among regional development agencies (Whitley, 1992; Saxenian, 1994; Gertler, 1995; Martin, 2000; Grabher, 1993).

1.3.3Why Pharmaceutical Industry

The pharmaceutical industry is both an old and a new industry. It went through eras of traditional medicine to chemical and recently biological technology. Before the discovery of manufactured medicinal compounds (new chemical entities) in the Second Half of the Nineteenth Century, people over the world made use of raw plants and minerals to protect from diseases (the epoch of natural pharmaceuticals). The nascent chemical industry was formed in the late nineteenth century in the Upper Rhine Valley near Basel, Switzerland when dyestuffs were found to have antiseptic properties. The German chemist Felix Hoffman (1868–1946), the often regarded leader of this phase of the industry, discovered aspirin in 1897 through adding a cluster of two extra carbon and five extra hydrogen atoms to a substance extracted from willow bark. A lot of today's international pharmaceutical giants, such as Hoffman-La Roche, Novartis[10],

[10] Novartis was later formed in the 1990s by the merger of Sandoz and Ciba Geigy

started out as Rhine-based family dyestuff and chemical companies. Nowadays, the pharmaceutical industry has been attracting fruitful achievements from biotechnology and information technology, which makes it no longer a single manufacturing industry but populated by a large number of entrepreneurial research-oriented firms, and is characterised by continually changing technologies and intense competition.

In the case of China, the pharmaceutical industry and its precursor, Traditional Chinese Medicine (TCM) industry, has a long and rich history. If we define pharmaceuticals as compounds manufactured for use as medicinal drugs (remedies), it can be dated back to 2735 BC and the Chinese Dynasty of Shen Nung. Since that, TCM had been an exclusive solution to keep healthy and cure diseases for a long time till the latter half of the 19th century when Western (chemical) medicine was introduced into China. Nowadays, the old way to treat various diseases is still of great importance in the double systems of Chinese and Western medicine. Traditional Chinese Medicine (TCM) is a comprehensive system of medical thought, pathophysiological concepts, and a range of therapeutic practices. Traditional medical practices of TCM includes herbal medicine, acupuncture and moxibustion, Tui Na (the ancient Chinese massage), and Qi Gong (the practice of energy movement in the body through physical movement). Herbal medicine is the primary therapeutic modality of internal medicine in TCM. The concept of TCM I will use refers merely to herbal medicine, excluding the other three forms of TCM. TCM industry denotes the industry of manufacturing herbal medicine, i.e. the commercial sector for TCM drugs is not included in my study. Currently, China’s TCM industry has changed its traditional handmade mode to modern machine production mode. In recent years, especially since the 1980s (the Dengist period), TCM enterprises have invested into research on new TCM durgs based on formal research and development.

Today, China has become a large nation of pharmaceuticals manufacturing and consumption, hosting a number of foreign pharmaceutical enterprises. After 30 years of market-oriented economic reform, China’s pharmaceutical industry started to manifest an internationally observed trend that this sector is geographically concentrated, for example, in San Francisco, USA, BioTech Munich, Germany, and Cambridge-SE, England. In China, the pharmaceutical industry has been going ceaselessly ahead, and some areas in China, such as Beijing (biotechnological pharmaceuticals), Shanghai, and Hangzhou in Zhejiang (Chemical pharmaceuticals), Tonghua in Jilin (Traditional Chinese Medicine, TCM) made great achievements in the industries. But it is still at its early stage of development, and there are many competing hypotheses about its future development. We have a limited understanding of the process of cluster formation. Keeping in mind the industrial difference inside pharmaceutical industry, I limit the pharmaceutical industry to be study here to its sub-sector of TCM. I believe that my founding would be helpful to contribute to understanding temporal–spatial peculiarity of industrial evolution.

Moreover, the pharmaceutical industry is a highly regulated industry. As a result, the legal, regulatory factors restrict its dynamism. At the same time, biotechnology seems to offer developing countries a new opportunity to enhance economic performance and enter knowledge and information society. Various forms of biomedical and (bio) pharmaceutical industrial parks have been emerging in various countries, without the exception of China. In the case, it is feasible to research the role of institutions and government in the emergence of biotech industries in a region.

In short, the pharmaceutical industry, and its subsector of TCM, is characterised by continuous change, in terms of technology, firm organization and geographical distribution. At the same time, it is subject to the national and local regulations. These facts together offer us a good case industry, by which we can better understand the interactive impacts of technology, institution and firm on each other.

1.4 Structure of the Dissertation

This dissertation is organized as follows. the Chapter 2 construct the theoretical framework of the coevolutionary process approach to industrial cluster, which starts with basic questions of what is history and what kind of history evolutionary economic geography needs. This framework provides a “philosophical foundation” for coevolution, based on which history is understood as context. Path inter-dependence (co-evolution between paths) is a useful concept used to understand the complexity of history. Furthermore, I will explain why we need to shift to study coevolution and why we need a focus on the geographical mosaic of coevolution, and why we should take the industrial cluster as meso-level in studying coevolutionary processes of firm, institution and technology. In doing so, I will develop two terms to examine coevolutionary degree and effects.

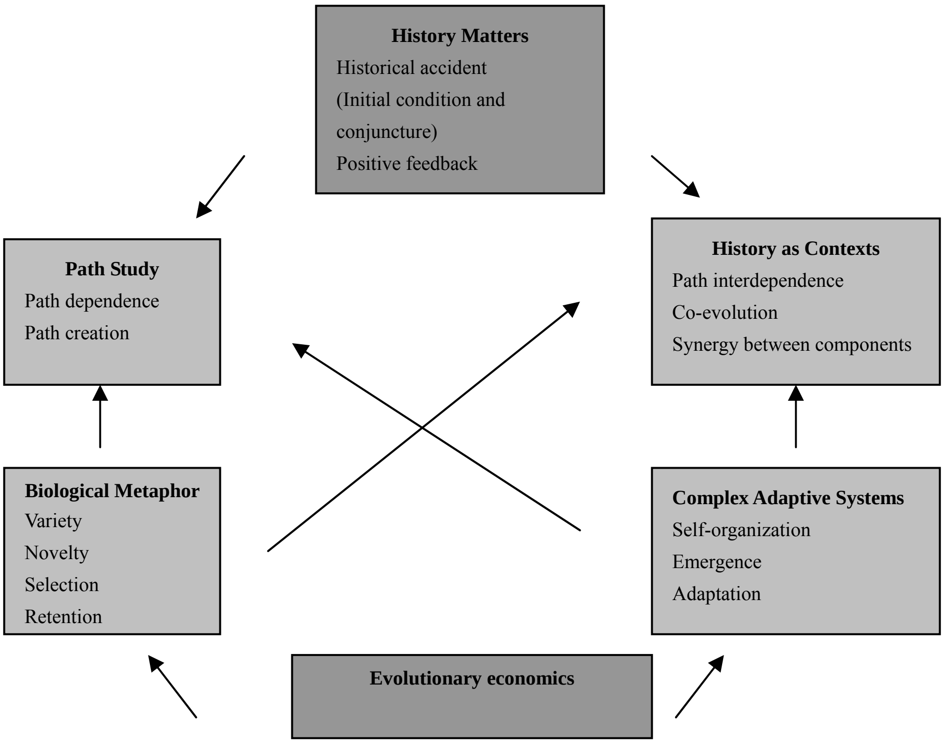

Figure 1.1 The theoretical base for a coevolutionary approach

In Chapter 3, I introduce the macro-environment, in order to help readers to understand changing China's pharmaceutical industry, by focusing on national institutions that have had a great impact on new venture creation, entrepreneurship, and innovation, and registrations on drug and healthcare system. At the same time, present the growth of market demand for China's pharmaceutical industry is presented in this chapter. Finally, the history and geographical patterns of China's pharmaceutical industry is also introduced.

In the next four chapters, after a short overview of Tonghua's pharmaceutical industrial cluster, I employ the methodology of business history and field survey to collect evidence of three threads, and their respective evolutionary histories, i.e., firstly, the history of the enterprises, secondly, the origin of entrepreneurship, and, thirdly, the evolution of knowledge. The last chapter examines coadaption and coevolution between local formal and informal institutions and organizations, and organizations in the Tonghua TCM industry.

Chapter 2 The Theoretical Base for Coevolution in Industrial Clusters

2.1 Making a Place for History in (Evolutionary) Economic Geography

2.1.1 The "Historical Turn" in Social Science

A "historical turn" has recently begun to emerge in the social sciences as a whole (McDonald, 1996; Pierson, 2004), which is more or less related to the revival of Darwinism[11] in social science, new advances in computer science, complexity science, and thermodynamics. The "historical turn" in social sciences indicates to a certain extent indicates a rise of interest in evolutionary dynamics across natural science. A clear evidence for this is an increasing tendency of employing concepts and terminologies such as "path dependence", "process", "sequence", "dynamics", "mechanism", and so on in recent literatures. This turn addresses big, substantive questions of how the system (e.g. economy, institution or culture) evolves, and takes time seriously, traces transformations and processes of varying scale and temporality, as well as specifies temporal and spatial sequences. It likewise makes an effort not only to bridge the gap between macro contexts (e.g. social environments, institutions) and micro individuals (e.g. firms), but also hypothesizes a time-consuming process between macro and micro levels rather than examining just one institution or process at a time. These three features – substantive agendas, temporal arguments, and attention to contexts, and configurations – add up to a recognizable historical-context approach which would make a significant contribution to our understandings of the relationship between the past and the present.

Indeed, the importance of history and taking time or process seriously is not newly perceived by social scientists. A historical analysis approach has long been used in the social sciences. As Mahoney and Rueschemeyer (2003, p: 3) pointed out: "*Those whom we now regard as the founders of modern social science, from Adam Smith to Alexis de Tocqueville to Karl Marx, all pursued historical analysis as a central mode of investigation*". Even when social sciences entered an epoch of separate disciplines in the early twentieth century, historical investigation still maintained a leading position in economics. For example, Joseph Schumpeter, who is widely acknowledged today as

[11] Since Darwinism was mistakenly regarded as the natural theoretical base for notorious racialism, it has been rejected for a long time after World War II.

one of the forerunner of evolutionary economics, adopted a more historical and empirical approach in nearly all his works (McCraw, 2006), and made a plea that "*economic historians and economic theorists can make an interesting and socially valuable journey together, if they will. It would be an investigation into the sadly neglected area of economic change*." (Schumpeter, 1947, p: 149). Unfortunately, other approaches to social sciences partially eclipsed historical research after neoclassical theory gained absolute dominance in economics around the mid-twentieth century (Mahoney and Rueschemeyer, 2003).

After a long period of neglect, the recent two decades have witnessed a dramatic reemergence of the historical and dynamic tradition. Though there are problems and dangers, not least concerning the scope and limits of methodological triangulation, this revived wave of history-oriented research has been making constant efforts to bring itself back to the center of today's social sciences, which is helpful as a whole for our understanding in the complicated world.

Today, the perspective of historical turn is slowly penetrating into a lot of disciplines in social sciences, including anthropology (Thomas, 1989), sociology (e.g. Somers, 1996; McDonald, 1996; Abbott, 2001; Mahoney and Rueschemeyer, 2003; Saldana, 2003; Pierson, 2004), policy sciences (e.g. Howlett and Rayner, 2006), politics (e.g. Pierson et al., 2002; Robert and Tilly, 2006; Pierson, 2000), literary theory (e.g. Myers, 1998, 1999), economics (e.g. Hodgson, 2001), business study (Lamoreaux et al., 2008) and organizational analysis (Clark and Rowlinson, 2004).

This significant transformation of the intellectual agenda in social sciences is apparent, which is evidenced by, for example, the appearance of the "new historicism" in literary criticism and literary theory (e.g. Greenblatt, 1982; Cox and Larry, 1993), a revived interest in "history in philosophy"(e.g. Hare, 1988; Lavine and Tejera, 1989), a historically oriented "new institutionalism" economics (prominent scholars here would include Robert Fogel and Douglas North), and political science (e.g. Dryzek et al., 1988; Pierson, 2004; Thelen, 1999; Tilly, 2006), the coming back of "evolutionism" to economics (e.g. Nelson and Winter, 1982; Witt, 1993a; Metcalfe, 1998), "ethnohistory" in anthropology (e.g. Thomas, 1989; Rubertone, 2000; Nicholas, 1996); "historical sociology" in sociology (e.g. Abbott, 1995; Smith, 1991), and even a more self-consciously reflexive and historicist methodological discussion in history itself (see McDonald, 1996).

Although there are variations inside history-oriented research in social sciences, even in some basic and fundamental issues, four characteristics existed as a whole. (1) Comparative research method is often used in historical study. Scholars in historical studies usually start by asking about various historically situated outcomes of broad interest – perhaps posing a puzzle about why something important happened or not, or asking why certain structures or patterns were shaped in some times and places but not others (Pierson and Skocpol, 2002). Douglass C. North, for example, explored a long-run institutional change – the role of economic institutions and political structure in producing modern economic growth – by asking why some nations succeeded even within Western Europe (The Netherlands and England) while others failed (Spain and Portugal); (2) Their main research question in general is to answer "how economic, political, social systems evolve through time". That is, historical scholars devote themselves to a better and more "true" understanding of social, economic and political change and transformation, although they sometimes employ various concepts and theories with diverse theoretical directions and frameworks. Again, for instance, North contributed to the understanding of institutional change in economic growth (for the contribution of Douglass C. North to economic theory, see Myhrman and Weingast,1994)[12]; whereas evolutionary-economists such as Richard R. Nelson and Sidney G. Winter also explored economic change, firstly focusing on technological change, recently also beginning to touch institutional evolution; (3) The principle of "history matters", or some variations of it including "sequence matters", or "the past influences the future", has been basically recognized by scholars in the historical traditional line, although different viewpoints of history or alternative models of historical sequencing coexist (Howlett and Rayner 2006)[13]. Those who have argued that "history matters" have challenged this general conception of the historical temporality of social processes, and insisted that change or its outcomes in the economic, legal and social system is much more contingent rather than deterministic. The sources of contingency are not only individual actions in a given environment, but also more structural factors like historical timing or the "ordering" of relevant events (Howlett and Rayner, 2006; Pierson, 2000); (4) Scholars under the umbrella of historical analysis do not merely look at what happened in the past, and their processes, but immerse

[12] But North limits himself in the undertaking of modifying neo-classical theory, Nelson and Winter go further and rejected the framework and core hypothesises of Neoclassical economics.

[13] Howlett and Rayner (2006) evaluate four general models of historical change processes which have emerged in various fields in the social sciences – namely stochastic, historical narrative, path dependency and process sequencing.

themselves more into exploring particularly temporal relationships among variables. This means that they not only made historically-grounded investigations, but also readily developed a sharper and broader explanation of the origins, variety, and dynamics of systems of economy, technology, and regulation. To do so, in the case of studies in path dependence, identification of crucial events (like initial conditions, critical juncture and their corresponding results) is of much importance (Pierson, 2000; Mahoney, 2000). In other words, the timing and sequencing of significant events and the genesis of variety indicate a great deal for scholars who devote themselves to historical or evolutionary study.

2.1.2 Bringing History to Economic Geography

In one sense, the recent emerging evolutionary thinking in economic geography and economics (David, 2001) can be seen as or a part of a broader, more catholic intellectual turn of a quest of history in social sciences. Accordingly, I find it useful to devote a few lines to historical thinking in economic geography.

(1) Historical Thinking in the Economic Geography

There is a long and distinguished history of historical thinking in the field of economic geography[14] and some economic branches such as development economics. For instance, in German geography, there is also a historical school, 'Kulturlandschaftsgenese' up to the present which is a kind of path dependence investigation of cultural landscapes (Schamp, 1996). Martin and Sunley (2006, 2009) and MacKinnon (2008) have identified the history of history thinking in this theorizing line, but they reduced the historical turn in economic geography and regional development sciences to "path dependence thinking"[15], which narrows down the meaning of the concept of history. Here I will outline the main theoretical approaches that have ever involved into this wave of the "historical turn", based on previous

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[14] Because of the fuzzy boundary of economic geography and the strong influence of some economics (for example development economics in 1950s, and New Economic Geography pioneered by Krugman and Fujita) on economic geography, the term of economic geography I use here includes "economic geography", development economics to some degree, regional science and other subjects that study spatial and geographical issues of economic activities. As to New Economic Geography, I totally agree with Martin that New Economic Geography's models (the work of Krugman as representative) are better characterised as economics than as geography (Martin, 1999), actually Krugman himself never claims that he is a geographer, but considering that New Economic Geography also deal with geographical issues, for instance, economic agglomeration in geographical space, and the core-periphery structure of the global economy (see Fujita and Krugman 2004), and deepened our outstanding, New Economic Geography could be included.

[15] Evidently, the problem of the replacement of "history matters" by path dependence study is associated with a fundamental question of "what is history" and "can historical study be reduced to the path study". Briefly speaking, my argument is that path dependence study is merely a small piece of the grand field of history-oriented research. I will go back to this problem later.

studies, including Martin and Sunley (2006, 2009), MacKinnon (2008), and Schamp (1996).

In the 1950s and 1960s, Myrdal, Hirschman, Kaldor and others, who were influenced by Thorstein Veblen, explained uneven spatial development with the concept of cumulative causation (O'Hara, 2002; MacKinnon, 2008). The research on industry life cycles (see Chapman, 1992) which is a concept derived from the product cycle model (Vernon, 1966), could be probably included in this wave as well. Marxist economic geography in the 1980s, which views uneven regional development as a historical process, is also a remarkable school in the wave of 'historical turn'. Massey (1984) argued that the new spatial divisions of labour, partly resulted from economic imperatives, are determined by broad changes in social and political struggle and transformation; and that the legacies of its past exert an influence on the present and future development (see, Martin and Sunley, 2009). Inspired by Marx' concept of "surplus capital", Harvey used (is still using) a similar terminology of 'spatial fix' based on his approach of "historical-geographical materialism" to explain the instability and geo-political dynamics of capitalism (Harvey, 1982, 1985, 2006). But this research was too concerned with changing forms of uneven development over time rather than directly focusing on evolutionary processes (Boschma and Martin, 2007; MacKinnon, 2008).

The contemporary economic geographers have also been swept up in this wave of 'historical thinking'. A number of leading theorists in the subject have argued that "history dependence" is one of the fundamental features of the economic landscape. For example, Storper and Walker stated that "*Localized technological change in an industry can be understood, like all industrial development, as an evolutionary path in which each step moves one way from a past that cannot be recovered and that limits future directions"* (1989, p. 113). Richard Walker (2001) himself further explained that:

> "*One of the most exciting ideas in contemporary economic geography is that industrial history is literally embodied in the present. That is, choices made in the past – technologies embodied in machinery and product design, firm assets gained as patents or specific competencies, or labour skills acquired through learning – influence subsequent choices of method, designs, and practices.… It does not mean a rigid sequence determined by technology and the past, but a road map in which an established direction leads more easily one way than another – and wholesale reversals are difficult. This logic applies to industrial locations as well…" (p: 126).*

Allen Scott (2006) has a similar argument that any attempt to understand the economic landscape

> *"must formulate the problem by reference to a dynamic of cumulative causation whose logic is definable not in terms of some primum mobile or first cause, but in terms of its own historical momentum. This… points… to the importance of an ontology of regional growth and development that is rooted in the idea of path dependent economic evolution and cumulative causation." (p: 85).*

There are two distinct terms of "economic geography" to treat history in understanding the significance of history in economic landscape. One is the 'new economics geography' (NEG), associated particularly with the economist Paul Krugman (for example, Krugman, 1991a; 1991b). The other is "Evolutionary Economic Geography", which is fundamentally different in basic standpoints from the former. Advocators of NEG recognise that 'history matters' in regional convergence and divergence processes and their models incorporate notions of path dependence, increasing returns as well (for a more detailed review, see Martin and Sunley, 2006). For example, Krugman emphasizes the importance of history in explaining observed patterns of industry location and growth in the sense of initial location patterns which then become locked in by path-dependence generated by processes of cumulative causation: "*The long shadow cast by history and accident over the location of production is apparent at all scales, from the smallest to the largest … this clear dependence on history is the most convincing evidence available that we live in an economy closer to Kaldor's vision of a dynamic world driven by cumulative processes than to the standard constant-returns model*" (Krugman, 1991a, p: 9-10). However, history (as his concept of geography) is an abstract notion in Krugman's formal models of urban agglomerations or regional production systems. Namely, in the model of NEG, history is oversimplified to "small historical accidents", there is little attention paid to history in the sense of change and development, as Martin and Sunley (1996) have pointed out: "*He claims that the same broad locational forces which explain the growth of nineteenth-century concentrations also underlie the continued tendency to agglomeration. Indeed, this is one reason why he is reluctant to emphasize technological spillovers as a key determinant of contemporary clusters.*" (Martin and Sunley, 1996, p: 269). Furthermore, new geographical economics still retains some conceptual apparatus of mainstream (orthodox) economics, requiring explanations based on methodological individualism, full information, utility-maximizing individuals and profit maximizing firms [16](Scott, 2006; p:60; also see Martin 1999). Accordingly, Krugman's approach can be considered as a recent extension of neoclassical thought to explain trade, specialization and agglomeration, relaxing the frequently used assumptions of perfect competition and constant returns to scale (Boschma and Frenken, 2006a), questions such as the changing balance between the spatial concentration and dispersal of industries over time are the main issue of attention rather than evolution per se.

Evolutionary economic geography claims even more emphatically that its basic concern is with "*the processes by which the economic landscape – the spatial organization of economic production, distribution and consumption – is transformed over* (real, I add) *time.….is both with the ways in which the forces making for economic change, adaptation and novelty shape and reshape the geographies of production, distribution and consumption, and with how the spatial structures and features so produced themselves feed back to influence the forces driving economic evolution*" (Boschma and Martin, 2007, p: 3), so it can be seen as part of the broader "historical turn" in social sciences. This new school of economic geography theory which derived from evolutionary economics and complexity science (Boschma and Martin, 2007; Martin and Sunley 2007), makes efforts to better understand uneven development and adaptive transformation of the economic landscape over time. This new approach blends Nelson and Winter's evolutionary theory of the firm, Generalised Darwinism based on the evolutionary principles of variety, selection and retention (Essletzbichler and Rigby, 2007), concepts such as path dependence (Martin and Sunley, 2006) and coevolution (Schamp, 2009), and self-organization in complexity theory (see, Martin and Sunley, 2007). Evolutionary economic geography, based on more realistic assumptions concerning the agent (bounded rationality, imperfect information) tries to understand the historical far-from-equilibrium process or dynamics of changing economic landscape. Although the institutional economic geography and relational economic geography also admit the importance of history in the formation and evolution of institutions and social networks, they are silent on the dynamic process of

[16] Marchionni distinguished between realism and realisticness and argued that despite of the above mentioned "unrealistic assumptions" of geographical economics, their representations of the core of real-world phenomena might nonetheless be approximately true (Marchionni, 2004, p. 1742).What is I have to say is that the attitude of economic geographers to new economic geography should be more tolerant, not acridly captious and endless attack, because new economic geography is the only friendly field in economics to geography which attempts to incorporate the role of space into conventional economics. A friendly and tolerant dialogue atmosphere in which distinct theoretical, methodological and epistemological genres can be accommodated is conducive to deepen our understanding of the geography in economy, which is a joint mission of economists in new economic geography and geographers.

economic landscape, at least not evidently. Hence, evolutionary economic geography could be the only one ‘evolutionary school’ in economic geography, which really contributes to understand a historical and non-equilibrium process of changing economic landscape. Here, I must stress that what is new in evolutionary economic geography is not its research contents, but a special perspective; i.e. the evolutionary perspective opens up a new way of thinking about what is arguably the central concern of economic geographers – firm location, uneven geographical distribution of economic activities[17] (Boschma and Martin, 2007, p: 2). At the same time, just as Boschma and Martin (2007) and Boschma and Frenken (2006a) said, evolutionary economic geography is still under construction, we have a lot to do until it becomes an established field. This section of my dissertation tries to construct the historical methodology for evolutionary economic geography, by elevating history to the methodological foundation of evolutionary economic geography, on which concrete research methods should be based. Before discussing on what kind of history evolutionary economic geography needs, I would like to illuminate how important it is to introduce history into economic geography, both theoretically and methodologically; and how to avoid the risk of over-emphasis to empirical and historical evidences.

(2) Significance of Bringing History into Economic Geography

The significance of bringing history into economic geography lies in at least three aspects. Firstly, history is one of the main intellectual sources, for both theorists and policy makers. As Schumpeter advised us 50 years ago, “*Nobody can hope to understand the economic phenomena of any epoch, including the present, who has not an adequate command of historical facts and an adequate amount of historical sense or of what may be described as historical experience.*” (Schumpeter, 1954, p: 12). At the same time, history can allow us to see how economic change occurs through the changing relationship between economic and non-economic variables; the inspiration from history could be helpful when we are confronted with the uncertain future.

Secondly, notwithstanding economic geography today is optimistically viewed as a rising star of the social sciences (see, Ashby, Monk and Monk, 2007), it looks still like a clumsy dwarf standing by the giant of economics. That is related to the fact, at least to

[17] Boschma and Frenken (2006) argued that the key issues addressed in evolutionary economic geography are the spatial evolution of firm dynamics, the spatial evolution of clusters, the spatial evolution of industries, the spatial evolution of networks and the evolution of urban/regional systems. However, I would like to add the evolution of institutions at these three levels of aggregation to the key issues of evolutionary approach to economic geography. My added issue has begun to be the recent research focus of evolutionary economic geographers, for instance Boschma and Frenken (2009) and Schamp (2005).

some degree, that economic geographers have not devoted much to historicity or temporality of economic geography for a long time (maybe Marxist economic geography in the 1980s is one exception). Regional or geographical speciality, rather than general and abstract economic theoretical questions, has been at the heart of economic geography. Temporality is also an important dimension of any entity, equally important to spatiality. More attention to history would be helpful to elevate economic geography to the status of a real star of the social sciences.

Last but not least, bringing history into evolutionary economic geography is meaningful for methodology. Methodology here refers to the rationales and the philosophical assumptions that underlie a particular study and data collection, rather than specific scientific methods. I agree that diversified theoretical approaches and analysis tools can co-exist in evolutionary approach, but they should be built on a fundamentally unified methodology. Methodologically, the historical research method is the foremost important approach of the evolutionary economic geography. Murmann's book (2003) *"knowledge and competitive advantage: the coevolution of firms, technology, and national institutions*", gave an outstanding example[18]. In short, the quest for change and transformation of economy should be based on the utilization of historical evidence, and focus on a dynamic process. Accordingly, bringing history into economic geography could make a valuable contribution to the construction of "historical" methodology and evolutionary economic geography.

(3) A Historical Lesson for "Being Historical" in Economic Geography

The major theoretical sources of evolutionary economic geography seem to be more and more obvious. For example, two advocators of evolutionary economic geography, Ron Boschma and Ron Martin, believe that both Darwinian evolutionary theory (variety, selection, retention and the like) and complexity theory (emergence, self-organization, dissipation, criticality, 'far-from-equilibrium', co-evolution) would be main intellectual sources for constructing this new school of evolutionary economic geography (see Boschma and Martin, 2007; Martin and Sunley 2007). There is however a debate within evolutionary economics itself about its theoretical sources and precursors[19]. And so the discussion continues. No evolutionary scholars, however, can

[18] Comparative historical research method might be a more appropriate term for Murmann's study. My argument here is historical research method is more important than a comparative one, methodologically, for that study of process.

[19] For this debate, see Hodgson (1993), Witt (2003), Metcalfe (1998), among others. The commonly acknowledged forerunner of evolutionary economics might include C. Darwin, K. Marx, E Engel, H. Spencer, A. Marshall and Carl Menger, and T. Veblen, J. Schumpeter, and E Hayek, and Schumpeter. It is worth noting, nobody of the pre-Nelson/Winter (1982) economist prepared a comprehensive theory for explaining the evolution of Economy.

deny that the German Historical School of Economics has had a heavy influence on evolutionary economics, through Schumpeter (Reinert, 2000; Reinert and Daastøl, 1997; for a detailed explanation, also see Michaelides and Milios, 2008), and even today this old school is still nourishing evolutionary scholars.

In fact we can find that their writings on evolutionary economics and German historical school of economics have several common characteristics, including minimal explicit reliance on mathematics, rejection of universal laws and principles and more emphasis on spatio-temporal specificity of economic theory, abjuration of atomism and reductionism, and predilection for holism and organicism. My motivation here is not to make a detailed explanation of the historical influence of the German historical school on evolutionary economics (see, Hodgson, 1993, 2001; also Shionoya, 2001; Howey, 1982, for this topic)[20], but to stress that the German historical school of economics not only offers theoretical inspirations, but also would give methodological illuminations for evolutionary study, in both economics and geography. Now I will turn to another issue, the methodological illuminations from the German historical school and her followers.

I believe that there are at least two points as follows: (1) The German historical school rejected the universal validity of economic theorems and insisted on the historical (and, we might add, geographical, because German Historical School places emphasis on nation- specific policy) specificity of economic theorems; evolutionary thinking also views economy as contexts-specific (including culture-spatio-temporal-specific). Evolutionary scholars should equally have a sense of history as German historical economists. (2) The German historical school heavily critiqued the deductive approach of the classical economists, especially the writings of David Ricardo, and employed abundant historical material to make careful empirical and historical analysis. They denied what Schumpeter later called "*the Ricardian vice*" (Schumpeter 1954, p: 569). The Ricardian vice is prevalent in economics, named after David Ricardo, one of the first economists to bring mathematical rigor to the discipline, and refers to the

[20] The German historical school has ever had so wide influence in history. For example, it had in part contributed to the emerging American institutional economists in the early part of the twentieth century (Hodgson, 2001, p.xüi), but also it exercised an influence on today's economics, particularly so-called heterodox economics such as evolutionary economics. Heterodox economics normally refer to a category of unorthodox economic traditions or schools. Orthodox economics is "mainstream economics" or the Walrasian tradition which has largely developed from the neoclassical economics in the late 19th century, benchmark by Alfred Marshall. Today, Heterodox economics include Post-Keynesian economics, (old) Institutional and Evolutionary, Behavioral, Ecological, Feminist, Social, Socio, Marxist, Radical Marxian and Austrian economics. For more information, see the Heterodox Economics Web, http://www.orgs.bucknell.edu/afee/hetecon.htm.

tendency for economists to introducing utterly bold assumptions into an already oversimplified representation of the complex economy and resulting in theories that are mathematically beautiful but largely useless for practical applications. By the way, we should note here that mathematical method as a tool is good for understanding the economic laws; and what is actually against is the abuse of mathematics, namely, abstract model-building and mathematical formulas with unrealistic assumptions and too much dependence on mathematics. But we can't go to another extreme – what we might call "*the vice of historians*" – over-attention to empirical and historical evidences, and blindly rejecting generalizing economic laws. In this sense, evolutionary scholars should have enough historical knowledge and depend more on historical evidences, meanwhile should shake off a vice of indulging ourselves with countless historical data.

2.1.3 "Being Historical" and Evolutionary Economic Geography

(1) Evolutionary Study Needs History

Evolutionary economics as heterodox economics has borrowed some biological metaphors from natural sciences and employed population thinking and systematic thinking to study economic processes of economy instead of its final results. Evolutionary scholars, both in economics and economic geography, state that novelty (innovation) is the fundamental driving force of economic changes. Thus, evolutionary economists participate in research on issues in the range of innovation-related fields including, but not limited to industrial evolution, national innovation system, etc. Economic geography, as a field of study on the uneven distribution of economic activities in space, surely has made an attempt to apply evolutionary economics into economic geography to probe into the changes in economic landscape.

Evolutionary economics focuses on the processes rather than consequences (Witt 1993b; Shiozawa, 2004). Witt (2002, p: 10)[21] summarizes the main characteristics of evolutionary economics, which, in my opinion, can be partly applied to evolutionary economic geography, as follows: (1) historical: it concentrates on historical processes and transitions from one state to another over time which are irrevocable and path-dependent (Witt, 2002, p: 10); (2) dynamic: an evolutionary explanation needs to

[21] Aside from the previous two characteristics I have already quoted here, an additional one in Witt (2002) work is self-transformation explaining—in that it includes hypotheses relating to the source and driving force of the self-transformation of the system. But my argument for this point is that the system thinking canot be viewed as a common feature that all branches in evolutionary economics share, because part of evolutionary economist employ biological analogy. For the detailed explanation, see Chapter 2.2.1.

identify units of transmission, sources of variation, mechanisms and processes of transformation, and sources of isolation (Durhan, 1991, p: 22); (3) another characteristic should be added specifically for economic geography, namely, geographical. In contrast to evolutionary economics which to a large extent ignores the dimension of "geography" of the evolution of systems (with the exception of a few innovation system scholars, for example, Lundvall, 1988), evolutionary economic geography "*takes history and geography seriously by recognizing the importance of place-specific elements and processes to explain broader spatial patterns of technology evolution*" (Essletzbichler and Winther, 1999, p: 180). In sum, "being historical" and "being geographical" are two necessary conditions, while "being dynamic" is the sufficient condition of evolutionary economic geography. Thus, "being historical" is quite indispensable to evolutionary study.

(2) A Crisis in the Methodological Construction of Economic Geography

Over the last couples of years, economic geographers and economists have started to make joint efforts to deal with geographical issues. During the dialogues between two camps, geographers learned much more from economists than economists from them. The international community of economic geographers has recently made a large number of theoretical achievements and empirical work that can't be neglected even by economists. Unfortunately，the methodological issue of economic geography was hitherto taken less into consideration (but with a few exceptions. e.g. Clark, 1998; Yeung, 1997, 2003; Markusen, 1995; Schoenberger, 2001, and Tickell et al., 2007).

Just as Trevor Barnes and his colleagues said in their new book "*Politics and Practice in Economic Geography*", in the last two decades "*economic geography has passed through a series of far-reaching cultural, institutional and relational 'turns*' " (evolutionary could be added to here). However, its objects, subjects, means of study and research practices have been repeatedly overhauled, but, questions of method – the how and why of research – have been only fitfully (re)considered (Tickell et. al, 2007, p: 2). The lack of methodological consideration will definitely be a big danger to the advance of economic geography.

Methodology in scientific research plays an equally important role as philosophical and epistemological foundation, and the construction of basic concepts. Any subject or school neglects its methodological construction, especially at its very beginning; thus, it will be involved into a disadvantageous situation in the competition of scientific concepts. If we take a look at different fates of economic geography and economics, we can understand the importance. Economics has already become imperialistic today while economic geography had descended to a clumsy dwarf standing by the economic giant. Economists concern more about methodology than geographers, from the very start. Classic economists, from Smith to Marshall to Schumpeter, perceived the importance of methodology. Schumpeter's *history of economic analysis* (1954*)* is one of the best illuminations of attempted efforts to offer systemic research methods for economics. In addition, methodological debate in economics has never stopped. It is the constant methodological fights that accelerated the advance of economics, at least partially. However, economic geographers seem to forget this momentous mission. This may be partly explained why economic geography is at the crossroads, and why it is embarrassing when economics and sociology break into its territory.

Accordingly, back to the recently developed but potentially promising school in economic geography, what evolutionary economic geographers should urgently do at the start is not only to construct a theoretical framework (associated mainly with the work of Ron Boschma and his colleagues (for example, Koen Frenken), Eike.W.Schamp and Jurgen Essletzbichler, Ron Martin), conceptual reconstruction (benchmarked by Ron Martin and Eike.W.Schamp) and empirical work (in the case of spinoff, e.g. Steven Klepper), but also to make methodological reflection. I believe that historical methodology would be useful for evolutionary economic geography, and this mission of constructing of historical methodology is very pressing. Now I turn to the discussion on what kind of methodology evolutionary economic geography needs.

(3) Research Methods in Evolutionary Economic Geography

Evolutionary economic geography, rooted in economic geography and partially in economics and social economics, deals with issues regarding spatial evolution over time at micro, meso and macro levels, and calls for analytical innovations to better grasp the specificities of spatial changing processes at different levels over time. Due to the complexity of its study objectives, evolutionary economic geography relies on a combination of many research methods (Boschma and Frenken, 2006a, 2006b). The literature pools a wide set of very different contributions, including in-depth case studies (Garnsey and Heffernan, 2007), social network analysis (Glückler, 2007; Boschma and ter Wal, 2007; Giuliani, 2007, 2008), spatial econometrics (Essletzbichler, 2007; Rigby and Essletzbichler, 1997), data envelopment analysis (Jacob and Los, 2007), complexity theory (Sorenson et al., 2007), gravity modeling (Maggioni and Uberti, 2007), and etc.

Evolutionary economic geographers seem to open all research methods, including mathematical modeling and case study. However, such massive hybridization of multifarious methods has left evolutionary economic geography rather analytically adrift. The direct application of research methods without any reflective consideration is not unproblematic, thus geographers should apply concepts to geography with caution. In fact, the reconstruction of research methods is as important as the theoretical remaking of evolutionary concepts like Martin and Sunley (2006) and Schamp (2009) did. Since no methodology is a panacea, this principle of "no one fits all" can likewise be applied to methodology. Methodology in evolutionary economic geography should be diversified. The reason for the decline of the German Historical School in the Methodenstreit with Carl Menger and the Austrian School at the end of the 19th Century is that the German Historical School fell in absolutism that historical research method had absolute advantage over others. We should keep this lesson in mind and need other methodologies to complement the first and most important methodology of evolutionary approach.

(4) Methodological "Being Historical" for Evolutionary Economic Geography

Studying historical or evolutionary processes requires historical data, but the essential difference between historical studies and ahistorical studies is not whether historical data is used, but how to use historical data. Merely listing time series data does not lead to an evolutionary study. Ahistorical studies in which longitudinal data are also employed have rarely studied with an explicit concern for the mechanisms involved. The evolutionary approach cares more about an explication of the underlying mechanisms at work. This debate involves the following questions, what is "history", how to treat history, and how to study history.

To address these questions, we need to distinguish between historical methodology and historical method at first, which are partly related to each other but in fact are quite distinct concepts. The distinction would be useful for understanding what kinds of study under the label of evolutionary or historical is evolutionary economics or a really historical study in social sciences more generally. The historical method refers to the concrete techniques, by which the historians gather data (primary sources and other evidence) in quest of history. However, historical methodology is more than a simple set of methods; it refers to the rationale and the philosophical assumptions that underlie a particular study. The historical methodology is associated with two questions of what does history mean and how history is incorporated in economic model, since the historical evidence is never conclusive. Historical fact does not prove theory, while true-explanation is always hypothetical and fact is observed in the light of theory. Despite of the "under-determination of theory by evidence", science gets results in conformity with ground rules of method.

Defining the History

Collier and Mazzuca (2004, p: 473-374) summarize that time has four notions, taking history in political analysis as instance: firstly, history as *period* refers to the fact that phenomena are located within some socially defined interval of time; secondly, history as *conjuncture* indicates a temporal coincidence of a potentially limitless number of forces, actors, structures, and events, including the accidental and the contingent; thirdly, *timing,* namely, the fact that phenomena may occur in different sequences and with different temporal spreads; and the fourth temporal idea involves *changing over time*, including the unfolding of a series of different but interconnected events, the longitudinal trajectory of single factors, and the speed of a process or change.

Being in Historical Time

More importantly, the term 'historical' in historical analysis denotes historicity inherent in economic phenomena, which is common with the German Historical School. The distinction is not the one between history and theory, but rather the one between ahistorical study and historical study (see, Dopfer, 2001, p: 162). Foster summarized the difference between historical-evolutionary study and ahistorical one in saying that time irreversibility, absence of equilibrium, structural instability and fundamental uncertainty are features of historical processes, as stressed by many evolutionary economists, but they are not to be found in ahistorical biological analogies (Foster, 1997, p: 448-449, also Hodgson, 2002, p: 262). I want to say that the most basic distinction is the different viewpoint of time (or how to treat history).

Although some ahistorical studies have a series of historical events and temporal periods that can be measured by physical time-distance, ahistorical analysis can determine a time path, for instance "a continuous accumulation of capital, or a particular pattern of fluctuations" (Robinson, 1962, p: 23), this kind of study cares less about the temporal and causal ordering of phenomena unfolded over history, namely *longitudinal trajectory* that tracks changes of a single factor over time. This could be related to the temporal viewpoint of ahistorical studies. In ahistorical studies, all points in time are treated the same (*temporal homogeneity*), and disconnected from all other points (*non-history dependent*), which is defined by Robinson as "*the logical time*" (Robinson, 1962, 1979). In her contributions to time-in-economic- theory, Joan Robinson (1962, 1979) made a distinction between logical and historical time, addressing the problem of interpreting the historical process of accumulation as a movement from one equilibrium position to another, a sequence of equilibrium positions, or a progression along an equilibrium path (Harris, 2005, p: 93). In reference to the process of economic modeling, she claimed that, "*in a model depicting equilibrium positions there is no causation. It consists of a closed circle of simultaneous equations. The value of each element is entailed by the values of the rest.*" (Robinson, 1962, p: 26).

At any moment in logical time, "*the past is determined just as much as the future*" (Robinson, 1962, p: 26). In other words, "tomorrow" is always like the "past" and known for certainty (*temporal homogeneity* or *time reversibility)* in logical time. Therefore, decisions taken today in anticipation of future events are always confirmed by future events (*historical determinism*). As Robinson (1980, p: 219) pointed out, however, 'today' is influenced, but not completely bound, by the past. Any action or decision taken today is either the result of blind habit and convention or is directed towards its future consequences, which cannot yet be fully known (*history-dependent but not fully determined by history*). The viewpoint mirrors her idea of "historical time"[22]: "*In a historical model, causal relations have to be specified. Today is a break in time between an unknown future and an irrevocable past. What happens next will result from the interactions of the behaviour of human beings within the economy. Movement can only be forward.*" (Robinson, 1962, p: 26)

In historical time, the , 'arrow of time' points only one way (*irreversibility*), which means that there is strictly one-way traffic, time moves forward, and events occur in a uni-directional sequence in which *'today is a break in time between an unknown future and an irrevocable past*' (Robinson, 1962, p: 26). At any instant, the past is irrevocable

[22] The historical time in economic theory has a long and reputable history. For instance, an interest in the implications of historical time can be found in Austrian, and Institutional economics, Keynes and the Post-Keynesian school (Setterfield, 1995). Perhaps, it is true that no model can be truly faithful to being historical in a strict sense, partially because all models involve some level of abstraction, while history is so complicated that it is not impossible to be abstracted and decomposed, so all are unrealistic by definition. Nevertheless, some models may be less unrealistic than others by virtue of the types of abstractions they make, and also less ahistorical.

and the future in some sense open (Curry and Barnes, 1988, p: 146). Furthermore, *"any event occurring in the present exists in the context of a given and immutable series of prior events corresponding to the periods which make up the past."* (Setterfield, 1995, p: 3) and also is contextualized by current conditions.

History as Context

Historical study, just as Dopfer (2001, p: 161) addressed evolutionary analysis, is not truly 'history friendly' when it refers to context, which could be understood as what "surrounds" a single phenomenon. Therefore, context is distinct from the single phenomenon itself, which can be seen as either a single event and a process or a causal relation.

Table 2.1: Logical versus historical time

	Logical Time	Historical Time
Directionality of Time	Reversibility	Irreversibility, One-Way, Move Forwards
Nature of Time	Homogeneity	Heterogeneity
Time Intensity of Action	Instantaneous	Discreteness, Lags, Inertia
Expectations	Correct Foresight	Future Unknowable
Change	Disembodied	Embodied, Path-Dependent
Equilibrium Or Dynamic	Equilibrium	Dynamic

Source: modified from Harris (2005, p: 98)

The reasons of taking context into account in understanding the historical phenomenon of primary interest might be premised on the idea that economic events are dependent on initial and boundary conditions, which are, in turn, influenced and shaped by those events (Dopfer, 2001, p: 163). Economic phenomena or processes should be understood as the thing occurring in many discrete space and discrete time contexts (spatio-temporal heterogeneity), not in homogeneous space or homogeneous time (Potts, 2001). Even a contingent event is not determined by chance but has an inherent dynamic that must be recognized as endogenous in its historical nature.

Here we should note that taking history as context denotes that a place- specific particularity of phenomena should be put more emphasis on. A place here is not only a point on the globe having a distinct material endowment, but also, or more important, a place with different embedded cultures, and institutions (e.g. politic- economic regime).

To sum up, evolutionary economic geography, evolutionary economics as well, not only requires time, the temporal period of historical phenomena, but also needs historical time and contexts of historical phenomena. The historical study can be regarded as a true evolutionary or historical study only if it emphasizes historical time and in the quest for the causation of historical events.

2.1.4 Understanding Historical Evolution: Path Dependence and Path Creation

(1) "History Matters" Can't be Reduced to "Path Dependence"

Despite of the increasing use of the concept of "history matters" or its derivative terminology and notions such as "path dependence", or "path creation" by economists and geographers, some basic principles are still not clear yet. For example, the most often used terminology of "history matters" as if it is already self-evident and wholly unproblematic. As a consequence, this, what I want to call "the first principle of the historical turn in social sciences", and related concepts, needs more time to make an extensive and detailed discussion. I will critically reflect in brief and draw on the established concepts to construct a novel model in order to account for change and non-change in history.

It seems that "history matters" has become a widely-used concept across a wide range of history-oriented research literatures, mostly through the notion of "path dependence". However, history in economic processes or more general systems does not always matter (David, 2001), at least not in the same ways. Furthermore, the degree of the "importance", as David (2001) has already addressed, should be attached to the particular category of path dependent dynamical processes, in the sense of what proportion of the changes occurring in the economy and how much 'importance' must be addressed by empirical inquiries. That appears to call for a careful examination of the degree of "historicity", i.e. of the strength of the influence of the past in economic dynamics. David (2001) coined several terminologies of "weak history", "moderate to mild history", and "strong history" (see also Castaldi and Dosi, 2004). Actually, this unresolved question is associated with a fuzzy concept of history, namely of "what does history mean". Very surprisingly, there has been little extensive or detailed discussion on this very fundamental issue of "history should be viewed in a highly abstract term, or as concrete historical events, or both", at least not explicitly. Because history consists of small events over time, I would like to argue that history here refers to particular events that occurred in the historical past and their historical consequences, not to an abstract and whole history. Further, history is important because some important historical events, not all events over time, are meaningful. Namely, some events are history dependent while others might be history independent or very week history dependent (during some period). More interesting for geographers, these seemingly similar historical events are very important for a specific region, while it means nothing for others. For example, there are numerous military stations of research and technology all over the world, but merely a few regions with a long root of military technology have become hi-tech company clusters, the most famous one among which is Silicon Valley in San Francisco Bay Area (see, Saxanian, 1994). It means that the degree of "historicity" is place-specific.

In sum, historical research contributed so much to understanding the relationship between the present and the past, which partly owed to a number of theoretical and empirical studies on path dependence. But we should watch out for a dangerous trend that most authors use path-dependence to define simply "history matters". Here it is very urgent to indicate that the first principle of social sciences, history matters, is much richer than this concept of "path dependence" in meaning. Therefore, we should have an alternative to understand how history matters.

(2) Main Arguments of Path Dependence Theory

Path dependence, a terminology widely used in understanding history in social sciences, has produced a variety of usages, even some misinformation, as Paul David (2001) himself complained. To avoid potential confusion here, I will confine path dependence theory to some classic discussions which will be shown later.

Research on the concept of path dependence has been stimulated by Paul David's long-term interest in seeking to understand technological trajectory, and also by Brian Arthur's studies on non-linear economic processes. Today, besides the literature on economics and technology, there is another prominent way of thinking about path dependence, namely, the work of new institutional economists (advanced by Douglas North and Mark Setterfield), which focuses on institutional path dependence through time. Other branches of social sciences, including anthropology, history, political science, sociology, economics and management studies, also often employ the notion of path dependence (for an excellent review, see Martin and Sunley 2006). Some famous examples of path dependence in the field of industrial standards include the dominance of the QWERTY typewriter keyboard (David, 1985), the VHS video player (Cusumano et al., 1992) and the gauge of railway tracks (Puffert, 1991).

In his seminal work, Paul David (1985) illustrated through the now-famous case of the QWERTY typewriter keyboard that some new sub-superior technologies, for idiosyncratic and unpredictable reasons, can achieve an initial advantage over alternative, even more effective technologies, even if in the long run the alternatives would have been more efficient. This domination of sub-superior technologies is probably linked to several interrelated sources of feedback and reinforcement, namely, what David called QWERTY- nomics or Arthur's various forms of increasing returns in generating path dependence in the economy (1994a, b). David (1985, p: 334) argues that there are three features of the evolving production system which were crucially important in causing QWERTY to become "locked in" as the dominant keyboard arrangement: technological interrelatedness (the reinforcing effects of complementarity and compatibility between different components of a technology and its uses), economies of scale (the benefits associated with the use of a technology), the quasi-irreversibility of investments (the inertia of sunk costs arising from the difficulties of switching technology-specific capital and human skills to alternative uses). At the same time, somewhat different from but related with David, Arthur identifies four types of increasing returns: large fixed, initial, and set-up costs (which give the advantage of falling unit costs to increased output); dynamic learning effects (learning by doing, learning by interacting and learning by using all tends to entail positive feedbacks); co-ordination effects (which confer advantages to 'going along' with other economic agents taking similar actions); and self-reinforcing expectations (where the increased prevalence of a product, process or practice enhances beliefs of further prevalence) (also see Martin and Sunley 2006, p: 399).

In the mode of path dependence, both Paul David and Brian Arthur, together with other proponents[23], highlight the importance of small, historically contingent 'accidents' or 'chance events' which can have long-run effects on the future path of economic technologies, organizations and system. For instance, Arthur claimed, "*Under constant and diminishing returns, the evolution of the market reflects only a priori endowments, preferences and transformation possibilities; small events cannot sway the outcome. . . . Under increasing returns, by contrast, many outcomes are possible. Insignificant circumstances become magnified by positive feedback to 'tip' the system into the actual outcome . . . The small events in history become important*" (Arthur,

[23] But they have difference, in a strict sense. For example, as Thelen (1999) pointed out that David emphasizes chance elements and essentially random factors in determining among an apparently very wide range of possible outcomes, but Arthur (1989) is overall more circumspect and nuanced.

1989, p: 127). As a consequence, " '*historical accidents' can neither be ignored nor reality quarantined for the purpose of economic analysis; the dynamic process itself takes on an essentially historical character*" (David, 1985, p: 332). This idea is akin to the concept of "first mover advantage", in some sense.

A clear logic is involved in strictly defined path dependent processes: once entered upon at a "critical juncture", a path generates self-reinforcing or positive feedback processes ("increasing return effects") that will stabilize and entrench it, turning it into a deterministic frame. That is, path dependent processes can be highly influenced by relatively modest perturbations at early stages, and once being plunged into a particular path (lock-in), however, systems are likely to find it very difficult to reverse course. This difficulty is connected to some of the above mentioned version of increasing returns. These increasing-returns economies often give rise to a third element in this literature, models of multiple equilibria. In the David type model of multiple equilibria dependence model, systems of technology and economy depend on their own historical developments which may be balanced on different equilibria (multiple equilibria, associated mainly with the work of Paul David). The concept of multiple equilibria constitutes a main difference from the traditional theory of the neo-classicists who take just one equilibrium into consideration, which is obligatorily met through market-mechanisms.

(3) Challenges of Path Dependence

Path dependence provides a unique and fertile analytical framework which can not only explain and assess the ever-changing adaptation process by characterizing economic action in a dynamic perspective but also appreciate the role of historic time. So, it should be considered as one of the most fruitful concepts within the field of evolutionary economics. But the concept is based on problematic simplifications (Sydow et al., 2005; Meyer and Schubert, 2007), so it confronted (and still is receiving) much challenges and criticisms.

The first criticism concerns the philosophy of small or random events. The concept of "path-dependent" gives rise to the debate on the influence of chance versus necessity (see e.g. Kwasnicki, 1994). But path-dependence seems to go to an extreme. The so called small events may actually be so small and not so random and innocent after all (see, Bassanini and Dosi 2001; Sydow et al., 2005), but embedded in a more much broader socio-economic structure.

In addressing the emergence of Silicon Valley in Northern California, it is often believed that an accidental event – William Shockley (coinventor of the transistor) left from Bell Labs to found his own laboratory (Shockley Semiconductor Laboratory) in Mountain View (a city in Santa Clara County, in the U.S. state of California) in 1956[24] and brought silicon to Silicon Valley – is very important to the success of the industry of silicon transistor in the 1970s and even the sequential domination of Silicon Valley over the world in the filed of information industry. However, this historical event is not random, not only for William Shockley himself (highly dependent on his personal experience, Shockley completed his secondary education in Los Angeles and earned a bachelor's degree in physics at the University of California at Los Angeles), and also deeply rooted in regional contexts (for example, the state of California had established high qualified research institutes in physics). From this aspect, we should turn to broader socio-economic surroundings in order to understand the necessity behind accidents.

Moreover, path dependence scholars mostly view the emergence of novelty and new pathways to be serendipitous. It might be true that in some cases, for example, the discovery of penicillin might be a chance event, whereas, as a general rule reliance on random chance is not a good enough explanation for the creation of new pathways. Indeed, this problem is related to the second one. Namely, the path dependence concept leaves less space for the transformation of the path itself. Classical path dependence scholars also acknowledge the possibility of change, but hold it to be essentially rare and occurred in radical ruptures, namely, once a path is locked-in, and remains largely unchanged, path transformation is presumed to be highly unlikely except through rare radical ruptures or reorientations, which are often associated with violent external shocks (Djelic and Quack, 2007). This means that path breakthrough is wholly exogenous in this model of path dependence, and tends to grant little sense of agency to actors once a particular trajectory has been set in train (Grabher, 1993; Hassink, 2005). Consequently, there is still an unresolved critical issue in path study of *why and how new pathways get started*. More recent literature tries to fill this gap, so they move away from the simplistic and historically deterministic path dependence theory to alternatives. For example, Hudson (2005) used the notion of "path contingency", which

[24] Merely a point can tell us the powerful influence of Shockley Semiconductor Laboratory: Fairchild Semiconductor and Intel Corporation are both its spinoff. The former is a leading global provider of semiconductor technology and has had over 50 offspring companies in 1980s, while the latter is the world's largest semiconductor company and the inventor of the x86 series of microprocessors, the processors found in most personal computers. Hence, William Shockley is called the father of the transistor, and the father of the Silicon Valley.

better captures the economic development of North East England over the 19th and 20th centuries in terms of how it was influenced by particular circumstances and events (rather than being driven by a clear historical logic).

Last but not least, path dependence, the highly condensed concept of history importance, can't so well reflect the richness of history, partly like what Sewell said *"what has happened at an earlier point in time will affect the possible outcomes of a sequence of events occurring at a later point in time"* (Sewell, 1996, p: 262). The keyword to be underlined here is "possible", but not "necessary". In much of path dependence literature, the historical study on the historically complicated causal relationship was simply reduced too much to a study on relatively deterministic chains of temporally ordered and causally ordered events, namely small events at critical junctures, and what Mahoney defined self-reinforcing sequences and reactive sequences (Mahoney, 2000)[25]. Due to this kind of highly reduced focus, path dependence theory simply traces a specific set of historical events, mostly by ex post facto artificially imagined causal relation (which I want to call 'a single path study'), which in turn results in the losing of something meaningful, in particular, the neglecting of the impact from the contemporary settings on historical events (similar to the concept of path interdependence of Martin and Sunly, 2006).

Consequently, the recognition of properties of complexity in historical evolution of (technological economic and other) systems can aid to understanding the shift from a simple evolutionary perspective of change along a given trajectory (single path dependence) to evolution understood as an interactive change of one trajectory dependent on others (path interdependence, or co-evolution of paths). The more recently developed co-evolutionary theory would be useful for understanding the complexity in evolution of the real world. I will go back to this point later on. To understand how, how much, and in what way multi-paths become interdependent, in case of the formation of an industrial cluster, will be a main mission of my dissertation.

In short, path dependence is a strong tool of "historical economics", but its premises of rational choice and its basically deterministic structure evoke objections and raise intriguing questions. More seriously, path dependence arguments tend to focus

[25] Mahoney (2000) developed two types of path dependent sequences: 'self-reinforcing sequence', and 'reactive sequences'. The former is characterized by the formation and long-term reproduction of a given institutional pattern, which often demonstrate what economists call 'increasing returns'. The latter are chains of temporally ordered and causally connected events. This kind of sequence is reactive in the sense that each occurrence within the sequence is a reaction to an earlier event. Thus, each step in the chain is dependent on prior steps, similar to the sunk cost approach.

on mechanisms that anchor and stabilize trajectories while pay less attention to the sources and mechanisms of change. It focuses mostly on past directions enclosing or restraining directions for coming changes (Mahoney, 2000), which I call "backwards-looking" thinking. Since we live in a time of rapid, unpredictable, and novel change, I am fully convinced that it is very necessary to move to "forwards-looking" thinking, namely, to some issues, such as how to create a new path, on what degree a "new" path is dependent on an "old" one (the degree of path dependence) or another one (path interdependence), would be very important. Subsequently, I suggest that the notion of the path dependence concept requires modifications.

(4) Path Creation and Path Inter-Dependence: Complementary to Path Dependence

Some concepts emerged with the criticism on path dependence, and the most brilliant one among them are path contingency and path creation. The very concept of path-dependence provides much less insight into regional adaptation and adjustment than the concept of path-contingency developed by Ray Hudson (2005). The concept of path contingency "*captures the character of the growth process, and in particular the transition from growth to decline, more adequately than does that of path dependency*" (Hudson 2005, p: 583). This concept better expresses the possibilities of moving between as well as along developmental paths (Hudson, 2003; Hardy, 2002), but did not provide much knowledge about how to create a new path. Perhaps the notion of path creation developed by Raghu Garud and Peter Karnøe (2001) can fill this gap.

The concept of path creation by Raghu Garud and Peter Karnøe (2001, 2003) is also based on the same fundamental assumptions to path dependence, for instance cumulative causation, increasing returns and history as an endogenous variable in path transformation, but makes a significant shift from "describing our past worlds" (the way of path dependence concept) to "shaping our current states" (the way of path creation notion) to create new futures. The creation of a new path perhaps benefits from conscious strategic choices, deliberate and mindful action, as what Garud and Karnøe (2001, 2003) term "mindful deviation" model, particularly of entrepreneurs. In this model of path creation, entrepreneurs are imagined as the powerful actors who can intentionally exercise strategic actions. In the process of deviating mindfully to create new paths, on the one hand, entrepreneurs dismember themselves from the existing cognitive structure, through overcoming their long-formed habits and cherished beliefs; on the other hand, they reframe their thoughts and actions around what will benefit the new path, and what will advance it forward (Pham, 2006, 2007).

Garud and Karnøe (2001, p: 2) criticized that proponents of a path dependence perspective often celebrate historical accidents to explain the emergence of novelty and relegate human agency to "choosing to go with a flow of events" that actors have little power to influence in real time. It means that the genesis of novelty becomes a black box and there is no role to human agency in path dependence theory. The concept of path creation by Raghu Garud and Peter Karnøe (2001, 2003) offers solutions for some of the problematic simplifications of path dependence, by placing the entrepreneur in the newly refined model. In the new model of path creation study, the genesis of novelty in path evolution is placed at the center. Hence, experimentation and exploration are necessary wherein any action is a probe into the world even as it is being created. Because experimentation is time-consuming, entrepreneurs must maintain control over the path, sometimes must be patient to wait for right time for new ideas to be refined even as new institutional and market preference structures co-evolve (Van de Ven and Garud, 1993). In this sense, path creation is a co-evolutionary process. So entrepreneurship requires an ability to mobilize time as a resource and control the speed of path change.

The recently developed theory of path creation, i.e. the assumption that human agents have control over historical outcomes in real time, has a much longer genealogy, at least tracks back to the work of Marx, Veblen, and Schumpeter. But the popularity of path dependence in social science made us forget about these economists and their works in which human agency (e,g. entrepreneurs) has been placed at the center, for example, Schumpeter's *Creative Destructio*n. It is important to stress that a Schumpeterian entrepreneur is not an inventor, but an innovator (of new products, processes, organization mode and so) (McCraw, 2007). Accordingly, we can say that Schumpeterian entrepreneurs play a role as the creators of new path. Without these new path creators, capitalism would lose propulsion. The emergence of the theory of path creation reminds us once again of the significance of human agency in economic processes (Pham 2006, 2007).

But we should note that despite of epistemological and ontological differences between path dependency and path creation (see Garud and Karnøe, 2001), both notions could be complementary, but not mutually exclusive to each other (Meyer and Schubert, 2007) in understanding path processes. The path dependence concept of Arthur and David places too much weight to history, and emphasizes the relevance of emergent and non-intended consequences of actions and the stochastic properties of the resulting processes, but it inadequately characterizes the fragility of any path as it is produced and reproduced through micro-level practices where social rules and artifacts are enacted (consistent with the routine of Nelson and Winter). In contrast, the path creation notion by Garud and Karnøe stresses the deliberate influence of path developments through powerful (collective) actors (Meyer and Schubert, 2007). That is, what is new in the path creation model to the study of path is just adding the concept of actors with deliberate actions and their role, by which we can understand path processes better; in particular, path bifurcation, namely, how a new path in some sense is created. Path creation focuses on path breakthrough at critical junctures, however says very little about the following development trajectory of a path after it has been created. That is why we need a combination of both in understanding a path process.

Value-Added of Path Creation in Path Study

According to the principle of “history as context”, evolutionary or historical studies should place a system in real time, i.e., construct temporally joint “moving” pictures of events and surroundings rather than “snapshots”, and place more attention to interacting relations of entities and their surroundings over time. Technically, historical contexts can be explored through understanding overlapping multi-paths and interaction among them over time. So it is safe to say that the shift from a simple evolutionary perspective of changes along a given trajectory (single path evolution) to the co-evolutionary thinking, in which evolution is understood as interactive changes between trajectories (path interdependence, or co-evolution of paths) can vastly enrich our understanding of complex social dynamics.

As mentioned previously, the more recently developed co-evolutionary theory (e.g., Nelson, 1994[26]; Witt, 1997; Helfat, 1994; Lewin and Volberda, 1999; Rodrigues and Child, 2003; Volberda and Lewin, 2003) is consistent with the Martin and Sunley’s concept of “path interdependence” (2006, 2009). According to Murmann’s definition (2003), co-evolution refers to “*two evolving populations co-evolve if and only if they both have a significant causal impact on each other’s ability to persist*” (Murmann 2003, p: 210). The keywords to be underlined here are multidirectional causalities between micro- and macro-co-evolution, as well as between and across other system elements. Co-evolution can be understood as intertwined multidirectional causalities between multiple paths, or interactions between the evolving single theme and its

[26] Although Nelson did not make explicit use of the notion of path dependence, their term of “natural trajectories” with regard to technological change has similar connotations.

surroundings (naturally, surroundings can be describes in terms of other paths).

The concepts of path inter-dependence or co-evolution (among multiple paths) extend the path study which focused on an evolving single theme to multi-specific interactions between two or more populations, in which, the fitness of an evolving population depends not only on itself, but also on the state of other coevolving entities. It is becoming increasingly obvious that single-theme explanations for change and/or non-change of a single population, such as the concepts of path dependence and path creation (which I term "a single path study"), have reached their limit, and evolutionary scholars should adjust research strategies and take into account all interacting populations of organizations and environments where organizations survive, compete, and change.

Co-evolution, together with the concepts that derived from it such as mutual adaptation (co-adaptation), becomes a powerful tool for inherently interacting populations. Different from a single-path study in which a certain population is often seen as an isolated entity and the environment as a parametrically fixed one, co-evolutionary study emphasizes more on the interaction between genetically distinct populations and between the population and their environments. The concept reflects well the viewpoint that the world is complex, in which human cultural and social behaviors are not predictable, and human behavior is dynamically linked to its environment on a range of temporal and spatial scales (Winder et al., 2005, p: 355).

There are at least two ways to understand path interdependence for economic geographers (Schamp, 2009; Martin and Sunley, 2009). Firstly, path interdependence involves interactions between industrial paths, as what Schamp terms "the co-evolution of two firm populations" (Schamp, 2009). As we know, economies are typically ensembles of overlapping sets of inter-related sectors (Metcalfe et al., 2006; also see Martin and Sunley, 2009). Secondly, path interdependence in a regional context would be interactions between different socio-economic "arenas", including what Schamp (2009) calls "*the co-evolution of populations of firms and institutional arrangements*", interactions between the broader local economic, technological and socio-institutional systems, and interactions between multi-geographical scales as well. Economic geographers have been interested in the phenomenon of co-localized firm (e.g. today's industrial cluster), but at present, there are few empirical investigations on these kinds of path interdependence so that we have little knowledge about how far they can effectively change the course of an industrial path, possibly by spinning off and the rising of market niches, and subsequently co-adaption between market, technology, industry, and institution. Therefore, studying path-interdependence should be put on the research agenda of evolutionary economic geographers as soon as possible, both theoretically and empirically (see Martin and Sunley, 2006 and 2009).

2.2 Paradigm Shift from Evolutionary Approach to Coevolution Thinking

2.2.1 Two Types of Evolutionary Economics

Although evolutionary thinking has recently attracted increasing attention in economics (Dopfer and Potts, 2004, p: 195) and economic geography (Boschma and Martin, 2007), a single coherent body of concepts and methods can't be observed in this emerging field, and appears to be a 'massive hybridization in theory' of evolutionary theory, complex systems theory, self-organization theory and agent-based computational theory (Dopfer and Potts, 2004, p: 195)[27]. The hybridized theory at least incorporates Austrian, Behavioural, Original and New Institutional, Post-Keynesian and Schumpeterian economics and French regulation theory. At the same time, it is methodologically characterized by a great variety in tools and methods, many of which were not originated within economics or social sciences, but from thermodynamics, biology, systems theory, complexity theory, cognitive science, computer science and neuroscience. The advance in evolutionary economics is also associated with the important recent development in mathematical economics, the evolutionary game theory, and the work developed by the Santa Fe Institute in the United States, which entails applications of chaos theory and several other types of computer simulation. This situation is associated more or less with three facts: (1) the subject domain is non-mechanistic, non-deterministic and unpredictable, complexity and open economic processes, which need a high-dimensional, non-linear dynamic perspective (e.g. Foster, 2003; Lawson, 2003); (2) the sources of evolutionary theory in natural science, which enlighten evolutionary economists are numerous, and not unified; (3) evolutionary thinking itself, both in natural and social sciences, is evolutionary. Moreover, when applied and used in a context of human society, additional issues arise that reinforce this predicament, because a huge gap of evolutionary mechanisms exists in natural and

[27] Hodgson (1999) pointed out the existence of 'at least' six main groups using this term.

human realms.

(1) Biological Metaphor and Population Thinking

Basically, there are two ways to understand the economic process inside evolutionary economics. One group consists of some evolutionary scholars who openly acknowledge and employ the biological metaphor, historically including Marshall, Veblen， and Nelson and Winter[28], Hodgson and Knudsen. There are some differences inside this line, however, for example, the original Nelson/Winter's book (1982) draws on Lamarckian rather than Darwinian evolutionary ideas, while Hodgson and his colleagues (Hodgson and Knudsen, 2006a, 2006b) claim that an adequate explanation of the evolution of such a system must involve the three Darwinian principles of variation, inheritance and selection, and hence requires a generalized Darwinism. As a whole, they all appeal to biology as a source of inspiration and metaphor for a non-mechanistic economics.

Evolutionary economists who borrow biological metaphor to economics follow Darwin's 'population thinking', reject typological thinking supported by neo-classical economists like Marshall. Darwin's "population thinking" demarcates Darwin's theory from the essentialist mechanics of Newton. The idea is implicit in works such as Penrose (1959) and Nelson and Winter (1982), and explicit in Metcalfe (1994, 1998). Population thinking maintains not only the change at the micro level which determines the aggregate results at the macro level, but also the macroeconomic policy and environment which influenced individuality, creativity and distinctness of individuals in the population (Mantzavinos, 2004). Adoption of population thinking means that the economy consists of heterogenous firms with different characteristics or traits that are distributed with a certain frequency. There is no one 'typical' individual agent, but unique and heterogeneous agents in the organic world of economy.

(2)Anti- biological Metaphor and Complex System Thinking

However, the other group argues that economists (e.g. John Foster, Ulrich Witt, and Matthias Ruth) should abandon biological analogy and favor an economic self-organization approach (see Foster and Metcalfe, 2001 for an overview). For example, John Foster and Matthias Ruth directly reject the use of "biological analogies" in economics (Foster, 1997, p: 444; Ruth, 1996). Witt partially acknowledges evolutionary

[28] Although the processes of selection, mutation and inheritance are invoked not as biological metaphors but as real economic processes, the authors nevertheless explicitly acknowledge that there is an analogy between bio-genetic process and firm dynamics.

biology[29] (see Hodgson, 2002, p: 263), but this group as a whole prefers to employ the theory of self-organization as the foundation for evolutionary economics. For example, Witt (1997, p: 489) says: "*The theory of self-organization . . . provides an abstract, general description of evolutionary processes*." Foster seems to go further and argues that self-organization is an alternative to "biological analogy" (see Witt, 1997, p: 444; Foster, 1997).

Different from population thinking, the self-organization approach is also used by some evolutionary economists who reject biological metaphors. The self-organization approach developed firstly in physical sciences, focused on the non-linear, 'far-from equilibrium' properties and structural transformation in natural realms. Entering the 1990s, it and its varieties such as the "science of complexity" or "complexity theory" have diffused into economics (Anderson et al., 1988; Arthur, 1999; Arthur et al., 1997; Metcalfe and Foster, 2004), and economic geography (Frenken and Nuvolari, 2004; Frenken, 2000) [30]. Actually, the thinking has a long history in economics, and has been presented in various guises by eminent economists such as Herbert Simon, Friedrich von Hayek, Gunnar Myrdal and Nicholas Georgescu-Roegen, to name but a few. For instance, Georgescu-Roegen (1971) argued that the entropy law was the ultimate foundation of dynamic economic analysis. It is associated with the Santa Fe Institute as well which is dedicated to the study of complex systems. Recently evolutionary economists have employed a (complex) system approach (see Foster, 1997; Witt, 1997). A new notion of "complex adaptive systems" was coined, with a purpose bridging a system theory with the ideas of generalized Darwinism. According to Levin (2003), such systems have three properties: (1) diversity and individuality of components, (2) localized interactions among these components, (3) an autonomous process that uses outcomes of those interactions to select a subset of those components for replication or enhancement.

The opponents of biological metaphor or Darwinism in economics are afraid that the similar situation to Newton's mechanics controlling neo-classical economics would take place in evolutionary economics. However, Hodgson and Knudsen (2006a, b) insist that the Darwinian evolutionary philosophy is universal, namely, Darwinian principles of evolution can explain a wide range of complex material phenomena, from

[29] Witt opens the door to evolutionary biology, notwithstanding only to admit biological mechanisms of variation, inheritance and selection among human individuals.

[30] For a brief review on this point, see Martin and Sunley (2007).

cosmic to social objects, despite of the distinction between a natural and economic domain. In addition, some supporters of biological metaphor (for example, Hodgson) fear that evolutionary economics would be deluged with the mathematical formalization and modeling[31] potentially caused by the self-organization theory.

We should keep in mind that each approach has its own advantages and disadvantages, thus, there might be a third way to adopt, a combined approach of biological metaphor and self-organization/complex theory. Actually, the evolution of all open, complex systems needs to be understood in terms of the logic that Darwin used to explain biological evolution, as Foster's microscopic selection mechanisms (1997, p: 44). Witt himself (1996, p: 714) also argues that "*Darwinism may even become a fruitful part of evolutionary economic theories, not through metaphorical use, but through direct application*" (also see Witt, 1999, p: 30), which is in terms of understanding the biological evolution of human preferences (Witt, 1999, p: 27). Since "*complexity is one of those ideas whose definition is an integral part of the problems that it raises*" (Nicolis and Prigogine, 1989, p: 36), the complex theory would be useful to understand complexity at different levels of a structure in a single system. In economics, the idea of self-organization has a long tradition, associated with Austrian economics that was quite independently of natural science (see Witt, 1993c). Austrian economists have conceived processes of "spontaneous order" in the formation of economic structures, based on human creativity and diffused into economic organization and complexity through the transmission and storage of knowledge. Thus, the revitalization of older traditions in economics and political economy provides some useful insights for an ongoing nonlinear structural change of economic systems (Foster, 1997), equally to biological metaphor in economics.

2.2.2 Micro-Theory for Evolutionary Economics

(1) Bounded Rationality

In a neoclassical view, various types of economic agents (such as all consumers, or all firms) are assumed to be perfectly rational, regardless of specific circumstances. That is, economic agents have the same level of full rationality, of ability to recognize and implement both the best product mix and the best practice techniques (rational

[31] Accurately speaking, what do evolutionary economists want to oppose is not the application of mathematical tools in economics, but the excessive concentration on formalization through mathematical simulations.In fact, some evolutionary scholars including Nelson and Winter themselves employ mathematical simulation in studying economic evolution.

agent). This is at crux of many recent critiques of neoclassical theory from heterodox economics. Evolutionary economics stands on the opposite side of mainstream economics and also criticizes neoclassical economics for taking for granted that economic phenomena are based on rational choices of profit-maximizing firms and utility-maximizing agents, presuming that economic agent is perfectly or absolutely rational and thus economic processes are totally deterministic. Hence, evolutionary economists argue that most decisions of firms and consumers are strongly restricted by their cognitive limits (*bounded rationality*), and that human decisions are made in a habitual manner. To be more specific, decision-making processes are programmed (Simon, 1979), and also generally bound by rules, norms and institutions. The most important part of the decision-making process is to find a problem, and then solve it, which is driven by the ability of the subjects to formulate and to solve it. Accordingly, the core of the decision-making process is therefore the activity of searching a solution to a problem. We should especially note here that bounded rationality (Simon, 1979) implies that the decision-making process is highly path-dependent and locked in the existing organizational routines, on the one hand; on the other hand, agents can create novelty by learning or searching, imitating and mutating of the fitter routines of other agents.

In the evolutionary model, firms are presented as “repositories of productive knowledge” (Nelson and Winter 1982, p: 175), in which knowledge is stored, memorized, and applied in their operational routines. This kind of approach primarily maintains that organizational routines which developed from past experiences enable agents to cope with future complexity and uncertainty under the condition of bounded rationality, and that difference in organizational routines is the basis of a firm’s distinctiveness. Hence, the evolutionary approach adopts a historical perspective in which behaviour of agents or changes in the spatial structure is conditioned, but not determined by structures on the micro (routines of organizations) and macro-level (institutional and geographical structures).

A path-dependent (or local) search is much more likely than an undirected and global search process, because in this early process agents already refer to the structures or structural properties of a social system (like the organization) and more or less consciously select one or another of many alternatives (Sydow et al., 2005). Different to the neoclassical economics in which all agents are assumed to be exactly identical (representative agent), evolutionary economics recognizes differences among agents (heterogeneous agent). Economic agents are heterogeneous in knowledge, resources and organizational routines and never perfectly informed, and consequently tend to operate in a familiar way in order to reduce uncertainty and risk. It is increasingly recognized that heterogeneity in the organizational routines and in the productive technologies of firms is crucial for technological changes (e.g. Nelson and Winter 1982, Cantner and Hanusch 2001). In the case of my study, there are two interwined levels of heterogeneity. One is the heterogeneity of sectors (a population of firms), and another is that of firms. More specifically in my empirical study, I will take into account the differences not only between traditional Chinese medicine (TCM) sectors and other pharmaceutical sectors (mainly through comparison with the chemical pharmaceutical sector), but also among firms inside the TCM sector. Because new characteristics that frequently emerge at the industry level (a population of firms) are based on the continuously generated variations at the firm level, my evolutionary study of the Tonghua TCM sector will explore how the population changes, based on how much novelty at the firm level is generated.

(2) Dynamic Capabilities

Bounded rationality and unprogrammed decisions imply that learning, mostly based on interaction among (local) agents, becomes important. The issue is necessarily related to the dynamic capability theory of the firm. The dynamic capabilities' literature tries to integrate the resource-based theory of the firm with dynamic and evolutionary views, and builds upon a theoretical framework founded on the work of Schumpeter (1934), Penrose (1959), Cyert and March (1963), Nelson and Winter (1982), Teece (1988). The resource-based view of the firm portrays firms as a collection of tangible and intangible assets, resources or competencies, which are tied to the firm and are difficult to be imitated by others. It argues that the firm's competitiveness is determined by how resources are employed and in what manner the experiential knowledge of its personnel is developed and applied (Penrose, 1959). This approach has been criticized for ignoring factors surrounding resources, instead assuming that they simply "exist". Considerations such as how resources are developed, how resources are integrated within the firm and how they are released have not been taken into this theorizing. Drawing on Nelson and Winter, the approach of dynamic capabilities attempts to link firm resources to its capabilities to its ever-changing environment, by adopting a process approach, with an aim of explaining how firms achieve and sustain competitive advantages despite an ever-changing environment. Consequently, Teece et al. (1997, p. 516) define dynamic capabilities as "*the ability to integrate, build, and reconfigure* *internal and external competencies to address rapidly-changing environments*". The resource-based approach to the firm emphasizes the resource choice (the selecting of appropriate resources), while the dynamic capability perspective stresses resource development and renewal (Teece and Pisano, 1994; Teece et al., 1997; Eisenhardt and Martin, 2000).

Teece (1988) describes a firm's competencies as a set of differentiated technological skills, complementary assets and organizational routines that provide the basis for a firm's competitive capacities in one or more businesses. According to Chandler (1990), a firm gains competitive advantages through the making of three interrelated investments: (1) investment in production to achieve the cost advantages of scale and scope; (2) investment in product-specific marketing, distribution, and purchasing networks; (3) investment in the managerial talent and management structure to plan, coordinate, and monitor the firm's often dispersed operations. The theory of dynamic capabilities of firm argues that all strategic investments are constrained by internal routines or standard operating procedures. These routines, already standardized solutions to specific problems, are deeply embedded in historical processes of the firm, hence they are not ready to be replicated or imitated by other rivals. In the dynamic capabilities view, the difference in routines is the most important heterogeneity, which makes firm performance different. As discussed in Nelson and Winter, standard operating procedure or organization routine is highly path-dependent in nature. But coping with a changing environment needs changes in routines, otherwise a successful firm finally fails, which means learning in the firm is an inherently organizational process. The existing routines determine how firms locate, identify, and make use of information and new resources. But learning, and searching new solutions and constant learning adds knowledge and information to current routines, and then changes its trajectory. The new routines allow the firm to respond to and exploit changing market environments.

2.2.3 Key Evolutionary Concepts

The evolutionary framework for the interpretation of economic dynamics, as some excellent evolutionary economists stated (e.g.Hodgson, 1995; Metcalfe, 1988; Nelson and Winter, 1982), must be built on core principles such as heredity, variation, competition and selection. In this dissertation, I will concentrate on the evolution of industrial cluster, a geographical level of sub-nation, but similarly, I hope, the arguments to be formed here can be equally used to understand the change of spatial pattern of economic activities at the national level in the following ways.

The economy at any moment in time comprises a population of firms. Firms are heterogeneous, each of which is identified by a unique combination of technological, organizational, and informational characteristics, as well as the legacy of past choices. This means routines of firms are different. As I previously discussed, a new firm inherits a subset of routines of its parents, at the same time it has to learn how to search new incremental or radical routines in order to survive and adapt itself to new environments (e.g. in terms of market and technology). Essentially, this process is a process of learning by doing, learning through interacting, trials and errors, and learning how to learn. Imitation of a successful firm's routines is also a method, even a more economical one. However, only those firms with fitter routines can survive. Although market competition increases variety through continuous trial and search in existing firms and new entrants, it also destroys variety through processes of selecting the better, imitation and firm exit (Metcalfe, 1998; Foster and Metcalfe, 2001; Rigby and Essletzbichler, 2002). In the market, the differential allocation of profit across firms tends to be based on the quality of original routines and later variation of routines. The competitive process of market selection consequentially decides on which firms and which routines can survive. In other words, on the one hand, firms in market competition adopt positively selected variations to seek competitive advantages (Metcalfe, 1994); on the other hand, the selection environment limits diversity by eliminating less efficient variations in firm behaviors, and wiping out unprofitable firm from the active population (Essletzbichler and Winther 1999; Metcalfe 1994). It is notable that considerable selections finally alter the environment within which future decisions are made. Since there is a certain level of inertia in firm characteristics, for example, institutional inertia, these behavioral routines may preserve some continuity over time in organizational form, i.e. the behavioral routines of firms tend to be relatively stabilized in the short run.

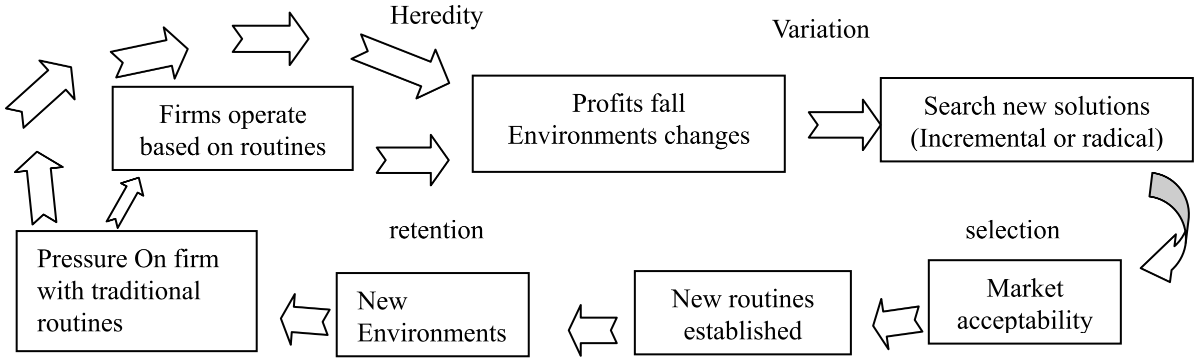


Figure 2.1: The evolutionary mechanism

The evolutionary arguments noted above have considerably enriched our understanding in the micro-level of economic changes — the firm level. Similarly, they help us to increase the apprehension in the changing patterns of geographical distribution of industries. As in economy more generally, the technological change and economic change at the regional level are shaped by the processes of heredity, variation, selection and retention. A given industry in a region that consists of a population of competing firms may be characterized by its variety in terms of technological, organizational, and informational features. At the beginning of the cycle of an industrial district, higher profits and huge potential markets allure more new firms into this area. With the standardization of products, competition among firms and especially cost competition becomes fiercer. Only those profitable firms can survive in a region, while those poorly-performed firms are doomed to leave this region or industry, which consequently affects the spatial distribution of the industry (Boschma and Frenken 2006b).

2.2.4 The Paradigm Shifts to Coevolution

(1) Defining Coevolution

Evolution is a mode of explanation based on the selective retention of renewable variation, and accounts for phenomena of structural fit and change in a variety of domains. A co-evolutionary explanation, however, entails two or more evolving systems whose interaction affects their evolution. Socio-environmental co-evolution involves human systems (material practices and non-material ideas and values) and non-human systems (living and physical). The challenge then is how to develop case-specific and empirical applications that define and elaborate the variants which co-evolve and specify the processes of mutual selection. Applications could benefit from existing classifications and causal propositions in the natural and social sciences. Co-evolution is part of a larger analytical toolkit for looking at complex socio-environmental problems. Although distinct, there are strong synergies, complementarities and potentials for combined uses of co-evolutionary, co-dynamic and complexity-based explanations.

The concept of co-evolution, like other notions in evolutionary study, has risen in the biological sciences and has also spread across a number of disciplines, including linguistics, computer modeling, and psychoanalysis, economics among others. Darwin's original insight that reciprocal interactions of species can give rise to complex co-evolutionary responses was neglected for a long time, by biologist and zoologists. Darwin virtually recognized that ecological interactions among species are the most important processes that drive the adaptive evolution and diversification of species: "*I can understand how a flower and a bee might slowly become, either simultaneously or one after the other, modified and adapted in the most perfect manner each other, by continuous preservation of individuals presenting mutual and slightly favourable deviations of structur*e" (Darwin, 1871)[32]. In the 1960s a handful of biologists began to be aware of the importance of co-evolution (Porter, 2006). The term of co-evolution made its premier appearance in Ehrlich and Raven's (1964) paper describing reciprocal evolutionary relationships between butterflies and food plants. Since the 1980s co-evolution has been identified as a major research framework in the biological sciences (Futuyama and Slatkin, 1983; Thompson, 1982, 1994, 2005).

In the 1990s, scholars in the fields of economics and management, especially organization study, borrowed the concept from biology, sometimes together with the recent achievements from complexity science, emergence, computational organization theory, and population ecology. Recently, some evolutionary economists, such as Nelson (1994), Coriat and Dosi (1997) and Murmann (2003) have clearly called for a need to construct the co-evolutionary model for better understanding the driving force of economic changes. They believe that studying the co-evolution of economic changes will help further to reveal the complex reality of the economy. In these studies, co-evolution is still a new entrant, but the work applying the co-evolution construction has been garnering an increasing attention in recent years. The evidences prove that co-evolution can provide a powerful alternative not only because it grounds on formal

[32] Darwin, C.(1871), The Origin of Species, available at the website http://www.literature.org/authors/darwin-charles/the-origin-of-species/index.html

theorizing with more realistic assumptions (like bounded rationality and disequilibrium, which is the same in evolutionary studies), but also it abandons a worldview in which the population to be examined (for example, firms) is described as an isolated entity, free from the changing surroundings.

According to Murmann (2003), co-evolution means: "t*wo evolving populations co-evolve if and only if they both have a significant causal impact on each other's ability to persist*" (Murmann 203, p: 210). Applying a co-evolutionary approach is not simple (Kallis, 2007). As a result, most publications with co-evolution in the title are, as Volberda and Lewin (2003, p: 2128) noted, not in reality empirical studies on co-evolution. On the basis of the disordered status in this field, Volberda and Lewin (2003, p: 2128) presented certain requirements that empirical co-evolutionary research must satisfy. Choosing the appropriate populations and the existence of bidirectional or causal mechanisms between the populations are necessary conditions for an applied co-evolutionary study.

The co-evolutionary approach has been gaining adherents, but it is far from being well accepted or understood. Volberda and Lewin (2003, p: 527) analyzed the essential properties of co-evolution: (1) multilevelness/embeddedness, co-evolution takes place at multiple levels within firms as well as among firms; (2) multidirectional causalities at least include direct co-evolution, in which one population evolves in response to another population, and diffused co-evolution, in which one or more populations evolve in response to several other populations in a broader ecological system (Baum and Singh, 1994); (3) nonlinearity. Changes in one variable can produce quite counterintuitive changes in another variable; (4) positive feedback. Organizations and organizational environments have a recursive bidirectional cause-and-effect relationship; (5) path and history dependence. Adaptation in a co-evolutionary process is path/history-dependent. On the basis of these properties of co-evolution, they identified several requirements that distinguish co-evolutionary research from the non-co-evolutionary research: (1) studying organization adaptations over a long period of time; (2) examining organizational adaptation within a historical context of the firm and its environment; (3) considering multidirectional causalities between micro- and macro-co-evolution, as well as between and across other system elements; (4) incorporating mutual, simultaneous, lagged, and nested effects .

Because my research focuses on the applied level of evolutionary economics, spatial evolution of industries, I will discuss the co-evolution in an industrial cluster to illuminate how to make a co-evolutionary study in the strict sense. The articulation of a sound co-evolutionary explanation for the spatial evolution of industries involves three very significant steps. The first step is to choose the appropriate populations. In other words, one needs boundaries of populations before starting to explore their co-evolutionary mechanisms and processes. Because "population" as a concept is extremely flexible, an entity may be a common member of various populations, there is the difficulty in selecting population. The usual way is to choose a given population like a special industry at first, and then find out the important influencing factors as co-evolving populations. The second step is to examine whether bidirectional or causal mechanisms exist in the chosen populations. Only when those populations have a significant "causal impact on each other's ability to persist" through time, the third step can be done. The third step is to link the evolutionary trajectory of populations by causally affecting the variation, selection, and retention processes in their respective arena (Sotarauta and Srinivas, 2005). In this dissertation, I will follow these steps and explore the co-evolutionary mechanisms and process in the geographical scale of industry cluster, by focusing on the interactive causal chains of TCM firms, institutions (concerning the Tonghua industry cluster) and TCM technology.

(2) Co-evolution Research Status

For more than a decade, the concept of "co-evolution" aroused the curiosity of scholars from various fields. Several organization researchers, following the tradition of the model of variation, selection, and retention of changes (Campbell, 1969), have highlighted the phenomenon that organizations co-evolve with their environments (March, 1994; Koza and Lewin, 1998; Lewin, et al., 1999). Rosenkopf and Tushman (1994), for example, point out the fact that technology and industry coevolve (Rosenkopf and Tushman, 1994). Recently, evolutionary economics scholars, including Nelson (1994), Coriat and Dosi (1997), and Murmann (2003), have emphasized that it is very necessary to develop co-evolutionary models to better understand the dynamics of economic changes. Johann Peter Murmann's book about the co-evolution of firms, technology, and national institutions (2003) was awarded the 2004 Schumpeter Prize by the International Joseph Alois Schumpeter Society to recognize his contribution to Schumpeterism and evolutionary economics. In his book, he purposed articulating a co-evolutionary model that links industrial, technological, and institutional dynamics. Although Murmann presented a very strict definition of co-evolution, "*two evolving* *populations co-evolve if and only if they both have a significant causal impact on each other's ability to persist*" (Murmann 2003, p: 210), he simultaneously claims that "co-evolution" can also be used in the broader sense in which multiple things are jointly evolving.

Research on co-evolution of institutions at the national level and industry is conspicuous in the diverse literatures on the co-evolutionary approach. Freeman et al. (1982) made an early discussion on the interactive relationship between public institution and technology changes. Many excellent studies have helped us to understand how these factors drive the rate, path and characteristics of technical change – and thereby, economic growth is shaped over time by the co-evolution of industries, technologies, and supporting institutions (Nelson, 1994; Tucker, 2003). Sotarauta and Srinivas (2005) have recently made various case studies on regions in Finland, India, and the USA to show heterogeneity in development, specifically technologically innovative development, and attempt to provide us with a co-evolutionary framework for a more comprehensive view of regional development processes. There are good examples of experiential research on the co-evolution of new emerging industries and institutions, besides the above mentioned works, McKelvey's (1996) work on the rise of biotechnology industry and Murmann's study on the synthetic dye industry between 1856 and 1914 (Murmann, 2003). Consoli (2005) purposed elaborating an evolutionary perspective on the process of a structural change that has characterized retail financial services in the United Kingdom (UK) from the 1840s to the 1990s. The recent "co-evolutionary turn" in evolutionary study is meaningful. Here I will explain the significance of the paradigmatic shift from an evolutionary approach to co-evolution thinking.

2.2.5 Significance of the Paradigmatic Shift

From the above discussion, we can see that the co-evolutionary study is different from the evolutionary research: evolutionary study devotes itself to looking for single-theme (or single population) explanations for the adaptation– selection phenomenon, while co-evolutionary study wants to extend standard evolutionary search to multi-specific interactions between two or more populations, in which the fitness of evolving solutions depends on the state of other coevolving individuals. As Volberda and Lewin (2003, p: 2114) pointed out, it is becoming increasingly obvious that single-theme explanations for the adaptation– selection phenomenon have reached their limit, evolutionary scholars (including in the field of organization theory, economic and geography) should adjust research strategies and take into account all interacting populations of organizations and environments in which organizations survive, compete, and change.

Co-evolution, together with these concepts that derived from it such as mutual adaptation (co-adaption), becomes a powerful tool for understanding inherently interacting populations. There are differences between evolutionary and co-evolutionary perspectives. In the evolutionary approach, a certain species is often seen as an isolated entity, while the environment in which species survive is considered as parametrically fixed. However, the co-evolutionary perspective emphasizes more the interaction among genetically distinct populations or between species and environments. The key ideas of the co-evolutionary approach are that the world is complex, human cultural and social behaviours are not predictable and human behaviour is dynamically linked to its environment on a range of temporal and spatial scales (Winder et al., 2005, p: 355). This raises another question, how a population evolves in a changing environment. There are two different approaches to this issue. One is to see the changes of the environment as exogenous (to the model), another is that they are endogenous. The latter is the co-evolutionary approach, because co-evolution means "*changes in one population can propagate by changing the selection pressures experiences by others*" (Winder et al., 2005, p: 351), and "*selection pressures are not exogenous and fixed, but reciprocally coupled and dynamic*" (Winder et al., 2005, p: 355). It means that co-evolution is at first about evolution, and then more about "co" (reciprocally coupled links). Each of these populations is an evolutionary system in its own right, but we can't ignore the fact that they are coupled, at the same time, that co-evolutionary selection pressures are not exogenous and fixed, but reciprocally coupled and dynamic. Each of the reciprocally linked evolutionary sub-systems has the potential to change the selection regime experienced by the others (Winder et al., 2005, p: 355).

It is here worth to note that the co-evolutionary approach is not a result of decanting the old wine of complex system theory into increasingly fashionable co-evolutionary skins (Winder et.al, 2005), the complex systems with their view on socio-natural interaction focus on framing dynamics in terms of flips between multiple stable states or attractors (Berkes et al., 2003), but co-evolution is the evolution of two or more populations through the action of reciprocal selective pressures and adaptation between them. The central problem of co-evolution is to understand how interactions among populations are shaped by reciprocal natural selection and how they persist across space and time even as they undergo constant and often rapid co-evolutionary changes. In the co-evolutionary model, technology market conditions and other external environments are not parametrically fixed, but endogenous. One of the biggest differences between evolutionary and co-evolutionary study is that co-evolution studies have a two-way or multi-way causal relationship, while evolution focuses on a one-way causal relationship, for example, the adaptation of organizations to the environment, which does not touch any influence of organizations on the environment change. In recent years, many scholars are becoming aware that it will be difficult to fully understand organizational conduct and performance, if their studies only focus on a single adaptation or selection, they don't consider the inherently causal link between the changing environment and changes in organizational behavior. So it is safe to say that the co-evolutionary approach is the ground block for the evolutionary study, which is not only the extension of the evolutionary study, but also provides a powerful analytical tool for better understanding evolutionary processes of economic and social systems.

2.3 Why Co-evolution between Institution, Technology and Firms

As I have already pointed out before, together with some evolutionary scholars (for example, Volberda and Lewin, 2003), the contemporary evolutionary approach is moving to co-evolutionary research from its traditional perspective which focuses more on the adaptation – selection process of a single population. My analysis will concentrate on the co-evolving interactions of three populations, i.e. institutions, technologies and firms. The reasons behind why these three populations are chosen are (1) these populations are often examined in co-evolutionary study (for example, in the work of Murmann, 2003); (2) TCM industry is highly subject to the changes of related institutions and technologies (see for a more detailed explanation, Chapter 1.3.2). Considering that the conceptually blurred boundaries between institution and organization, I will firstly make a distinction between institution and organization, which might be a base of my co-evolutionary study.

2.3.1 Distinction between Institution and Organization

Today nobody can deny the importance of the role of institutions in economy. But many unresolved issues remain as to the real content of the concept of institution and the scope of the specific institutions that must be taken into consideration. It is important to distinguish general social rules (sometimes called the institutional environment) and particular organizational forms (sometimes called institutional arrangements), although organizations can also be thought as sets of rules. I follow a traditional institutionalist approach, defining institutions as the “rules of the game” that govern human behavior and interactions (North, 1990). Institutions include formal institutions, such as the legal system, written documents or rules that are determined and executed through formal position, such as authority or ownership, and informal institutions such as socially accepted implicit customs and rules, social norms, routines. Organizations are deliberately and intentionally created by people pursuing a set of collective purposes, with established roles, methods of coordination, procedures, culture and space (Jonsson, 2007). Organizations can include political bodies (political parties, government, Congress), social or religious groups (churches, clubs, associations), economic bodies (firms, cooperatives, financial corporations), and educational and scientific bodies (schools, colleges, training centers, research institutes) (North, 1990).

2.3.2 The Long Division of Technology and Institution in Theory

Since Adam Smith, economists have been explored the determinants of economic growth, and the roles of technology and institution have always been their main concern. Smith analyzed the impact of the division of labor on technology, as well as national institutional structures on the national wealth. Marx explored more directly the relationship between technology and institution by using the terms of productive forces and productive relations. However, there has been a big difference in this topic for a long time. We can clearly see three threads around this issue: one is *technological determinism* advocated by economics in the camps of classical, neo-classical and neo-classical growth theory, another is *institutional determinism* supported by neo-institutional economists. Recently some scholars want to go the middle course of co-determinism of institution and technology (coevolution between institution and technology).

These economists, from Marx, Schumpeter, even his followers, Neo-Schumpeterian and the New Growth Theorists, argue that technology determines economic growth: The classical theory of economic growth hypothesizes that technology is given, and the neo-classical theory of economic growth presumes that technology is in progress but exogenous. In the model of new growth theory, however, technology is fully endogenous, which reflects a theoretical development trajectory of gradually regarding technology as an endogenous factor of economic growth. By contrast with technological determinism, institutionalists, including old institutional economists (for instance, Thorstein B. Veblen, Wesley C. Mitchell, John K. Galbraith) and new institutional economists (Ronald Coase, Douglass North and Oliver Williamson) stress that institution, not technology, plays a determining role in economic growth. Although old institutional economics wanted to uncover the "black box" of institution which neo-classical economics seldom addressed, this school as a whole was shadowed by technological determinism. But new institutional economics regards institution as an endogenous variable, and argues that institutional innovation and change are a decisive power for economic development. In this sense, new institutional economics as a whole is similar to "institutional determinism" which is characterized by North's doctrine of institutional change and economic growth.

Here I do not want to defy the roles of technology or institution, to criticize technological determinism and institutional determinism for their ignoring the research results from each other: for example, Neo-Schumpeterian theories which focus too much on technology, and never take institution into consideration. Similarly, new institutional economics concentrates itself on institutions and rarely refers to technology. Obviously, focusing on technology or institution might be helpful to form a systemic and coherent theory. However, this may bring about a bias, i.e. excessive preference for its own theories, and then ignore some equally useful research achievements from another side. However, in real economic life, economy is jointly driven by technology and institutions; which are deeply influenced by each other. That is why co-evolutionary theory between institution and technology has been recently developed.

2.3.3 Ongoing Convergence or Divergence: Technology and Institution in Theory

Contemporary economics, institutional economics and evolutionary economics initially focus on institution and technology[33], respectively. Hence, it is necessary to examine their relatively complex relationship. (Original) institutional economists claim that the evolutionary approach is synonymous to (original) institutional economics in the work of evolutionary institutional economists (for example, Hodgson, 1999, p: 18;

[33] Strictly speaking, evolutionary economics here refers to the work of Nelson and Witter (1982), except the contributions of other evolutionary economists who place the role of institution in economy at the very start, for example, the early works of Christopher Freeman.

Groenewegen and Vromen, 1999, p: 105). However, there is an opposite argument that evolutionary economics and institutional economics have different immediate sources and distinct focal orientations (Nelson, 2002). There are possibly some reasons for this troubling phenomenon.

Firstly, scholars in both fields claim that they all draw their inspiration from the work of well-known economists such as Marshall, Veblen, even Commons and so on. That means that both institutional economics and evolutionary economics have common early pioneers. At the same time, as Nelson (2002) stated, both camps share common core assumptions and perceptions as stated above, such as bounded rationality, uncertainty, and some common research interests: for example, the determinants of economic performance, and how economic performance differs across nations and over time. In addition, institutional economics is divided into an original "old "branch, in which evolutionary ideas play a paradigmatic role, and a more recent "new" branch, which lacks a perspective on time, in particular "historical" time.

Secondly, both camps have common research issues, for example, they both deal with the evolution of institutions. In addition, the marriage of the two research traditions is helpful for studying some applied questions such as innovation systems and industrial development, so that the two camps should work together (Nelson, 2002). But this does not mean that there is a theoretical convergence between them. Actually, the two research traditions remain largely autonomous and specific, even if there are some interactions (Brousseau, 1999). This is mainly determined by their respective theoretical orientations.

Finally, both schools have respectively different theoretical orientation. The orientation of institutional economics is to discover the set of factors that mold and define human interaction, both within organizations, and between them. In contrast, the Nelson and Winter's evolutionary economic theorizing focused centrally on the processes of technological advances (Nelson 2002, p: 19) at the very start, with an aim to understand the cause, processes and consequences of economic changes in general (Brousseau, 1999, p: 4). But recent explicit evidences show that the two strands work together again. On the one hand, nowadays the best known scholars in the realm of institutional economics have gradually adopted an evolutionary perspective regarding how institutions are formed and changed , for example, Hodgson (1988, 1993), Langlois (1989) and North (1990). On the other hand, recently institution had been placed at the center of evolutionary theory (see Nelson, 2002; Nelson and Sampat, 2001; Pelikan, 2003).

As regards the realm of economic geography, on the one hand, economic geographers have recently been paid a large amount of attention to both institutional and evolutionary approaches to better understand the dynamics of regional development (for example, Boschma and Frenken, 2003; Boschma and Frenken, 2006a; Boschma and Lambooy, 1999). On the other hand, they made full use of the core ideas and concepts from institutional thinking such as “lock-ins”, “embeddness” and “social network” (e.g. Schamp, 2000, 2002, 2005; Grabher, 1993; Boschma and Frenken, 2009). Institutional economic geography argues that the differences among territories are primarily related to the differences in institutions which is more related to North’s definition of institution (North, 1990) as humanly devised formal law and informal social norms (Whitley, 1992; Saxenian, 1994; Gertler, 1995; Martin, 2000; Storper, 1997). The evolutionary approach, as Schamp indicated (Schamp 2005, p: 617), can be applied to different institutional levels in different ways, that is, the region, the sector, and the firm, depending on which dimensions of space and time are considered.

2.3.4 The Co-evolution of Firms, Technology and Institutions

As pointed out above, though it is not safe to say that institutional economics and evolutionary economics will converge, they surely have some common research interests. The kind of marriage would be useful to understand the complexity in the real economic world. Nelson and Winter’s (1982) pathbreaking research originally concentrated on evolutionary theories of technological changes, but evolutionary economists also tried to bring institutions into evolutionary theorizing (Nelson, 2002; Nelson and Sampat 2001; Pelikan, 2003), and emphasized on co-evolution and the interaction between technology and supporting institutions (e.g. Nelson,1995).

Some literatures made attempts to link technology, industry and institutions together to study their co-evolutionary relationships (e.g Nelson, 1994; 1995; Fatas-Villafranca et al., 2008). Murmann (2003) executed a distinguished dye case (Murmann, 2003). By comparing the development of the synthetic dye industry in Great Britain, Germany, and the United States through the lenses of evolutionary theory, Murmann identified differences in educational institutions and patent laws as the key reasons for German leadership in the industry. Different from previous analyses that focused on technical developments, educational systems, and other influences, and have neglected the role of the individual firm and overlooked the institutional context, Murmann has set out "*to integrate the existing theories that emphasize either environmental or firm-level factors into a comprehensive framework*" (Murmann, 2003, p: 198).

Murmann highlights the mutual relations between individual companies and institutions and successful firms engaged in the construction of organic chemistry knowledge institutions, such as impressive universities, and advanced polytechnic and business schools. These knowledge institutions not only provide highly qualified employees for this sector, but also cooperated closely with the research and development departments of individual companies. At the same time, the two social communities (the firm giants and knowledge institutions) jointly deeply influenced the German patent law. The soundly interlinked scientific networks provided the German system with a number of advantages. This has led Murmann to the following hypothesis: "*the relative strength of a national industry which has a significant input of science or engineering knowledge is causally related to the strength of the relevant science or engineering discipline in the nation and vice versa. Over longer periods, a nation cannot remain weak in one domain and strong in the other. Both domains will either become both strong or both weak.*" (Murmann, 2007, p: 33)

The analysis identifies three causal processes as being responsible for the co-evolution of national industries and national academic disciplines: the exchange of personnel between industrial firms and academic organizations, the formation of commercial ties between the two social arenas, and lobbying by each on the other's behalf. In both social arenas, the exchange of personnel affects the variation, selection, and retention processes, whereas the formation of commercial ties influences only the variation and selection processes, and lobbying impacts only the selection processes.

As Murmann demonstrated, co-evolutionary theory takes into consideration the impact of institutions on the historical development of firms and stresses the causal links between industrial, technological, and institutional dynamics. Hence, a complex co-evolutionary process linking firms, technology, and national institutions resulted in industrial success. But like other previous analyses of co-evolution, this study has been conducted at the national and industrial levels, but not regional level. Accordingly, this gives rise to some questions, for example, can the co-evolutionary theory at the national/ industrial level pioneered by Murmann be applied to a sub-national and regional level? How to link evolutionary mechanism of regional to national levels? My dissertation tries to fill this gap and do a co-evolutionary study at the industrial level and regional level.

2.4 The Geographic Mosaic of Coevolution and Co-Evolutionary Degree and Effect

Co-evolution is one of the major processes organizing the intertwined populations (for example, technology and institution). But co-evolution is an ongoing process so that a geographic perspective is needed. The biggest current challenge for economics and regional development science is to understand how co-evolution operates across broad geographic landscapes, how some regions gained high economic performance while others did not. At the same time, it is necessary to see co-evolution itself as a self-reinforcing process in which the interactive effects and degrees of intertwined populations varied over time.

2.4.1 The Theory of the Geographic Mosaic of Coevolution in Biology

Recently John N. Thompson, an outstanding scholar in evolutionary biology, provides a framework for asking how co-evolution continually reshapes interactions across different spatial and temporal scales (Thompson, 1994, 2005). This framework of "the geographic mosaic of co-evolution" analyzes how the biology of species provides the raw material for long-term co-evolution, evaluates how local co-adaptation forms the basic module of co-evolutionary change, and explores how the co-evolutionary process reshapes locally coevolving interactions across the earth's constantly changing landscapes, and then tries to answer how geographically structured co-evolution differs in various locations. I believe that this intellectual satisfying work would be also important for understanding these co-evolutionary processes in human-altered systems, namely how co-evolution continually reshapes interactions across different spatial and temporal scales.

2.4.2 The Geographic Mosaic of Coevolution in Economy

In fact, we can find similar phenomena of geographic mosaics in economic life. Economic growth is not geographically even. Britain gained the hegemony in textile industry in the late half of the 18^{th} century, continental Europe (Germany and Switzerland) in the 19th century dominated over machine tools, chemicals, and pharmaceuticals etc, but during most of the 20th century America held the supremacy in semiconductors, petrochemicals, computers, and biotechnology. Later the Asian Newly-Industrializing countries (NICs, Japan, Korea) got partial leaderships in electronics, machine tools during the second half of the last century (Nelson and Wright, 1992; Nelson and Pack, 1999; Schamp, 2000; also see Fatas-Villafranca et al, 2008).

There is a well-known fact at some point in the development process of multiple industries that a handful of regions and a small number of firms from the same nation (or from a small group of nations) have reached an unquestionably competitive position on a worldwide level. Today's world economic climate is dominated by the first-class industrial clusters, which have become powerful instruments for building economic capacity for regions to compete in the global market. The typical examples cover the computer technology clusters in Silicon Valley, the financial clusters in New York and London, the movie production cluster in Hollywood, the automotive clusters in Southern Germany and Detroit, the aerospace cluster in Toulouse, the fashion clusters in Northern Italy, software outsourcing in Bangalore, the diamond cluster in Antwerp and others (Porter, 1990). The geographic concentration of competitive industries constitutes the geographic mosaic of material wealth. Here I prefer to call these competitive industrial cluster hotspots of co-evolution among firms, technology and institution. Hot spots are regions in which interacting populations have reciprocal effects on each other's fitnesses through the mechanisms of local co-adaptation and selection and are often embedded within broader surrounding regions in which the fitnesses of at most one of the two species depends on the interactions with the second species (Co-evolutionary cold spots).

2.4.3 Call for a Study on Co-Evolutionary Degree and Effect

There has been no disputation in the field of biology about the idea that species co-evolve as groups of genetically distinct populations. Initially, many biologists believed co-evolution occurred rarely but only under strong pair-wise interaction. From the late 1960s onwards, however, a growing number agreed with Darwin that evidence of co-evolution was far from rare (Winder et al., 2005; Thompson, 1994)[34]. The idea that grass and grazers, predators and prey, mammals and their parasites have not emerged by co-evolution seems implausible, and even absurd. But we should note that

[34] See Thompson 1994 for a history of co-evolutionary biology.

the concept of co-evolution is very fuzzy, because no entity is isolated, all processes interact with their environment and other species, and species and populations are a part of the environment that determines the selection pressure experienced by others. As Winder et al. （2005, p: 356) pointed out, perhaps bees and donkeys have a co-evolutionary impact on each other, but the dynamic linkages between them are so weak and rates of co-evolution are so slow that they can be treated as isolated evolutionary systems at a first level of approximation.

Moreover, the uncritical and direct application of the biological concept of co-evolution to the study of human society is problematic. Even in biology, no population of one species co-evolves with one population of another species within a real biological world. Co-evolution in real species, however, involves multiple interconnected populations, and complex environments (Thompson, 2005, p: 9). From this point, we have to say that, if we can’t carefully examine the degree of interacting link between populations, co-evolution will otherwise make no sense. Another important statement is that we should differentiate positive co-evolution from negative one. Despite co-evolution, like evolution, is a value-neutral concept, the co-evolutionary result can be added to value, for example, good and bad for human welfare. Furthermore, the plea for an examination of co-evolutionary effect and degree is also in connection with a few empirical studies on this aspect in social sciences. Hence I will adopt a dynamic viewpoint to study co-evolution itself, but my geographical level is the level of industrial cluster, a sub-national level.

2.4.4 Co-Evolutionary Degree and Effect at a Regional Level

In order to illustrate this argument more clearly, we can group different types of regions along two axes: the degree of relationship between co-evolving populations (coevolutionary strength: week or strong) and the effect of relationship between co-evolving populations (coevolutionary effect: positive or negative). We can identify four types of regions. First, there are some regions with a lower degree of co-evolution among firm, institution and technology as well as a lower level of positive effect, as referred to ‘cold spots’. A good example is Zhong'guancun before 1980. It was not until the early 1980s that the commercialization of scientific and technological knowledge began in China’s “Silicon Valley” and largest intellect-intensive region where the research and education establishments have been (and still are) densely concentrated (Wang and Wang, 1998).

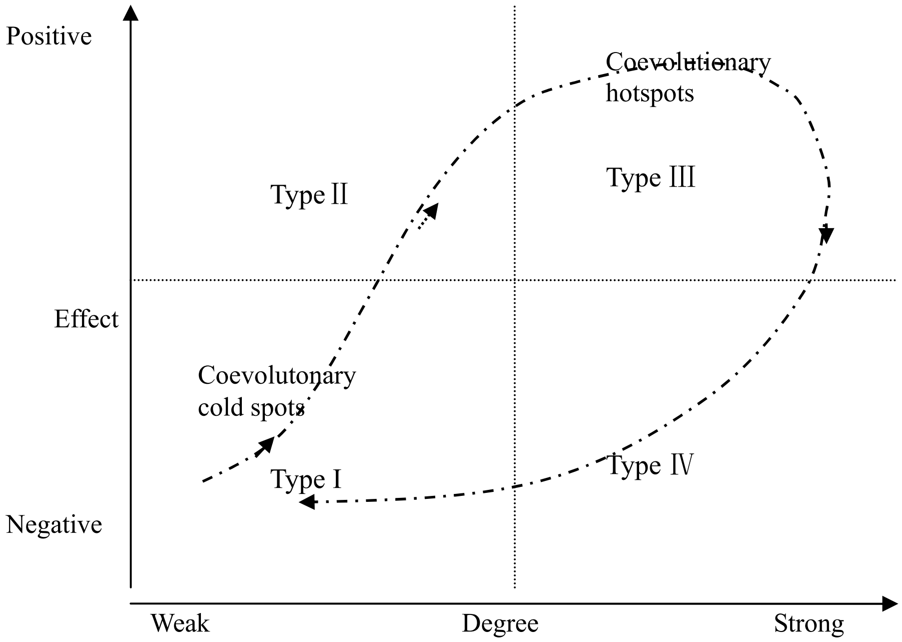


Figure 2.2: Coevolutionary curve of degree and effect

Secondly, there are only a few examples concerning regions with a lower degree of interaction in firm, institution and technology but dominated by a higher positive co-evolutionary effect. One German example is the textile industry in Westmuensterland (from 1980s onwards) in which continuous new entrants, moreover the minor importance of this sector to local society in the terms both of economic and employment contribution, jointly weaken potential lock-ins, and these relatively weak functional, cognitive, and political lock-ins in turn lead to a successful renewal (Hassink, 2007).

Thirdly, at the opposite end of the figure we find some regions in which technology, institution and firms are tightly coupled ("strong co-evolution"), and this higher interaction brings about a "positive co-evolutionary effect". This type of region is what Pouder and St John (1996) define as "a hot spot". Nearly all most successful regions in history can be classified in this group, for example, the information industry in Silicon Valley in California from the 1980s onwards and nowadays top biotechnological clusters over the globe, such as Cambridge Biotech cluster and German BioRhine, the Scientific City in France, the ceramics industry in Sassuolo, Italy, auto manufacturing in the Basque Region, and medical instruments in Tuttlingen, Germany.

Fourthly, there are regions or industries with a high co-evolutionary degree but without so much positive co-evolutionary effect. Nearly all heavy industry complexes in old industrial regions, for example, Wales in UK, the Ruhr Area in Germany, and Great Lakes Regions in America between 1970s and 1980s (Cooke, 1995) belong to this type. The deteriorating performance of a hot spot can also be referred to as the development of ‘core rigidities’ (Leonard-Barton, 1992) or negative ‘lock-in’ (Grabher, 1993)

It is necessary to note that the different types of industries or regions are movable. Generally and theoretically speaking, economic performance rises with strong interacting links between institution, firms and technology. However, extreme strong ties lead them to ignore changes outsides the local community, and further result in a dangerous situation of lower performance. Once on this trajectory, it is not easy to go out, without strong external shocks.

2.5 Conclusion

As I have illustrated above, an embryonic “historical turn” has recently emerged in social sciences. In some sense, the recent development in evolutionary economics and evolutionary economic geography that both regard economy and economic landscape as a dynamic process is a response to the historical turn in social sciences. Bringing history to economic geography is of vital importance to theoretical and methodological foundation. “History matters” is widely accepted by social scientists, but often is simply reduced to the concept of “path dependence”. Although path dependence is very important, with history and memory influencing today and the future system, particularly in co-determining structure of the system (Cilliers, 1998), too strong “history” in this theory makes it very vulnerable to the suspects of historical determinism. When locked into some trajectory, there is little possibility to transform the existing path, and hence history can be known only as an ex post factor (backwards-looking thinking), and there is no place for human creativeness. Accordingly, path creation is also important, considering the huge uncertainty in technology market and even institution (Garud and Karnøe, 2001), it is necessary to add the role of human creativity and intentional actions to the traditional path study. In the redefined model of path creation, powerful and innovative actors make a new path possible. That is, the path breakthrough in the redefined model of path creation is endogenous innovation by traditional entrepreneurs in the Schumpeterian sense and institutional entrepreneurs, rather than the David type of path breakthrough, namely external shock. The path creation' forwards-looking thinking reflects the capability of human intention in the new model. Hence, the combination of path dependence and path creation could be useful to better understand stability and changes of complex systems.

Evolutionary economics as heterodox economics does not focus on economic final results but its processes, and employs biological metaphor and population thinking or complexity system thinking. At the centre of evolutionary economics is novelty (innovation) as the fundamental force driving economic change. This is why evolutionary economists and innovation scholars frequenctly make constructive dialogues. Their research scopes and contents sometimes overlap with each other, i.e. evolutionary economists, for example, Richard Nelson himself, do research on innovation system and at the same time, innovation system scholars such as Bengt-Åke Lundvall and Philip Cooke actively participate in constructing evolutionary economics. Economic geographers who are interested in dealing with the uneven distribution of economic activities over space, surely made an attempt to apply evolutionary economics into economic geography, and contributed to our understanding in the changes in economic landscape. Co-evolutionary economics not only considers the evolutionary process but also emphasizes the relationships and inter-dependence among the different systems (path interdependence), or multiple levels of a single system (multilevel interdependence). Therefore the notion of co-evolution will not surprisingly be helpful to understand the economic world more really.

Institution and technology have been theoretically separated in the past. Recently some theorists want to combine them and make some empirical explorations. The most outstanding one is Murmann's comparative work on the development of the synthetic dye industry in Great Britain, Germany, and the United States through the lenses of evolutionary theory. But most of theoretical and empirical discussions are at the national or industrial level, not regional or local level. An unresolved issue thereby still retains, can coevolution study on the national scale be straightly applied to sub-national scales? Moreover, we must adopt a dynamic view to study co-evolution itself. To do so, I tried to link co-evolutionary degree to co-evolutionary effect. As in biology, co-evolution in economic system also has a geographical dimension. Economic growth is not geographically even, and competitive industries only occur in a few regions in which firm, technology and institution interact in a favorable way, which I call co-evolutionary hotspots.

As previously pointed out (in Chapter 1.2.2), the main aim of my dissertation is to deal with an old but still ongoing question: how do industrial clusters come into existence and how do clusters evolve, but from a coevolutionary perspective. So my research focuses on the intertwined processes of firm organizational change, technological and institutional innovation in a cluster. China has undergone significant changes in many socio-political and economic aspects, among which the most significant are the two transitions, firstly from capitalism to a centrally planned socialism, secondly to a market economy, and industries in China experienced significant changes in firm organization, technology and institution. A good example is the pharmaceutical industry which started from TCM industry, through chemical pharmaceutical technology, and today entered the times of biotechnology. At the same time, large, middle and small-sized pharmaceutical enterprises coexist in this sector, some of them come from overseas. As regards its geographical structure, some geographical concentration of pharmaceutical enterprises emerged in China (see Chapter 3.4.3 and Chapter 3.5), among which the most remarkable are Beijing (biotechnological pharmaceuticals), Shanghai (biotechnological pharmaceuticals), and Shijiazhuang (Chemical pharmaceuticals), Tonghua in Jilin (Traditional Chinese Medicine, TCM). Beijing and Shanghai are the two largest metropolises in which most of China's first-class research institutes and universities in the field of pharmaceutical and medical industries are located, so these two cities' pharmaceutical sectors host a lot of R&D-oriented (foreign) pharmaceutical enterprises and small enterprises run by overseas Chinese students. The Shijiazhuang Chemical pharmaceutical industry is historically based on a large-sized state-run enterprise (today's North China Pharmaceutical Group established in 1958), and has been specialized in Chemical pharmaceuticals. The economic achievement of this sector in Tonghua city, however, is based on neither a R&D-based knowledge advantage nor origin from a large state-run enterprise. In addition to the technological history, though the Tonghua pharmaceutical sector has a long tradition in the production of TCM drugs, it transformed to Chemical pharmaceuticals between 1960s and 1970s and then shifted again to TCM productions after the mid-1980s. The pharmaceutical firms also changed significantly in their form of ownership, for example, from family-run store, state or collective-owned (during the Maoist period), to contracted enterprises or workshops (in the Dengist China), and private firms today. During the time, the firm size also changed. Nowadays, some Tonghua pharmaceutical enterprises have emerged that have relatively large shares in sales across China. So these characteristics of technological change (compared to Beijing, Shanghai and Shijiazhuang), variety in firm organization, together with local institutional change, enable us to better observe the interaction of technology, institution and firm in an industrial cluster.

Chapter 3 Changing Environments for China's Pharmaceutical Industry

3.1 Traditional Chinese Medicine and Chemical Medicine

3.1.1 Pharmaceutical Technologies throughout History

Fundamentally speaking, there have been three pharmaceutical technologies throughout history. Before the arrival of man-made drugs, the human race used natural plants and minerals to cure diseases. More specifically, in ancient times, people experimented with animals, plants and minerals in an attempt to fight against various diseases, with the result that only those cures deemed most, were handed down through the generations as drugs to treat various illnessness. This approach has played an important role in Western medicine from ancient to modern times.

However, the old treatment gradually lost its importance as pharmaceutical synthetic chemistry progressed in Western countries during the 19th century (Efferth et al., 2007), despite of still being used today. The creation of the first proprietary drug Aspirin acetylsalicylic acid that was synthesized by reacting acetic anhydride with salicylic acid from willow bark in 1897 ignited the new epoch of the chemical synthesis of drugs (see Chapter 1.3.3). During the late 19th century, encouraged by their success with synthetic dyes, German companies Bayer, Hoechst and Merck began the chemical synthesis of drugs, by first making analogues and derivatives of active substances found in medicinal plants. Following that, the pharmaceutical industry moved to a new way of science-based drug development.

In the early 20th century, German speaking nations (Germany and Switzerland) occupied, with an absolute advantage, the majority of the chemical synthetic medicine market. The third approach to drug development was the use of the body's own biological molecules to treat disease (biopharmaceutical technology). This approach had already been pioneered in the 1920s by companies such as Lilly, which developed injectable insulin for the treatment of diabetes, but is, in fact over the past thirty years, most closely associated with the rapid advance in biotechnology, and the rise of biotechnology companies. The leading pharmaceutical industry in today's world market has shifted to the United States (for a more detailed description of technological change in the pharmaceutical industry, see Dominguez, 2006; Hulse, 2003).

3.1.2 Traditional Medicine

Traditional medicine (TM) refers to various forms of indigenous medicines, which include plant, animal and mineral based medicines, spiritual therapies, manual techniques and practices, applied singularly or in combination, to treat, diagnose and prevent illnesses or to simply stay healthy. Of the major TM systems, namely traditional Chinese medicine, Indian ayurveda and Arabic unani medicine, and Greek (European) and Egyptian herbal and traditional medicine, perhaps the most sophisticated and most effective remains TCM (Kleinman, 1975; Goldbeck-Wood et.al, 1996; WHO, 2000). Unlike other forms of traditional medicine which have almost become extinct, traditional Chinese medicine continues as a distinct branch of modern medical practice, and has a far-reaching influence on medical systems not only in China, but also in Japan, Korea, Vietnam, and other East Asian regions. It continues to play an important role in the public health care system.

3.1.3 Traditional Chinese Medicine: A Comparative Perspective

As mentioned above, Traditional Chinese Medicine (TCM), one of the world's oldest medical approaches with its unique philosophical framework, different to another Western medical system, is a special form of Oriental Medicine. This traditional approach to treating diseases includes a wide range of traditional medical practices such as acupuncture, moxibustion and Chinese pharmacology (see Chapter 1.3.3). I will now continue with a summation of the characteristics of TCM, compared to Western medicine. Western medicine refers to synthetically manufactured single compounds that target a certain disease.

TCM and Western medicine take different approaches to health and disease. Each approach develops its own advantage in areas, such as chronic diseases and syndromes, gynecological and gastrointestinal problems for traditional Chinese medicine, while acute and catastrophic problems for Western medicine. This means that TCM helps the body to retain or maintain its balance in a step-by-step fashion. The philosophy behind how Chinese medicine should be applied is that a superior treatment consists of dealing with an illness before it appears.

As pointed out by the Medical Classic of the Yellow Emperor (Huangdi Neijing), written between the third and first centuries B.C, which laid the theoretical foundations for TCM, "*when one masters the mystery of the yin-yang principle, one can even enjoy a life as long as nature itself*" (as translated by and cited in Cai, 1998, p: 56), TCM considers a disorder of the human body as a disharmony in the external environment and in the internal body. This comes as a result from changing atmospheric and climatic conditions and an imbalance in a person's psychomental state, i.e. disharmony between two opposite aspects inside the human body, the yin and the yang, which are closely interdependent and constantly interrelated. From this viewpoint, the goal of TCM is consistent with the definition of WHO's 1948 that "health is a state of optimum physical, mental and social well-being and not merely the absence of disease and infirmity".

Western medicine adopts a reductionist worldview and argues that the individual part of physical body functions separately during the course of treatment, while the Chinese medicine treatment is influenced by the more holistic worldview, and sees the human body as a sophisticated organic whole in which each part is interconnected. Accordingly, TCM explains visceral phenomena, physiology and pathology of the body, by the "five phases" principle, somewhat similar to the humorism theory, which consists of five elements: wood, fire, earth, metal and water (Cai, 1998). TCM applies four varying methods for diagnosis, namely, inspection, inquiry, auscultation and olfaction and palpation. However, a final and accurate diagnosis can only be made following an overall and comprehensive analysis. As for the concrete treatment measures, besides acupuncture and dietotherapy as examples, the leading force against disease is the use of an extensive pharmacopoeia of over 6,000 herbal and other natural products.

Although both TCM and Western medicine are based on continuous experimentations and learning by trial and error (today's jargon, learning by doing), the advancement in TCM did not rely on research and development (R&D) based knowledge before the 1980s, but, instead, on constant personal observation - even experimentations with people's own babies, while any new chemical entities are developed in a formal way (formalized in-house R&D programmes). Modern Western medicine is scientific medicine based on the understanding of cellular structures and the organic chemistry of the human body. Compared to their Western counterparts, TCM doctors had a limited understanding of infection, which predated the discovery of bacteria, viruses (germ theory of disease) and an understanding of cellular structures and organic chemistry. Instead they mainly relied mainly on the observation and description of the nature of infections to figure out remedies. Based on theories formulated through three millennia of observation and practical experience, a system of procedure was formed to guide a TCM practitioner in the course of treatment and diagnosis.

3.1.4 Modern Technologies in Traditional Chinese Medicine

In the last thirty decades TCM characteristically involved formalized and organized R&D and scientists from various fields, working together as individuals or more often in teams, using state-of-the-art technology (for example chemical and biological technology) in order to identify and harness the potential of therapeutic compounds of natural herbs, as well as to reduce undesirable side-effects. The involvement of science and technology into TCM is partly caused by adjustments in national regulations of TCM in China and partly by increasing competition among domestic firms, mainly focusing on the domestic market.

The Chinese government began to strictly supervise the pharmaceutical industry in the 1980s, especially after the “Drug Administrative Law” in 1985, “Good Laboratory Practice” (GLP) in 1994 and “Regulations for Approval of New Drug Application” in 1994 (for this apect, see Chapter 3.2.4). According to these new regulations, it is necessary to submit information about the methods of production, quality indices, pharmacological and toxicological testing results as for the safety evaluation of TCM drugs to the pharmaceutical supervisory and administrative department of China, and only on its approval can clinical tests be carried out (for detailed information, see Chapter 3.2.4). Main purposes of clinical studies are: efficacy evaluation, safety evaluation and the establishment of a safe and effective dose range. Thus TCM is also involved in a great deal of in-house scientific experiments, using modern pharmacological knowledge and information, computing science, molecular biology and biochemistry as well.

For example, Shanghai Innovative Research Center of Traditional Chinese Medicine, a top R&D centre for TCM, constructed a TCM database which contains information about more than 30,000 compounds of active ingredients of TCM herbs. This database has been widely used in screening lead compounds, studying mechanisms of TCM drugs, predicting toxicity of herbal combinations as well as creating new TCM formulas, since it provides information on these compounds in a range of molecular structure, biological activity, herbs containing these compounds, toxicity, TCM formula and their clinical application.

3.2 National Institutional Changes

3.2.1 General Review on China's Transition

There were four significant ideological breakthroughs that governed China's economic reform after the death of Mao Zedong in 1976. The first breakthrough was the first wave of "emancipation of mind" driven by the debate on the "judge of truth" in 1978[35]. This debate ended with the speech of Deng Xiaoping at the Central Work Conference before the third Plenum of the 11th Chinese Communist Party Central Congress (CCPCC), affirming that "practice is the sole criterion of truth". Following this ideology, the Chinese leadership endorsed the economic reform and open-door policy at the third Plenum of the 11th CCPCC, which deviated from the development path in the Mao-era.

The second was the endorsement of a socialist planned commodity economy at the 3rd Plenum of the 12th CCPCC in 1984 by which the leadership accepted the elements of market in the economy that deviated from a pure planned economy in the past. These breakthroughs loosened the control of planning instruments, and then strengthened the role of market instruments, while appreciating, besides state-owned ones, other economic components.

The third was that Deng Xiaoping's 1992 Southern Journey re-affirmed the economic reform and open policies. Here, the 3rd Plenum of the 14th CCPCC in 1993 endorsed the shift of economic system to a socialist market economy. Since then China's reform has accelerated the pace of economic reform, and fulfilled significant breakthroughs in both theory and policy. This shift, though still insisting on socialism, has highly appreciated the role of the market in the economy and further loosened the previous ideological constraints. In November 1993, the third Plenum of the 14th CCP National Congress[36] highlighted that companies are to be classified into limited

[35] This was initiated after Mao's death by debating on which path the Chinese development should follow. The conservatives proposed to follow Mao's path, taking "two whatevers" as principle. On the contrary, the reformists or pragmatists recognized the major problem of the past development and proposed to rethink about the past. "Two whatevers" are: whatever Chairman Mao's policies are, we protect them; whatever Chairman Mao's instructions are, we follow them loyally from start to finish.

[36] The Third Plenum of the Fourteenth CCP National Congress marked the shift of the economic reform from a "quantity growth reform" to "an overall advancement.". At the same time, in order to establish the framework of a socialist market economy by the end of the 20th century, the 3rd Plenum highlighted the importance of reforming the state-owned enterprises (SOEs) in addition to macroeconomic reforms of taxes and finance. In the past, due to excessive emphasis on SOE deregulations rather than the restructuring of SOEs, the SOE reform was not effective. For some SOEs, not only did managerial and financial conditions not improve, the situation actually worsened. In view of this situation, the Third Plenum concluded that the direction of the SOE reform should not be deregulation; instead, it should be institutional innovation. After the Third Plenum, we started, on a trial basis, to establish the modern corporate system in some SOEs.

companies and joint-stock companies, and the former was only limited to a state investment company, and that a modern corporate system[37] should be established in State-Owned Industrial Enterprises (SOEs).

The fourth and most recent was the 15th CCPCC in 1997 which affirmed that private ownership is an important component of the economy, and decided to convert state-owned enterprises into entities with Western-type corporate governance. After that, the reform of state-owned enterprises, in particular the reconstitution of property rights, speeded up.

3.2.2 Enterprise Reform and Ownership Transformation

The transformation of the ownership system in communist China can be roughly divided into two major historical periods. The period between 1949 and 1979 was characterized by the attempt of the CCP to establish a new socialist planned economy, based on a complete public ownership, including collective and state sectors, wiping out virtually all private enterprises and any other forms of private ownership. The result of this transformation was the establishment of a Soviet-type command economy in China, although the Chinese economy might have differed from the Soviet economy to a certain degree. The reform period after 1978 was characterized by (a) the micro-management institutional reforms without any changes in ownership during the early reform period, and (b) the effort to transform ownership structures, especially since 1992, from a complete public ownership to the mixed ownership structure with predominant public ownership coexistent with other economic elements such as cooperative, individual (in Chinese, getihu)[38], private, foreign and joint-ventured ones. The post-Mao reform period can be divided into three main stages.

The first stage, from 1979 to 1987, is featured by the decentralization of management or an expansion of managerial autonomy of SOEs. The most important among them[39] is the introduction of the factory director responsibility system (in

[37] A typical "modern enterprise" is defined using sixteen Chinese characters: "clear property right, clarified rights and responsibilities, separation between the government and the firm, and scientific management. In new model of enterprise governance, the ownership of property of the SOE is revert to the state and the maintenance and increase of asset values should belong to the SOE.

[38] Individual enterprise is a Chinese form of self employed enterprise or private entity whose scale is smaller than 8 employees.

[39] The central government issued regulations to expand autonomy in 1979, including (1) the Regulations on Expanded Enterprise Autonomy, (2) the Regulations on Profit Retention of SOEs, (3) the Regulations on the Collection of Fixed Assets Tax, (4) the Regulations on the Improvement of the Depreciation Ratio of Fixed Assets of State-Owned Industrial Enterprises (SOIEs) and the Using method, and (5) the Regulations on Lending of Working Capital.

Chinese, Changzhang fuze zhi)[40] in 1982. At the same time incentives including 'mandatory planning reduction', 'profit-retention mechanisms', 'profit tax reform' and 'production responsibility systems' make enterprises more autonomous. They were allowed to produce more than the plan quota and to sell the surplus to the market. The extra profit was partly kept by the firms. Managers were given monetary rewards explicitly based on their firm's performance. In general the firms (factory director as representative) were given more freedom regarding to make management decisions (on production, marketing, investment, and profit distribution) (Byrd, 1991; Groves, et al., 1994). The new measures caused a dual pricing system. Dual pricing partitioned supplies of industrial products into plan (planned price) and market components (prices responded increasingly to the forces of supply and demand) (see, Jefferson and Rawski, 1994). Later the micro-management reform (1984-1986) shifted the financial obligations of the state enterprises to the government and exposed enterprises to market influences. The reform of 'Tax for Profit' (Ligaishui) [41] namely replaces 'profit remittances' by 'profit tax' [42], and divided public revenues and expenditures between the central and local governments.

The second stage, from 1987 to 1992, centered on the separation of ownership and management by introducing a system of 'contracted managerial responsibility' under which the power to manage enterprises was delegated to managers and directors by contracts, which clarified the responsibilities and benefits between the state and the managers. Here it is necessary to note that such a reform was in essence based on market mechanisms, despite still in the "old" publically-owned ownership framework. Evidently the reform was to clarify the authority and responsibilities of enterprise managers. In 1988 some events with deep historic meanings took place: the Provisionary Regulations on Private Enterprises, the Provisionary Regulations on Corporate Tax on Private Enterprises, and the Regulations on Collecting Adjustment

[40] In the new system, the factory director (or manager) as the representative of SOEs is responsible to the state, for not only the profit presented to the state but also production output, quality, cost and so on, and each unit within the enterprise such as a group, team, and worker is responsible for the fulfillment of work. Wages of staffs are directly related to their fulfillment, while in the old system, the SOE is responsible for the fulfillment of planned targets and for giving profit to the state, without any incentive to improve.

[41] In this reform, the government levied a corporate tax rate of 55% on the large and medium-sized SOEs while still adopting the profit payment system. The objective of this reform was to adjust the phenomena of the 'bian da quai niu' (whipping the fast cow) where the highly productive SOEs at the time of the introduction of the profit retention system had only a low retention ratio because of the low growth of profit and vice versa.

[42] In 1980, the new Regulations on Profit Retention enacted two profit retaining systems, i. e. SOEs in one system, could retain a certain ratio of profit in the previous year as a base, while SOEs in another system, could retain a high ratio of profit in the current year. That means the more productive SOEs are, the higher is the retention ratio during the period between 1980 and 1983.

Tax on Individual Revenues Invested in Private Enterprises were issued. Private economy came back in China once again and could be established legally in China. In terms of labor system contract systems were introduced in the same period.

In the third stage, from 1992 to the present, China's economic reform moved into “building a socialist market economy with Chinese characteristics” by transforming the ownership system into a mixed structure with a dominant public sector and various types of coexistent ownership (Qian, 1999). Since 1992 the enterprise reform focus was to build a Western modern enterprise system with “clarified property rights, clearly defined responsibility and authority, separation of enterprises from the government, and scientific internal management”. After becoming China’s premier in March 1998, Zhu Rongji made it clear that the government would finish the reform of SOEs within three years. The Beijing government has made serious efforts to initiate the reform agenda, for example, the policy of “grasp the big, let go the small” (in Chinese, zhuada fangxiao)[43]. This means that those companies most important to the national economy would be controlled by the central government, while other small and medium-sized SOEs could be directly turned into private firms through policy package measures including reorganizations, mergers and acquisitions, leases, and sales [44]. According to the State Statistics Bureau and the State Administration Bureau of Industry and Commerce, the Chinese economy today has become a mixture of eight sectors: state-owned, collectively-owned, privately-owned, individually-owned, cooperative or joint-ventured, shareholding, foreign-owned and others (including Hong Kong, Macao, Taiwan and other overseas Chinese- invested).

3.2.3 Changing China’s Science and Technology Management System

(1) Science and Technology Management System before the Reform

When the Communist Party assumed political control over China in 1949, the R&D administrative system focused exclusively on military industry. After the Sino-Soviet relationship fell apart, China became a “politically isolated island” and had to give priority to R&D and industries concerning the national security. This period before

[43] This guiding principle of SOE restructuring means that the government wanted to keep control of the biggest and most important companies, but woluld let the smaller ones fend for themselves. The Beijing government decided to keep 500 to 1,000 large SOEs inside of a few critical sectors under state ownership, and attempted to corporatize or restructure the SOEs into giant conglomerates, shareholding companies or shareholding cooperatives based on the competition of the market and to transform all other mall and medium-scale SOEs that run losses through policy package measures including reorganizations, mergers and acquisitions, leases, and sales.

[44] During the pivotal reform stage, SOEs went through a huge wave of downsizing, and the new phenomena of unemployment and layoff. To cope with this big social issue, a brand new social security networks started to take its shape.

the 1978 reform was characterized by: firstly, primary activities were distributed among thousands of functionally specialized organizations, and organizational boundaries were essentially defined by the type of activity; secondly, the power of decision-making (both operational and policy-related) was distributed vertically and horizontally (tiao/kuai) among a large number of governmental secondary actors with mandates defined by type of activity (such as education), industry (such as pharmaceuticals, machinery, and electronics) and institution (such as pricing), or what Lieberthal (1992) described as "fragmented authoritarianism"; thirdly, the dominant performance criterion for primary actors was scale of output, without any explicit attention to efficiency or, in practice, quality of output (see Liu and White, 2001; Xue,1997).

Hence under this rigid bureaucratic system manufacturing organizations acquired knowledge from governmental laboratories and then made production; at the same time government laboratories which were completely financed by center or local governments focused on R&D, regardless of the market potential of scientific achievement; universities contributed most of their resources to talent training. S&T activities at public research institutes (PRIs) and production at state owned enterprises (SOEs) were completely separated (Xue, 1997). Few S&T outputs at PRIs were efficiently transferred to industries, and since PRIs got research funds and other expenditures on the base of the number of employees in the institutes rather than the research performance, PRIs had no incentives to understand the needs of enterprises for technology (Motohashi, 2006). In the case of the pharmaceutical industry (the sub-industry of TCM), there is no direct link of knowledge between pharmaceutical manufacturing organizations and research institutes.

(2) Science and Technology Management System in Transition

A famous and profoundly influential proposition, "science and technology is the first productive force", by Deng Xiaoping at the very beginning of the economic reform, broke the long-standing neglect of intellectuals and began to mobilize scientific and technological personnel, who were tightly restricted during the Cultural Revolution. Some evidence showed that China began to reorient R&D activities from military to civilian products. For example, the Chinese government explicitly stated that "economic development must rely on science and technology, and science and technology must be oriented towards economic development" in 1982, and civilian technologies became the focus projects in the Sixth Five-Year Plan (1981-1985) (for a list of eight fields in this plan, see Sun, 2002, p: 481).

Before the reform research projects and R&D funds were allocated by corresponding level governments. The funding system was the focus of the reform and government-funded research institutes had to obtain funds from other channels. So new market institutions such as the technology market were introduced and technology trade was no longer considered illegal. At the same time S&T personnel was encouraged to "jump into the sea" (go to the market and become entrepreneurs), and the old funding assignment approach was replaced by a bidding system in 1986.

Table 3.1: Major national innovation programs in China

Policies	Dominant features	Year
Sparkle system	Promoting basic research in agriculture	1985
863 program (national high-technology research and development program)	High-tech promotion Enhance international competitiveness and improve overall capability of R&D in high technology	1986
National Natural Scienc e Foundation	Promote and finance basic research and some applied research	1986
Torch program	High-tech commercialization, high-tech zones establishment	1988
National S&T achievements spreading program	Promoting product commercialization	1990
National engineering technology research centre program	Technology transfer and commercialization of research products	1991
Climbing program	Promoting basic research	1992
Endorsement of UAEs by SSTCC	Promoting university and industry linkage	1992
S&T progress law	Technology transfer, S&T system reform	1993
Decision on accelerating S&T progress (CCCP)	Promoting URI-industry linkage	1995
Law for promoting commercialisation of S&T achievement	Regulating the commercialisation of S&T achievement	1996
Super 863 program	Commercialization, break-through in key areas	1996
Decision on developing high-tech and realising industrialisation (CCCP)	Encouraging technology innovation and commercialization	1999
Guidelines for developing national university science parks	Accelerating the development of university science parks	2000

Source: compiled by the authors from various MOST sources.

Since 1985 China formulated a series of general programs for scientific and technological research and development, aiming to improve China's competitiveness through science and technology (see Table 3.1).

For example, The Natural Science Fund Committee (NSFC) for basic research; The National Hi-tech R&D Program (or 863 Program) for the development of hi-tech technologies[45] including bio-technology; the Spark Program for rural economy through

[45] The hi-tech field in this project includes biotechnology, space, information, laser, automation, energy, new materials and oceanology technology.

science and technology; The Torch Program in 1988 for the application of research results by establishing some high-tech industrial development zones.

The reform during the period from 1978 to 1992 was merely limited to technology transfer, from knowledge production to application. The reform of science and technology management system after Deng Xiaoping's tour of southern China was characterized by a shift from the previous emphasis on technology transfer to systemic approaches with the major aim to build up an enterprise-centered innovation system. During this reform period PRIs have gradually lost their dominant role as main research actor, while enterprises have taken their losing role instead, and industrial enterprises became the primary force for technological innovation (Lundin and Serger, 2007, also see Table 3.2).

Table 3.2: Inputs of R&D in China in transition

Types	year	Number of R&D institutes	R&D personnel (in 1000 persons/year)	R&D expenditures (in 100 million yuan)	R&D expenditures (in %)
Public research institutes	1987	5,222	106.8	106.8	60.7
	2003	4,169	399.0	399.0	25.9
Universities R&D units	1987	934	7.0	7.0	4.0
	2003	3,200	162.3	162.3	10.5
Enterprise R&D units	1987	5,021	62.1	62.1	35.3
	2003	11,300	960.2	960.2	62.4
Others	1987	n/a	n/a	n/a	n/a
	2003	3,300	18.1	18.1	1.2
Total	1987	11,177	175.9	175.9	100
	2003	21,969	1539.6	1539.6	100

Source: website of Missions of the Ministry of Science and Technology of P.R. china, http://www.most.gov.cn/eng/statistics/
Note: n/a means non-available.

In 1995, the "Decision of the State Council Concerning the Deepening of the Reform of the Science and Technology Management System" specified that a closely integrated mechanism of scientific research, development, production and the market should encompass an enterprise-centered technology development system, a scientific research system with scientific research institutions and the institutions of higher education as its main body, and a socialized scientific and technological service system. However, it was clearly seen that those three systems were parallel and independent of each other, and not in an integrated policy framework. It is noteworthy that this differed from previous reforms. One of the reform targets during this period was the organization of higher education and their affiliated scientific research institutions in particular. Various forms of linkage between universities, government-sponsored institutes and enterprises were encouraged to develop. University staff was legally allowed to take part-time or full-time jobs in enterprises or establish their own enterprises (see, Zhong and Yang, 2007).

The National Congress of Technical Innovation in 1999 is a landmark which means China formally embarked to become an innovation-driven nation. “National Medium- and Long-Term Science and Technology Development Planning (2006-2020)” identifies innovation as the new national strategy, placing innovation capability as the strategic basis for S&T development and the core of industrial restructuring and growth mode of transformation. The main goal was to consolidate the ability for independent innovation and to make China an innovation-driven economy by 2020 (Xinhua News Agency, 2006). In addition, what is most prominent in this planning is that most of the innovation policies aim at enhancing the innovation in various enterprises, especially SMEs.

More interestingly, the number of new drug applications of foreign-invested companies in China has been increasing. The number of American applicants has reached about 40% of the non-Chinese applications, followed by Japan, Germany, France, Britain, and Switzerland, see Table 3.3.

Table 3.3: Foreign new drug applications in China

year / country	1997	1998	1999	2000	2001
U.S	618	494	634	924	824
japans	308	212	242	377	375
Germany	219	151	212	270	264
France	107	89	90	124	160
Britain	80	108	92	148	159
Switzerland	86	96	76	118	136

Source: Dai and Wang (2003)

3.2.4 Changing Registrations on Drug and Healthcare System

(1) Changing National Regulatory System

After 1949, the Ministry of Health had controlled China’s pharmaceutical regulatory system until 1979. The Ministry of Health and the State Pharmaceutical Administration of China were jointly responsible for the management of medicine after 1979 (Deng and Kaitin, 2004). The Bureau of Drug Policy Administration (BDPA) is an agency of the Ministry of Public Health (MOPH), which filled a function similar to that of the Food and Drug Administration in the U.S., and enforced the Chinese pharmaceutical law. The State Pharmaceutical Administration of China (SPAC) was set up in 1978 as an MOPH daughter agency. It supervised all activities relative to pharmaceutical R&D, manufacturing, sale and distribution. Since 1993 the SPAC's duties have been limited to reviewing and approving the administrative protection of pharmaceutical products. A new regulatory agency, the State Drug Administration (SDA), was established in 1998 by consolidating the SPAC, BDPA and the State Administration of Traditional Chinese Medicine (SATCM; similar to SPAC but only responsible for regulating traditional Chinese medicine), to conduct drug regulation and ensure the safety, effectiveness and reliability of medical products, directly under the State Council. It was transformed into the State Food and Drug Administration (SFDA) in 2003.

(2) The Regulation and Approval of New Drugs in China

Although the Chinese Ministry of Health published drug regulation to manage new drugs as early as in 1963, and the Ministry of Health as well as the State Pharmaceutical Administration of China in 1979 joined the New Drug Management Regulation, pharmaceutical manufacturers did not need to conduct systematic scientific experiments on new drugs. It was very easy for pharmaceutical manufacturing companies to receive the approval from the provincial department of health to market in China (Deng and Kaitin, 2004).

The Drug Administrative Law marked the beginning of a new era of drug regulation in China as the first law in China in 1985 (revised in 2001), because it established a legislative process for the regulation of drug manufacturing, distribution and new drug development. It was the first time that premarket testing and an approval for new drug products were required. In the same year a new regulation, "Provisions for New Drug Approval", was also issued by the Ministry of Health to require providing adequate preclinical data to verify the new drug's safety and to justify the commencement of clinical tests. "Drug" refers to a substance used for the prevention, treatment and diagnosis of human diseases, and with the object of regulating human physiological functions, with stipulated indications, usage and dosage, including TCM (Chinese medicinal materials and Chinese medicines sliced and prepared for decoction, prepared Chinese medicines), Western medicine (chemical raw material drugs and their components, antibiotics), biochemical drugs and so on. "New drugs" refered to those drugs which have never before been produced in China. Thus these new regulations were applied to TCM new drugs. It is not until 1988 that China promulgated the first importation rule to require imported drugs to be registered.

Table 3.4: Key regulatory and institutional events in the Chinese biomedical industry

Year	Event
1983	Drug distribution (centrally controlled supply system to market-oriented demand system
1984	The first patent law in China.
1984	The introduction of Good Supplier Practice (GSP), as recommendation.
1985	Drug administration law
1985	Enforced drug quality control
1985	Enforced regulating drug market
1987	Technology trade was permitted.
1992	The first revision of the patent law, in which biomedical products (chemicals/drugs) became patentable.
1994	Good Laboratory Practice(GLP)
1994	Regulations for Approval of New Drug Application, toxicological experiments for the safety evaluation of TCM drugs
1997	The introduction of Good Manufacturing Practice (GMP), as recommendation.
1998	State Drug Administration (SDA) was established.
1999	Good Clinical Practice (GCP) was introduced.
2000	The second revision of the patent law, in accordance to TRIPS.
2001	China' WTO accession, which implied specific conditions for biomedical industry.
2001	Good Supply Practice (GSP) became compulsory for medical- and pharmaceutical products.
2003	State Food and Drug Administration (SFDA) was established.
2004	GMP became compulsory for medical- and pharmaceutical products.

Source: Liu and Lundin (2007), Deng and Kaitin (2004) and Dong at el (1999)

To further protect the domestic pharmaceutical industry, China's State Drug Administration (SDA) issued the Regulations on New Drug Protection and Related Technology Transfer in April 1999. The regulations provided a 6-12 year period of legal protection for five different categories of new drugs. During that period a large number of Chinese generic drugs, which might have been patented drugs outside China, were protected as new drugs by the Chinese legislation, and thus sales expanded vigorously in China. In the same year Good Manufacturing Practice (GMP) was carried out. In the following years Good Clinical Practice (GCP) and Good Supply Practice (GSP) were introduced.

China's Patent Law was first enacted in March 1984, and it excluded drugs from patent protection, among other things. In the first patent law chemical entities were not patentable in order to protect domestic producers of generic drugs. This law, however, provided patent protection for the manufacturing methods of pharmaceuticals. China's Drug Administration Law, which was issued in September 1984, specified that pharmaceutical products that had never been manufactured in China, hence were new drugs. The law allowed Chinese pharmaceutical companies to replicate foreign drugs that had not been manufactured inside China even if they had been manufactured outside elsewhere or had been marketed inside China.

Table 3.5: Intellectual property rights system for pharmaceuticals in China

Protection System	Year in Force	Types of Patents and Protection Period
Trademark Law	1985	Marketing brands of drugs (10)
Patent Law	1983	Invention patent (20 years) Utility model (10 years) Design of patterns and packages (10 years)
Administrative protection[(a)]	1993	Applicable only by foreigners from some countries; 7.5 years
Protection Regulation for traditional Chinese medicine[(b)]	1993	Administrative protection for TCM; Applicable for TCM produced in China according State Standard; (30, 20, 10 or 7 year).
New Plant Variety Protection Regulation	1997	Artificial or development plant varieties 20 or 15 year

Source: own elaboration based on collected data

Notes: (a) Administrative protection must be meet conditions: (1) not applicable for patents that were in china before January 1, 1993; (2) received exclusive right in local nations between January 1, 1986, and December 31, 1992; (3) no sales have been made in china before the date of applying for administrative protection;

(b) the samples should meet the request of State Standard

Before the revised Chinese Patent Law in 1993, patent protection for intellectual property rights of new drugs mainly depended on administrative protection. Since 1993 two parallel systems of Patent Law protection and Administrative protection coexist. The administrative protection of patents here refers to the protection of intellectual property rights on drugs according to the administrative regulations by state administrative organs. At present the intellectual property rights related to pharmaceuticals can be protected in the following five protection systems (see Table 3.5).

(3) Drug distribution network

The Drug industry in China, similar to other sectors, also went through the centrally planned system to a market-based economic structure. In the planned economy manufacturing and distribution were separated, namely the manufacturing factories produced the drugs and the business sectors (drug wholesale station and drug station) sold the drugs. Specifically, the state-run enterprise produced drugs were distributed directly to province-level state-run drug wholesale stations and then to prefectural and county drug wholesale stations, finally to hospitals and drugstores. The hospitals usually purchased drugs from corresponding level drug stores (see Figure 3.1, Dong et al, 1999).

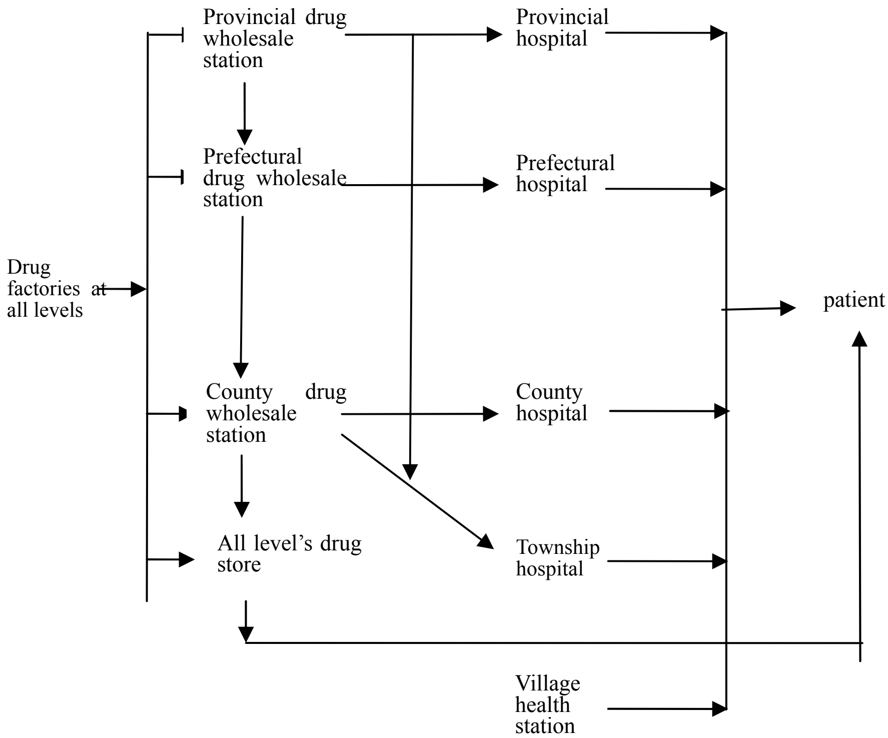


Figure 3.1: Old distribution network of pharmaceuticals in the planned economy
Source: Dong et al 1999

The centrally controlled and highly vertically organized supply system of drug distribution began to move to the market-oriented demand system in 1983. Figure 3.2 shows the new pharmaceutical distribution network, which is more complex than before and similar to the Western pharmaceutical distribution system. In the new distribution system pharmaceutical manufacturers can sell their products not only to the drug wholesale stations or other drug trading companies, but also directly to hospitals and drug stores. Salesmen on behalf of the drug factories or drug companies directly contact hospitals to persuade them in order to prescribe their products.

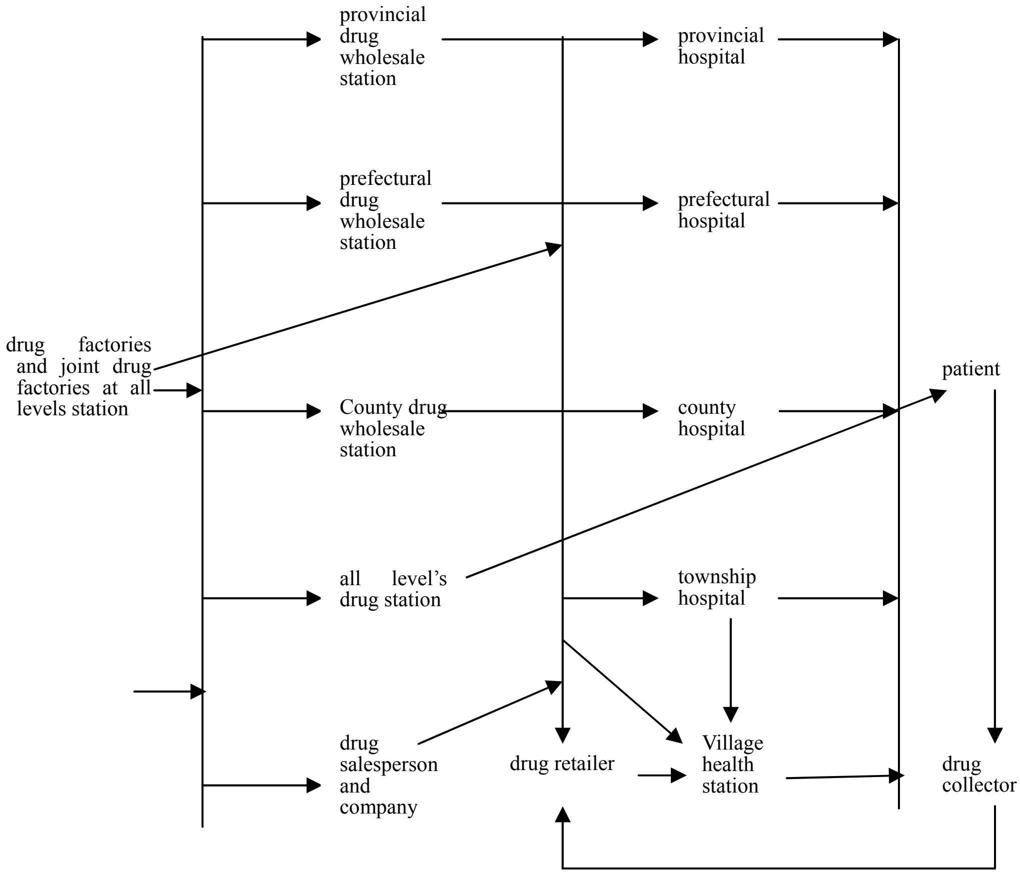


Figure 3.2: New distribution network of pharmaceuticals in the market economy
Source: Dong at el 1999

(4) Changes in Health Care Institutions

After 1959, Chinese rural areas carried out a Rural Cooperative Medical Care System together with the Rural Cooperation Movement. The Rural Cooperative Medical Care System witnessed an unprecedented development. In 1962 the coverage of the Rural Cooperative Medical Care System jumped up to 10%, and by 1976 it was over 90%. But since the Rural Household Contract Responsibility System was implemented in the late 1970s, the rural collective economy quickly collapsed and so did the Rural Cooperative Medical Care System. From its peak of 90% in 1978 the coverage descended sharply to only 5% of the country in 1989. The Chinese government once again considered rural medical insurance and wanted to rebuild the Rural Cooperative Medical Care System, mainly relying on the local governments' administrative impetus. Since 2003 the central government began to financially invest in this project.

In the planned economy urban residents in China shared the right to receive free medicinal care. Those who worked in state and collective enterprises, employees and their families received coverage by an employer-paid medical security system, while employees serving the government would enjoy medical care, financed by government funding. After the economic reforms some new problems appeared. State-owned enterprises with poor profits could no longer afford a sufficient medical insurance fund for their staff, and the non-state-owned enterprises (the private and foreign enterprises) were not mandated to provide medical welfare. As a result, 44.8% of urban residents and 79.0% of rural residents had no medical security and had to pay out-of-pocket, according to data from the Third National Public Health Service Survey in 2003 (Liu and Yin, 2006).

Today China's total health expenditures are divided into three parts: government, social security and individuals' finance. Since the 1980s government budget for health expenditures has been in a slow growth, individual health expenditures have increased relatively to total health expenditure. Figure3.3 shows that individuals are responsible for the increase in healthcare expenses. In the government budget expenditures dropped to 17%, in a sharp contrast, and the 53.6 percent of China's total health expenditures was taken by individuals.

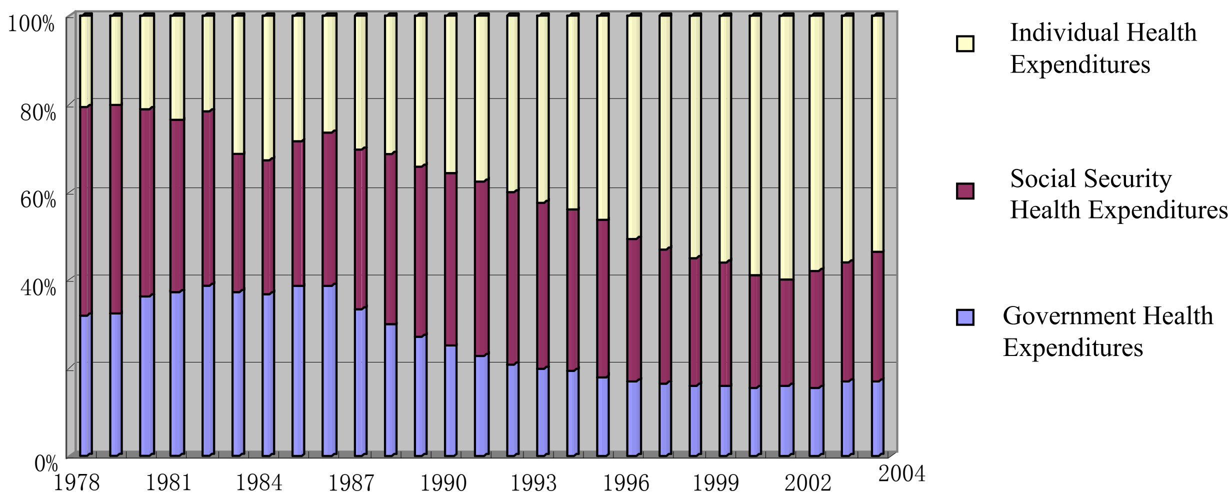


Figure 3.3: Payment Structure of Healthcare Expenditure in China（1978-2004）
Source: the website of the Ministry of Health (MOH) of China (www.moh.gov.cn)

(5) The Market Openness

In 1998 the first foreign investor, the Japanese Otsuka Pharmaceutical Co. Ltd., came to China and established a joint venture with Chinese manufacturers and distributors in Tianjin (China National Pharmaceutical Industry Corporation, China National Pharmaceutical Foreign Trade Corporation and Tianjin Pharmaceutical Holdings, Ltd.). Later on several multinationals established their business units in China. The WTO accession in 2001 brought market openness in a broader range of fields, such as distribution and service (see Table 3.6). Most of the top global pharmaceutical players have affiliates and operations in China today. At the same time the strong presence of foreign firms also imposed competitive pressure on the Chinese pharmaceutical enterprises.

In recent years, multinational companies in China expanded investment in the field of China's medicine market. At the end of 2006 the number of foreign owned and joint pharmaceutical ventures in China was more than 1,500, accounting for 30% of the total. For market share sales of foreign-funded enterprises in China accounted for around 25% of the entire pharmaceutical market. In the major cities foreign drugs and drug imports have occupied 60% to 65% market share. The hospital market is the main terminal market of foreign-funded pharmaceutical enterprises in China. All of top 10 hospital market leaders in 2006 are foreign-funded pharmaceutical enterprises. In addition, after the first foreign R&D center in China was founded by Novo Nordisk from Denmark in 2002, the world leaders in pharmaceutical companies have set up their own R&D centers in China, including Roche, Pfizer, Novartis, GlaxoSmithKline, and AstraZeneca.

Table 3.6: WTO pharmaceutical market timeline

	Distribution and Logistics
2001	China-foreign joint venture distributors were allowed.
2004	All restrictions on foreign involvement in pharmaceutical distribution were removed and foreign firms could start to distribute pharmaceutical products.
2007	All restrictions on foreign ownership of chain store pharmacies will be lifted.

Source: Ernst and Young, 2005

3.3 Market Demand and Market Consumption

3.3.1 Population Explosion and Ageing Population

In the past 60 years China's population grew explosively (see Table 3.7); the population policy has also gone through birth encouragement during the era of Mao Zedong to the Birth control during the late 1970s. The implementation of the "one child policy" in the early 1980s coincided with the coming of the age of the "baby boom" generation, and the birth rate slipped back up to 23.33 in 1987 before subsiding steadily to reach 16.03 in 1998, pulling the natural growth rate (birth rate minus death rate) down from 16.61 to 9.53 over the same period. Hence, population ageing is unprecedented without parallels in Chinese history. The official total population figure at the end of 2003 is 1,307.6 million, a quarter of the world's population. Due to the coming of the ageing society and rapid economic development, the well-off people enhanced health awareness and increased demand for medicine, both in quality and quantity.

Table 3.7: Population growth and population structure by age (1953-2000)

Item	1953	1964	1982	1990	2000
Total population (million)	594.35	694.58	1,008.18	1,133.58	1,265.83
Population by age group	%	%	%	%	%
0-14 years	36.28	40.69	33.59	27.69	22.89
15-64 years	59.31	55.75	61.50	66.74	70.15
65 years and older	4.41	3.56	4.91	5.57	6.96

Source: China health statistics yearbook, 2006

3.3.2 Climbing Healthcare Expenses

In addition to population growth, the ageing society and increased health consciousness, there is another economic reason for the huge increase in pharmaceutical consumption.

The constantly rapid economic growth brought about ever-improving living standards, and accordingly more expenses on health care. Figure 3.4 illuminates the growth of China's total health expenditures from 1978 to 2004 and the proportion of the total health expenditure to GDP.

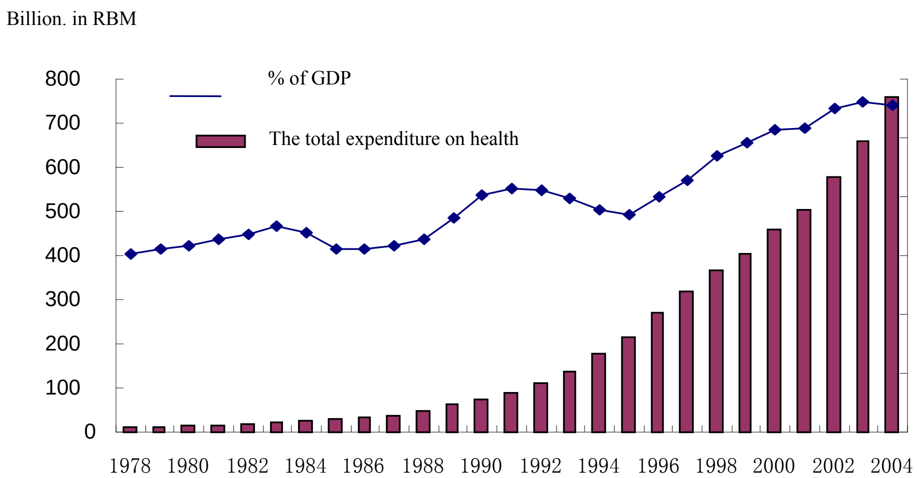


Figure 3.4: Total healthcare expenses in GDP (1978-2004)
Source: China health statistics yearbook, 2006

China's total health expenditure rose to more than 755 billion Yuan in 2004, from just over 10 billon Yuan in 1978. That is an increase of 68 times in less than 30 years. The per capita total health expenditure increased by 50 times, from 11.5 Yuan in 1978 to 583.9 Yuan. The proportion of the total health expenditure to GDP in 2004 reached 5.55%, while the number in 1978 was 3.04 %.

3.4 The Evolution of China's Pharmaceutical Industry and Geographical Patterns

3.4.1 Introduction of Western Medicine before the 1950s

The development of medical products and medical care in China has traditionally been characterized as Traditional Chinese Medicine (TCM), which has existed and been accepted for the last 4,000 years and still holds an important position in health care in China (Efferth, 2007). Tongrentang and Huqingyu, today's two predominant producers of TCM, were founded in 1669 and 1874 respectively and engaged in both manufacture and retail sales, operating drug stores. However, the traditional TCM enterprises were mainly operated by families, and were responsible for disease diagnosis, drug production, and retail, mainly for local inhabitants. As a consequence, TCM stores were almost small-scaled and distributed evenly throughout China.

It was not until the Opium War in 1840 that the so-called modern China's pharmaceutical manufacturing enterprise in terms of mass production and scientific technology had come into existence in China. The formation of the "modern" pharmaceutical industry in China is historically related to the introduction of the Western medicine. The introduction of the Western medical system into China can be traced back to the 16th century, by missionaries from Europe like Matteo Ricci. The

Western medical system, however, had no virtual impact on China's medical care system before the 1840s, because Western medicinal knowledge in the form of Chinese translations was not widely disseminated and merely limited to a few intellectual elites. After the Opium War, this situation changed gradually and considerably. Western medicine and the Chinese medicine began to co-exist in China. Firstly, some doctors from the U.S. and Europe, like Dr. Thomas Richardson Colledge and Dr. Livingstone, who ever served for the East India Company, practiced just in several limited coastal cities, mainly port cities such as Guangzhou and Macao. Secondly, Western medicine swarmed into China with foreign traders in China. Thirdly, the bulk of foreign-invested hospitals and clinics (see Table 3.8) was erected in coastal areas (Liu and Lundin, 2007).

Table 3.8: Geographical distribution of foreign- sponsored hospitals and drugstores in China (1921)

	No.of hospital	No.of drugstore	total
Fujian	41		41
Jiangsu	34	6	40
Guangdong	39		39
Hubei	27	8	35
Hebei	24	7	31
Jiangxi	12	19	31
Northeast China[(a)]	25	6	31
Zhejiang	19	9	28
Henan	16	11	27
Shanxi	11	12	23
Hunan	18		18
Gansu	2	12	14
Guizhou	3	6	9
Anhui	8		8
Guangxi	4		4
Total	283	96	379

Source:http://www.cintcm.com/lanmu/zhongyi_lishi/jindaijuan/xiyi/mulu/diyizhang2.htm
Note: Northeast China includes three northeastern provinces (Heilongjiang, Jilin and Liaoning).

Chinese people began to operate their own pharmaceutical industry after the "Westernization Movement" (1860s-1890s). In 1900 China's first pharmaceutical manufacturing company was founded in Shanghai by an English businessman named Star Talbot. From then on, the Chinese began their own pharmaceutical manufacturing industry. Generally speaking, most of China's pharmaceutical manufacturers gained their experience from being traders to become producers, i.e. firstly specialized in commerce of Western medicine and then transformed to chemical drug producers. Apparently the business model is closely related to the fact that Shanghai and Guanzhou were highly populated cities with foreign importers of medicine. In the case of Shanghai the number of Chinese funded pharmaceutical manufacturers during the First World War was as high as 24 and increased immensely to 58 in 1936. Guangzhou had about 30 pharmaceutical enterprises in 1938. During the Japanese invasion of China, the pharmaceutical industry in occupied territories was controlled by Japanese drug businessmen, and thereby the Chinese local pharmaceutical industry was almost ruined. However, Shanghai seemed to be an exception, because most of Shanghai pharmaceutical enterprises were located in the concession areas and received protection before the outbreak of the war in the Pacific in December 1941.

It is noteworthy that the pharmaceutical industry in other Chinese regions under the leadership of CCP during a time span from1937 to 1949, also developed to a given degree. There are two aspects of the significance for the succeeding regional development of the pharmaceutical industry. The first is that the early established pharmaceutical companies played a part of incubators. For example, the foundation of Shandong Xinhua Phara in 1943 opened a window for the Chemical medicinal industry. Historically the enterprise had a variety of relations with other local pharmaceutical enterprises. Some of the latter directly stemmed from it, others learned a lot from it in the planning system, and more recently, it gave birth to new local entrants in this sector. The second is a large number of professionals and experts as pharmaceutical engineers and drug researchers whom the CCP trained before 1949. They became the first generation of intellectuals who either worked in universities or served as managers for the new state owned pharmaceutical enterprises after the foundation of PRC. Notably the Eighth Route Army Health School established in 1937 in Yan'an was an important predecessor of today's China Medical University in Shenyang and Shenyang Pharmaceutical University. Another, the later Bethune Medical University (currently affiliated to Jilin University), can be traced back to Bethune Medical School in 1939. The three universities offered a mass of talents for the development of the Chinese pharmaceutical industry, particularly in Northeast China.

3.4.2 Highly Fragmented Geographical Layout before the Mid-1990s

In the first five year planning period (1953-1958), a few large-sized pharmaceutical enterprises were erected as key industrial projects. The North China

Pharmaceutical Factory (currently North China Pharmaceutical Group Corp, NCPC) in Shijianzhuang (which is the capital of chemical pharmaceuticals) and Taiyuan Pharmaceutical Factory (that was merged by NCPC), two of 156 Soviet-Assisted Projects, were formed in 1958 and 1960 respectively. Through construction of large new state-owned firms, nationalization of established private enterprises, reconstruction and expanding existing workshops and factories into mass production producers, China established basically integrated chemical and pharmaceutical industries. This marked a new era in China's pharmaceutical industry, totally breaking the decades-long situation in which most Western drugs could not be produced locally and thus China was forced to be highly dependent on imports.

However, after the first five year planning period, almost all established largest state-owned pharmaceutical enterprises were situated in province-level cities. In a quite long period, i.e. approximately from the 1960s to 1978, a great lot of middle and small pharmaceutical enterprises was established by local governments in non-metropolitan areas, even peripheral small cities, under the misguiding principle of "Self-Sufficiency". This irrational investment resulted in a highly dispersed geographical lay-out of the pharmaceutical industry at a very early stage of development. Driven by the unreasonable massive investment, mainly from government, China's medicine market enjoyed a high rate of growth. An average annual increase of 10.2% was achieved. The national aggregate sale of medicinal products in 1978 was RMB 5.03 bn., compared with RBM 0.46bn. in 1953, despite of a slight setback between 1962 and 1965 owing to the policy of "a significant reduction of the growth rate of industrial production and adjustment of industrial structures" framed in 1962 (See Table 3.9).

Table 3.9: Gross sales of China's medicinal goods before 1978

Unit: RMB hundred million

	Medicine	Medical Instruments	Chemical Reagents	Total
1953	3.3	1.1	0.2	4.6
1957	9.3	1.9	0.4	11.6
1962	19.0	2.3	0.7	22.0
1963	17.2	3.3	1.2	21.7
1970	21.6	4.2	1.6	27.4
1975	33.9	6.2	2.3	42.4
1978	39.0	8.3	3.0	50.3
Total growth (%)	1,081.90	654.5	1,400	1,043.20
P.a. growth (%)	10.4	8.4	11.4	10.2

Source: ICC of SDA, 2000: p: 152

Note: Medical instruments for 1953-1978 include glass apparatus

Since the implementation of the opening-up policy in 1978 the importance of the pharmaceutical industry in China's national economy has risen steadily. The annual sales increased by 17% between 1978 and 1997 with an exceptional annual growth rate of 22% during 1990–1995, which was nearly two times larger than GDP growth each year (See Table 3.10). However, the rapid growth also brought about the second wave of excessive investment. Since the introduction of fiscal decentralization with the economic reform local governments had a strong incentive to expand financial revenue. Given that background, almost all county-level governments established at least one (normally one Western medicine and one additional TCM) pharmaceutical plant. Moreover, local protectionism, following the decentralization of economic decision-making in the middle of the 1980s, undoubtedly consolidated this spreading situation of the pharmaceutical industry (Bai et al., 2004). Excess investments in this industry together with low research and development capability for introducing new drugs consequentially led to a series of severe issues, such as idle production equipment, small firm size and medical accidents caused by unqualified drugs.

Table 3.10: Gross Sales of China's Medicinal Goods from 1978 to 1997

Unit: RMB hundred million

	Medicine	Medical Instruments	Chemical Reagents	Glass Apparatus	Total
1978	39.0	8.3	3.0		50.3
1980	42.0	6.9	3.1	0.8	53.5
1985	61.3	10.3	4.2	1.2	120.6
1990	177.2	24.7	9.0	2.8	365.0
1995	464.0	42.6	12.4	4.2	803.6
1997	607.8	42.4	10.5	3.5	998.9
Total growth (%)	1,458.5	408.4	250.0	337.5	1,885.9
P.a. growth (%)	+15.5	+8.9	+6.8	+8.1	+17.0

Source: CC of SDA, 2000: p: 152.

Note: There are six major kinds of medical commodities in China after 1985, including medicine, medical instruments, chemical reagents, glass apparatus, traditional Chinese medicines and Chinese medicine preparations.

After the reform and the opening-door policies, another novel factor is worth to note, i.e. foreign-invested pharmaceutical enterprises came to China again and affected the development trajectory of China's pharmaceutical industry, both on the national and regional level. After the first foreign pharmaceutical investor, Otsuka Pharmaceutical Group from Japan, which entered China in 1981 and established a joint venture with Chinese manufacturers in Tianjin, some multinational pharmaceutical giants, e.g. AstraZeneca and Novartis, followed the wave to establish local production units. During the early phase joint ventures were the only permitted entry mode for foreign-invested pharmaceutical enterprises in China. Massive foreign investments filled the gap of capital shortage, providing a strong financial support for the take-off of China's pharmaceutical industry after 1990. During the 8th Five-Year Planning period (1990-1995) the total investment in fixed assets reached about RBM 45 billion and the actual utilization of foreign capital in this industry was about US dollars 1.2 billion. At the same time the demand gap for imported costly medicines was filled through the form of joint venture. By 1996 17 of the top worldwide pharmaceutical companies had established branches in China.

3.4.3 Moving Towards Geographical Concentration after the Mid-1990s

The period after 1995 was turbulent for China's pharmaceutical industry which witnessed painful policy adjustments, like the compulsory Good Manufacture Practice (GMP) policy, the ownership reform of state owned enterprises (SOEs) and the encouragement of foreign investment entrance. In gross output value the growth rate of pharmaceutical industry in China still maintained on a higher level than that of China's GNP during the corresponding time span. The total revenue of pharmaceutical products reached RMB 96.2 billion in 2000 with an increase of 13% compared to the one of 1995, in which the revenue of the state-owned and state-holding companies was RMB 47.88 billion, 9.5% more than that of the previous year (See Table 3.11).

Table 3.11: Profile of Chinese pharmaceutical industry from 1995 to 2004

	Number of Enterprises	Gross Output Value	Added Value	Sale Revenues	Profits	Taxes And Profit	Export
1995	5,388	961.26	264.67	902.67	51.48	101.72	127.32
1996	5,396	1,151.10	359.75	1,043.34	65.58	127.28	n.a
1997	5,028	1,262.34	411.51	1,177.58	72.73	149.15	n.a
1998	3,280	1,372.73	432.91	1,264.10	77.44	163.17	147.15
1999	3,272	1,497.22	514.86	1,378.96	101.46	199.43	162.54
2000	3,301	1,781.37	633.88	1,627.48	136.58	262.63	167.93
2001	3,488	2,040.86	722.43	1,924.39	168.05	312.78	183.38
2002	3,681	2,378.44	834.65	2,279.98	201.42	365.77	n.a
2003	4,063	2,889.90	1,024.92	2,750.73	259.58	446.91	n.a
2004	4,765	3,241.30	1,173.00	3,033.00	275.00	479.80	n.a

Source: China High-tech Industry Statistical Yearbook, 2002-2004

The total profit reached RMB 7.58 billion with an annual increase rate of 19%. The profits of foreign companies as well as enterprises with investments from Hong Kong, Macao and Taiwan rose by 14.8%, and the profits of collectively-owned companies grew by 6.5% over the previous year. The gross output value of China's pharmaceutical industry increased from RMB 178.13 billion in 2000 to RMB 324.13 billion in 2004, the industrial added value rose to RMB 117.3 billion, the profits summed up to RMB 30.33 billion, the sales revenue jumped to RMB 427.1 billion, and they all witnessed an average annual growth of about 20%.

At the same time, through 10 years of increasingly ferocious market competition and government-led industry restructuring and substantive foreign investment (see Table 3.12), Chinese pharmaceutical industry was moving towards geographical concentration in total, and simultaneously a proliferating geographical division of labor of Chinese pharmaceutical industry can be clearly identified among province-level regions, and this in turn contributes to the geographical concentration of China's pharmaceutical enterprises (Zhang and Van Den Bulcke, 2008). As regards regional distribution, 60% of the industry's total profit comes from the eastern coastal regions. According to Chinese Medicine Economic Statistics Report for 2004, the top 10 province- level regions, consisting of 2 of the 4 municipalities directly under the control of the central government (i.e. Shanghai and Beijing), 4 coastal provinces (Jiangsu, Zhejiang, Guangdong and Shandong) and Hubei, Jilin and Sichuan, Henan, accounted for approximately two thirds (66.76%) of the gross industry output value in 2003, employing 60 percent of national work force in the pharmaceutical industry.

From the viewpoint of technological distinction it is also evident that specialized pharmaceutical production districts are emerging in China (See Table 3.13). Zhejiang and Hubei successfully developed in the fields of raw materials and intermediate products. The former is mainly promoted by private companies, which partly can be attributed to an active spin-off mechanism from SOEs. Jiangsu is specialized in chemical drugs with strong participation of foreign-invested enterprises (FIEs). Shanghai and Beijing, as key bases for medical research and development, play a significant role in R&D of new drugs, especially in the recently emerging field of biomedicine. In the Pearl River Delta, particularly in Guangdong province, private and other forms of non state-owned companies remain relatively more energetic, taking a leading position in TCM, bio-drugs and medical equipment. For example, Shenzhen became a new well developed city in the biopharmaceutical industry. Shandong and Liaoning provinces focus on mass production of chemical raw materials and genetic drugs, which can be partly owned to established large state pharmaceutical enterprises before the 1980s, and their branches. Western China and frontier provinces, including Sichuan, Yunnan, and Jilin, typically based on natural resources, have a long tradition of TCM production with a quite diversified and complementary value added chain. As a consequence the TCM industry in these regions was considerably promoted, since more importance was recently placed on the industry with a long history.

3.5 The Emerging Pharmaceutical Industrial Clusters in China

In recent years, allured by American and European brilliant (bio)pharmaceutical industries, China’s central government and local authorities have established numerous pharmaceutical/biological parks as a key spatial strategy to enhance regional/national competitiveness of (bio)pharmaceutical industry in the global context. There is now an increasing trend to establish (bio)pharmaceutical parks in China. Chen (2005) identified 64 biopharmaceutical industrial parks until 2004, 23 of which were located in the hi-tech zones and 41 in independent parks. Eighteen of these parks were initiated or approved by the central government, while 26 were authorized by provincial governments and the rest by county-level administration. Zhang and Van Den Bulcke (2008), by calculating a location quotient based on location and employment data from the Directory of Chinese Companies (2006), identified 81 pharmaceutical industrial clusters in China, which host 62% of all China-based pharmaceutical firms and occupy 72% of the total employment in the industry. Although these studies had caused a debate on the accurate number of pharmaceutical industrial parks, partly because of different working definitions of the (bio) pharmaceutical industry, the number is arguably constantly increasing. At the same time these studies commonly demonstrate that the geographical concentration level of the Chinese pharmaceutical industry has become much higher than ever before.

When one takes a closer look at the location of the first class Chinese enterprises, the trend of geographical concentration of China's pharmaceutical industry is evident. According to the 2004 data from the National Statistics Medicine Network (www.yytj.net.cn), we can find that 3 municipalities (Beijing, Shanghai and Tianjin) and two old pharmaceutical industry cities (Hanzhou and Shijiazhuang) host most of the top 100 pharmaceutical enterprises in China. In Beijing there are 10 of the top 100 enterprises, most of which are multinational companies. Shanghai hosts 7 large pharmaceutical enterprises, 3 of which are aided by foreign capital. Hangzhou and Shijiang are also major habitats for first-class pharmaceutical enterprises.

In the north of China almost all the important pharmaceutical enterprises have remained in Beijing. Beijing's biomedical industries are distributed in three distinct parks in the Beijing Economic Development Zone. The Zhongguancun Life Park commits itself to research and development in life sciences. Enterprises work as an incubator, pilot production, to some degree because of the existence of universities and public research institutes concerning the life sciences and pharmaceutics. The two other parks, i.e. the Daxing biomedicine industrial base and Yizhuang Medicine Valley, are more oriented towards mass production. As Figure 3.5 and Table 3.14 show Beijing is the second largest place of foreign pharmaceutical R&D Centers in China, following Shanghai.

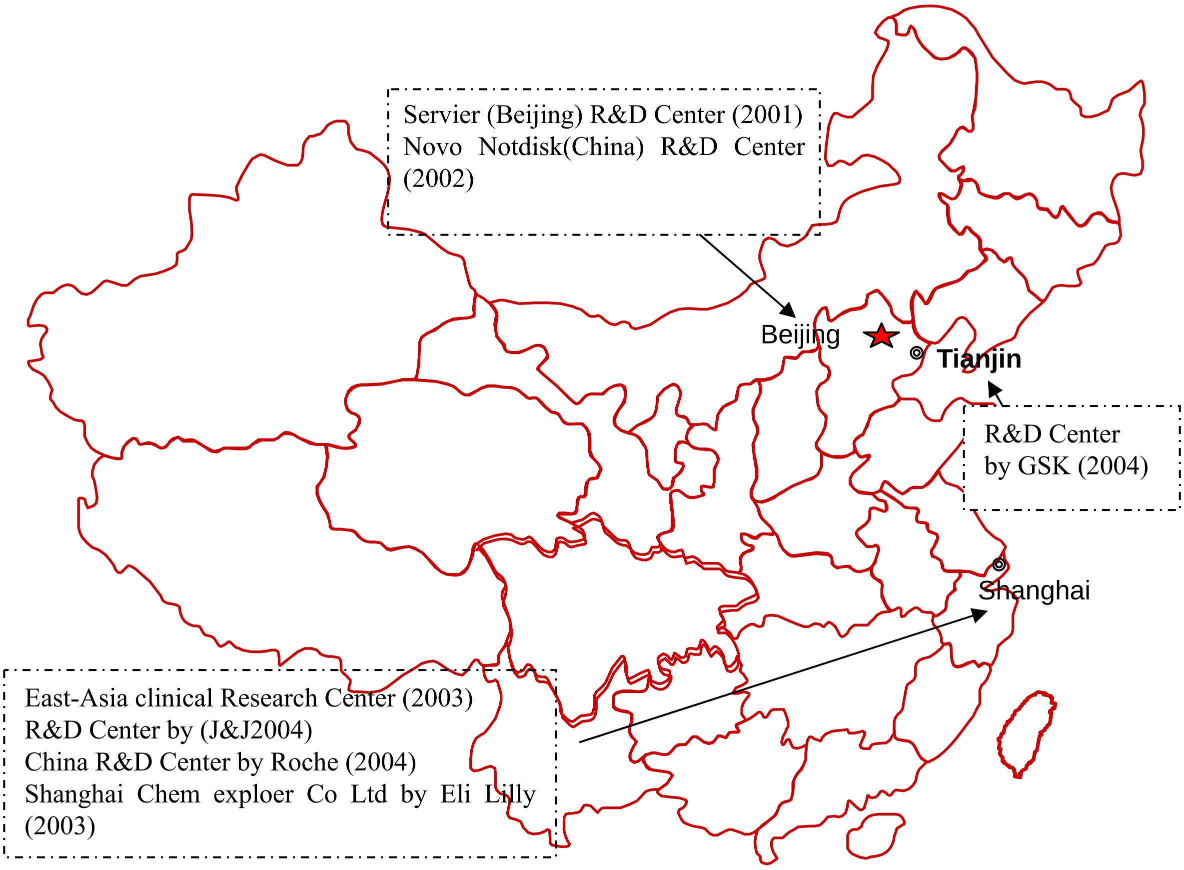


Figure 3.5: Location of foreign pharmaceutical R&D Centers in China by 2004
Source: Festel at el (2005: p. 116) and own research

The pharmaceutical industry in Jilin province seems to be the most competitive amongst the northeastern provinces in China, especially Changchun's biological industry and Tonghua's TCM industry. Both of them are the national industrial bases of the pharmaceutical industry.

In Hebei province, the city of Shijiazhuang manufactures annually 60,000 tons of chemical medicine, accounting for 12% of the national production. It ranks second (following Shanghai) by gross output value. It is impressive that there are a number of extra large-sized pharmaceutical enterprises with a strong competitive edge on national and even international markets, and some of them were ever state-owned, such as NCPC, CSPC, and Yiling Pharmaceutical Group. In addition, there is a great deal of small and medium-sized enterprises surrounding the large ones. It is estimated that there are currently 300 pharmaceutical manufacturers and 640 additional supportive and related enterprises in this city.

The Yangtze River Delta has already been one of the most economically dynamic regions of both the biotechnological and pharmaceutical industries. Shanghai and its neighbor cites, like Nanjing,Wuxi, Suzhou, and Hangzhou, became emerging industrial bases for the (bio)pharmaceutical industry. By 2004 more than 140 biomedicine enterprises, 54 of which are foreign-owned, had existed in Zhangjiang, with the largest biomedicine industrial park in Shanghai. More interesting, most of the international R&D centers established by the top pharmaceutical giants worldwide have been located primarily in Shanghai. And the number of foreign pharmaceutical R&D centers in Shanghai is still increasing.

In some of China's coastal areas the development of biomedical industries is mainly dependent on marine resources. Hankou in Hunan province began to make use of local biological resources to construct the so-called “Natural Drug Storehouse”. A medicine valley was claimed to be in its embryonic stage here. The development of the biomedical Valley in Qingdao City is similar to the story of Haikou city.

In Central China some satellite towns surrounding the provincial capitals, such as Liuyang in Hunan and Gedian in Hubei, built biomedical industrial parks in the early 1990s. The formation of industrial parks was basically from scratch and owed to local governments. In North-Western China (including Chongqing municipality, Sichuan province, and Yunan province and Tibet) the pharmaceutical industry is typically based on natural resources and is more oriented towards TCM manufacturing. In particular, Chengdu, the capital of Sichuan province, is the largest production base of the medicinal industry in North-Western China. Sichuan province is the first national-level TCM Industrial Base in China and was approved in 1998 by the Ministry of Science and Technology, Jilin province became the second TCM industrial base in 2002). Chongqi, Kunming and Guiyang respectively established their own pharmaceutical industry parks, based on unique resources of natural plants. Even in the northwest part of China, Ningxia province officially declared that it would make attempts to develop into a Western pharmaceutical valley, taking advantage of the opportunity of Great Western Development Strategy.

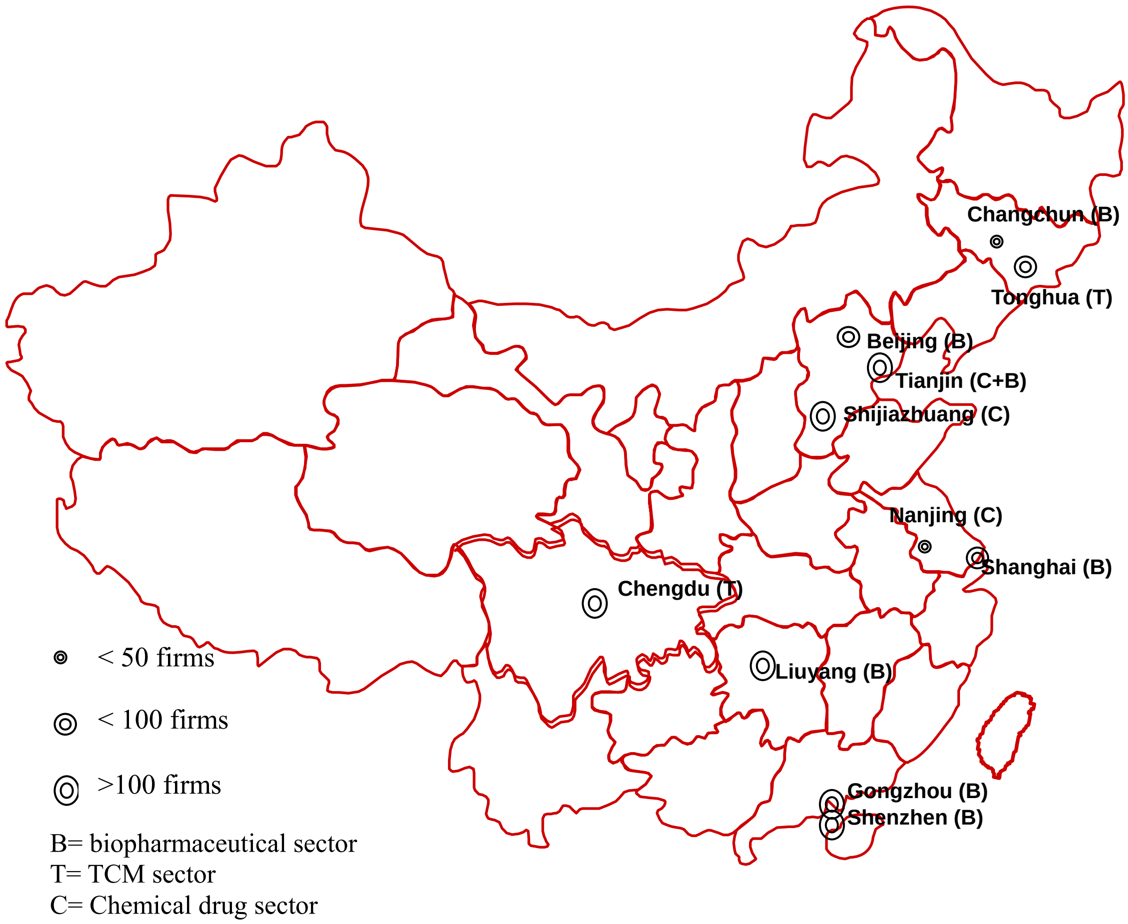


Figure 3.6: Emerging pharmaceutical industrial clusters in China
Source: own elaboration

Table 3.12: Ownership structure of Chinese pharmaceutical industry in 2003

Characteristics	Total	FIEs	SOEs	Collective firms	Private firms
Number of companies	4,634.00	794.00 (17.13)	678.00 (14.63)	364.00 (7.86)	2,798.00 (60.38)
Number of Loss-making enterprises	1,015.00	180.00 (17.73)	249.00 (24.53)	59.00 (5.81)	527.00 (51.93)
Number of employees	1,283,783.00	177,174.00 (13.80)	198,996.00 (15.50)	78,167.00 (6.09)	829,446.00 (64.61)
Industrial output (100 million RMB)	31,037.76	7,155.76 (23.05)	2,758.61 (8.89)	2,132.40 (6.87)	18,990.99 (61.19)
Output of New products (100 million RMB)	4,392.12	1,052.82 (23.97)	349.17 (7.95)	226.22 (5.15)	2,763.91 (62.93)
Sales (100 million RMB)	29,286.17	6,692.94 (22.85)	2,631.70 (8.97)	2,028.73 (6.94)	17,932.80 (61.24)
Export value (100 million RMB)	3,516.77	1,217.14 (34.62)	343.52 (97.68)	132.60 (3.77)	1,823.51 (51.85)
Added value (100 million RMB)	10,428.69	2,404.33 (23.05)	926.89 (8.89)	716.49 (6.87)	6,380.98 (61.19)
Assets (100 million RMB)	45,371.32	8,085.07 (17.82)	5,263.31 (11.60)	1,907.16 (4.20)	30,115.78 (66.38)

Source: Chinese Medicine Statistical Yearbook (2003)
Note: the number in brackets represents the percentage

Table 3.13: Top 10 provinces in Chinese pharmaceutical industry

Rank	Province	Number of Enterprise	Province	Total Output Value	TCM		Chemical Raw Material Medicine		Bio-Preparation	
					Province	Output Value	Province	Output Value	Province	Output Value
1	Jiangsu	428	Jiangsu	3,578,468	Guangdong	914,138	Hebei	1,326,659	Hubei	328,968
2	Zhejiang	386	Zhejiang	2,878,634	Jilin	801,950	Zhejiang	1,183,530	Zhejiang	309,222
3	Guangdong	339	Guangdong	2,670,385	Sichuan	512,007	Shandong	923,685	Shandong	252,223
4	Shandong	281	Shandong	2,490,432	Jiangxi	468,173	Heilongjiang	606,290	Shanghai	244,713
5	Shanghai	280	Shanghai	2,062,305	Shandong	466,383	Jiangsu	598,208	Guangdong	174,484
6	Hubei	270	Hebei	1,874,399	Guizhou	463,944	Tianjin	319,819	Beijing	166,887
7	Jilin	206	Beijing	1,430,688	Zhejiang	387,143	Hubei	314,547	Tianjin	139,540
8	Beijing	204	Hubei	1,377,999	guanxi	350,187	Shanghai	303,226	Jilin	96,937
9	Sichuan	202	Sichuan	1,181,766	Jiangsu	342,976	Liaoning	282,697	Jiangsu	92,626
10	Henan	200	Jilin	1,177,845	Beijing	323,631	Guangdong	229,224	Sichuan	85,196
Total of top 10 region		2,796		20,722,921		5,030,532		6,087,885		1,890,796
National gross		4634		31,037.76		8,102.7		7,125.499		2,463.05
% of top 10 regions in national		60.3		66.76		62.08		85.43		76.76

Source: Chinese Medicine Statistical Yearbook (2004)

Table 3.14: Foreign pharmaceutical R&D centers in China by 2004

Year	MNC	Name of R&D Center	Location	Investment	Ownership
2001	Sevier	Servier (Beijing) R&D Center	Beijing	n/a	Wholly foreign-owned
2002	Novo Notdisk	Novo Notdisk(China) R&D Center	Beijing	n/a	Wholly foreign-owned
2003	Astra-zeneca	East-Asia clinical Research Center	Shanghai	Fitst year:US 4 million	Wholly foreign-owned
2003	Eli Lilly	Shanghai Chem exploer Co Ltd.	Shanghai	All funds supplied by Eli Lilly,>100 scientists	Jont-invested with Shanghai Chem exploer Co Ltd.
2004	Roche	China R&D Center	Shanghai	Fitst year several millions,50 scientists	Wholly foreign-owned
2004	GSK	n/a	Tianjin	16 scientists	Wholly foreign-owned
2004	J&J	n/a	Shanghai	n/a	Wholly foreign-owned

Source: Festel at el (2005, p: 116) and own collection

Chapter 4 Empirical Research Method and Design

I have pointed out in Chapter 2 that the evolutionary thinking and coevolutioanry approach to economy and economic geography are helpful to understand the changes of the economy or economic landscape. However, both evolutionary economics and the coevolutionary approach need a real history. In Chapter 2.1.3, I theoretically answered to a basic theoretical question, what kind of history we need to better understand evolution in economic geography. There is still an unresolved question, namely, how to bring the historical methodology into (co)evolutionary empirical studies. The main aims of this chapter are to make this question clear and to explain from where the data for my study is sourced.

4.1 The Methodological Predicaments of Industrial Cluster

The literature on industrial clusters and the like can be methodologically divided into two intertwined strands in general. One is, based on a case study approach of economically successful regions, aiming at identifying some mechanisms and circumstances that seem to be responsible for or at least influence the economic success of a region. The specific history in the case of the Third Italy (Dei Ottati, 1994; Rabellotti, 1997), accidental events like research funding from the Department of Defence in Route 128 (Rosegrant and Lampe, 1992), and the existence of universities in the case of North Jutland (Dalum, 1995), are regarded to be the crucial factors for the emergence of the industries in special areas. Many other different prerequisites have been identified, including the existence of research institutes and universities (for example, Porter, 1990; Florax and Folmer, 1992; Dalum, 1995; Garnsey, 1998), the availability of venture capital (Florida and Kenney, 1988; Garnsey, 1998), the entrepreneurial attitude in a region (Fumagalli and Mussati, 1993), the specificity of local markets (Porter, 1990) and the influence of policy makers (Markusen and Park, 1993). But this research tradition has been criticized for the lack of a united framework and/or ignoring the importance of timing. Timing should be taken into consideration in the discussion about the evolution of industrial clusters (Brenner and Fornahl, 2003). Firstly, the importance of the above-mentioned mechanisms changes through time. Secondly, the market situation and technological development in industries play an essential role for the emergence of local clusters, and change over time in each industry. Finally, the emergence of local industrial clusters is a process, in which the impact and effectiveness of policy measures vary during the development of the cluster, and the same policy measures have different influences at different times. Therefore, when the case study is conducted, more attention should be placed to timing, at the same time, a more general and broader theoretical consideration should be needed.

The other strand is, based on more general theoretical approaches, to explore why economic activities, on a general and an industrial level, are geographically clustering, for example, Krugman (1991a), and Ellison and Glaeser (1997). These theoretical approaches try to rebuild geographic concentration in simulations (for example Camagni and Diappi, 1991; Jonard and Yildizoglu, 1998; Krugman 1991a; Ellison and Glaeser, 1994). However, these studies targeted a final spatial distribution similar to the one observed in reality, and failed to explain the dynamics of the distribution formation in detail. In other words, this theoretical approach neglects the key questions of how, where and when the localised industrial clusters evolve (with the few exceptions of Brenner, 2004). In addition, in some cases, for example, in the work of Krugman (e.g. 1991c), both place and history are viewed as abstract entities (for this aspect, see Martin, 1999 and Chapter 2.1.1). Although Brenner (2004) has made some progress in this direction by trying to construct a theoretical model which can accurately describe the evolution of clusters in general terms, beyond the peculiarities of each cluster, he only points to the fact that local industrial clusters do not exist in all industries, while he does not explore the sector-specific characters of clustering. In addition, this research line tends to be on a general and an industrial level, ignoring the place-specific characters of clustering. There have recently been a few attempts to study the spatial evolution of particular industries (i.g. Boschma and Weterings, 2005a; Klepper, 2002b; Weterings, 2004), with the application of evolutionary economics. Observably, there is little literature on how to bridge the principles of an evolutionary approach with the 'evolutionary' empirical investigations, which insists on situating an 'evolutionary' empirical analysis in the real history (see Chapter 2.1.3). Here I will develop another history-oriented research method for empirical research on the evolution of an industrial cluster, which is different from the history-friendly modelling method of Malerba et al. (1999, 2001).

4.2 History-Oriented Empirical Research Methods

As regards the "methodological variety and openness" in evolutionary economic geography, I entirely agree with Boschma and Frenken (2006a) that the methodological openness may be considered a strength of evolutionary economic geography, but all concrete research methods should be based on more realistic assumptions (like bounded rationality and disequilibrium) and real history, otherwise the over-openness of research methods will doubtlessly bring about potential dangers (see, Boschma and Martin, 2007). I elevate history to the methodological foundation of evolutionary economic geography in Chapter 2.1.3, on which concrete research methods should be based, and clearly state that to better understand evolution in economic geography should place history in historical time and historical contexts. For historical contexts, the concepts of path creation and path dependence should be used together in historical study. Here, I will focus on how to bring real history to a case study on cluster evolution in practice. Probably the history-friendly research method is a good choice.

There are actually some history-oriented research methods that have already been employed in industrial evolution studies. These history-oriented models, which are based on a detailed rigorous illustration of a specific industry, add *"richer, history-based, phenomenological details to the formal representation"* (Bottazzi et al., 2001, p: 614). A more recently used approach are the 'history friendly models' which Malerba et al. developed, which try to use carefully simulation models in studying specified, empirical 'histories' of individual industries, for example, the models on the history of the computer industry with a special focus on the role of IBM (Malerba et al., 1999, 2001) and the recent history of pharmaceuticals and biotechnology (Malerba and Orsenigo, 2002). The "History-friendly models" (HFM) are formal evolutionary economic models. They aim to capture – in stylised form – the mechanisms and factors affecting the evolution of various industries, technological and institutional change (Malerba et al., 2001). But HFM need further examination through historical evidences.

Here I will offer another descriptive "history-friendly" research method, but not in formalised mathematical models, for studying the evolution of an industrial cluster. This qualitative history-oriented research method is characterized by a mixture of the methods of business history case studies and ethnographic methods. My approach is closer to what Nelson and Winter (1982) labeled "appreciative theorizing", i.e. non formal explanations of observed phenomena based on specific causal links proposed by the researcher. The common points of HFM and my approach at least includes: (1) they both try to reproduce stylized facts in accordance with an evolutionary explanation; (2) their main purposes are to broadly explore the logic of evolutionary economic processes; (3) they both recognize the richness and importance of history, and give more attention to time series and specific sequences of events (for the point of HFM, see Malerba et al., 2001). But my approach is different form HFM in the following aspects: (1) HFM are quantitative theories, while my approach is mainly based on qualitative analysis; (2) HFM are more deductive but my approach is more inductive; (3) HFM believe that formal models play a crucial role for the development of more general theories of industrial evolution, but I think that my mixed methods also can identify variables of industrial evolution and relationships and test causal mechanisms.

Among the three research methods I will employ to study the evolution of an industrial cluster, business history is the base one for the other two in the sense that the materials and data used in the latter two methods are collected through the first method. The approach of business history was often used in early evolutionary work, for example, of both Joseph Alois Schumpeter and Alfred D. Chandler. Business history is an approach which moves beyond a "pure" empirical and historical approach to economics, and led Schumpeter to a uniquely powerful understanding of modern capitalism (McCraw, 2006, p: 261). Alfred D. Chandler employed the business history case study method to engage with a broader question, namely the importance of the large managerially directed enterprises (see Lamoreaux et.al, 2008). In a nutshell, business history case study could be seen as an interpretative history-friendly method, based on long-range empirical and historical data on (i) entrepreneurs (their behavior, decision-making rules, and interactions); (ii) individual companies, and (iii) the environment in which they operate, and other particular parameters that are likely to have been important in generating the observed history. The value-added of this method is that it offers detailed historical materials, but it is silent on the historical relationship between firms over time, i.e. the evolution between different firm generations. So we need other research methods to complement the business history approach, when we want to explore the evolution of co-located firms.

The genealogical method and the approach of "generative relationships" obviously can fill this gap. The genealogical method is a well-established ethnographic research method and was developed in anthropology in the late nineteenth century, by which ethnographers can symbolize an evolutionary connection between kinship, descent, and marriage. This genealogical method can be applied to industrial (cluster) evolution, because it is helpful to understand the "kinships" (of firms, technologies), by testing the effect of inheritance on any individual trait and variation, based on the collected materials and data through business history method. For example, in practice, we can record connections of kinship, descent and merger and reorganization of firms with diagrams and symbols, based on individual firm's histories, which can be collected through interview surveys with firm founders and/or key consultants, and second-hand data (e.g. enterprise autobiography) as well.

In light of the theories of complex systems and coevolution, however, an entity (for example firm organization) is not fixed, but constantly changing (a complex adaptive system itself); at the same time, it is also a member of a higher-order complex adaptive system comprising the focus entity itself and the others with which it interacts. This means that the changes in one entity are not just elements of its own evolution (*path-dependent processes*), but, rather, are influenced by heterogeneous and unpredictable contingent factors. For example, the final particular form of technological development we observe is not only the result of technical necessity, but is influenced by social, economic factors and, to some extent, political and institutional factors as well. Often, interactions between particular sets of entities take place in recurring patterns that persist over time, and these interactions may give rise to relationships between the participants (Lane et al., 1996, p: 59) that we can call "generative relationships" (GRs). The notion of GRs was put forward by Lane and Maxfield (1996) and was defined as "*a relationship that can induce changes in the way the participants see their world and act in it and even give rise to new entities, like agents, artifacts, even institutions"* (Lane and Maxfield, 1996, p: 215). GRs has two important characteristics: (i) *generative*: interactions amongst the participants in a GR can give rise to something new, which one of the members of the relationship could not have produced alone; (ii) *unpredictable:* the loosely coupled reciprocal relations and their results could not have been foreseen in advance. It was created by the interaction between the parties (for extended discussion of generative relationships, see Lane and Maxfield, 1996; Lane et al., 1996, p: 59; Russo and Hughes, 2002). This approach, as Russo and Hughes (2002) pointed out, is consistent with the definition of innovation suggested by Schumpeter (1934).

The combined approach I will use is not new in the evolutionary study of an industrial cluster. A good example is that Patrucco (2005) explicitly employed the notion of "generative relationships" and the ethnographic approach, and implicitly used the approach of business history case study as well, in studying the emergence of technology systems in the Emilian plastics district, Italy. With this method, a detailed analysis on the individual paths of main entrepreneurs, both specific and idiosyncratic, can be made. The historical and in-depth analysis of formation and transformation of firms is extremely important for grasping the historical relationships among firms at any point in time in the local pharmaceutical sector. It is notable that the mixed method only provides some rough lines implying the material succession between enterprises, therefore, it is indispensable to examine how the knowledge, especially the knowledge of industrial technology and business management, flows through personal movement in this local industry. In a nutshell, the mixed method enables longitudinal and evolutionary studies, in particular in the case of small studies, in which the number of firms is relatively small. If the amount of firms is sufficiently large, the work on data collection and depicting generative relationships of clustered firms is so much that it is impossible to be well finished.

4.3 Data Sources for Empirical Exploration

4.3.1 What Kind of Information Should Be Collected

According to "*historical time, as opposed to a time-line, is uneven and punctured by even*ts" (Clark and Rowlinson, 2004, p: 342) and what kind of history evolutionary scholars need (see Chapter 2.1.4), it is essential to identify particular influential events. Since I explore the evolutionary trajectory of Tonghua's pharmaceutical industry through three populations (namely, firm, technology and institution), I should identify those important historical events that had have a great influence on these three populations. The emergence and growth of an industrial cluster depend both on the growth in firm number and the increase in economic performance of individual firms (through various forms of innovation inside and between enterprises), thus all important historical events that impact the rise and fall of firm number and enterprise innovation should be included. More specifically, as regards firm organization, the momentous events such as firm creation and firm closure, the ownership change should be involved; as far as technological events are concerned, these events like the emergence of new technology, redevelopment of "old" technology, and influential research projects must be included; for institutional change, events including key regional and industrial planning and strategies should be contained as well. Furthermore, all innovative events (for example, the creation of new ventures, and adoption of new technology) are involved with entrepreneurs; hence some entrepreneurial events should also be included.

4.3.2 Data Sources and Survey Processes

The main task of this Ph. D. thesis is to explore the regional industrial trajectory in the transitional context in China, taking Tonghua's pharmaceutical industry as an example. To accomplish this task, the empirical analysis should provide strong empirical content related to theory. To be sure, a historical or evolutionary approach to an industrial cluster involves serious methodological challenges. These include the construction of time series data that permit longitudinal analysis and provide information sufficiently fine-grained to reveal how the dynamic interplay of micro-level adaptation sequences and meso-level events is implicated in an industrial cluster. At the same time, the difficulties of acquiring reliable data at the firm and industry level in an industry cluster requires the generation of data sets for the long-term evolutionary study. Tonghua's pharmaceutical industry began in the second half of the 19th century; however there is at most over 20 years of data (from 1985 onwards) available to researchers. It is hence statistically questionable whether industry-level panel data analyses can be validated within the boundaries of statistical confidence. The issue is also acute at the firm-level. On the one hand, data on many of the variables influencing industrial clustering are not available in published enterprise-level data sets; on the other hand, data (for example, output value, and sales) are available merely in relatively large private enterprises. Thus, face-to-face interviews can best identify the relevant variables and their causal relationships between them. The empirical study to be presented in the next four chapters is largely based on the information about the founding events and organizational backgrounds of each individual pharmaceutical enterprise in the cluster until the end of 2005. Data collection was mainly based on reading secondary data, in-depth interviews with local actors and with local experts and Jilin provincial government agencies (see Appendix 1-3). The collection of the information, which has involved an extensive amount of work to trace the foundation and historic events of every firm having ever been a part of this regional industry, was conducted in the following ways.

In order to better map the contexts and backgrounds of the Tonghua pharmaceutical industry, I conducted personal face-to-face interviews with Jilin provincial government agencies (the Development Research Centre of Jinlin Provincial Government, the Jilin Province Development and Reform Commission, the Jilin Province Development and Reform Commission, the Jilin Provincial Science & Technology Department, the Jilin Food and Drug Administration, the Jilin Academy of

Social Sciences) and local government agencies (the Tonghua City Administrative Office of Pharmaceutical Industry, the Tonghua City Science Technology Department, the Erdaojiang District the Organization Department, the CCP Tonghua City Committee, see Appendix 1) , complemented by second hand materials, including the materials provided by the interviewed government agencies, previous studies (Wang, 2006; Hou, 2007; Wang, 2006; Xue, 2008; Li,2006; Gao,2005), local and provincial newspapers (Tonghua Daily, and Jilin Daily), public publications (Tonghua Statistical Yearbook and Tonghua industrial history, the History of Jilin Province Forty-Year Manufacturing Industry), and local industrial reports and public speeches. The semi-structured interviews with the government agencies interviewees focussed on the following issues: (1) the change in national and provincial regulations on the pharmaceutical industry, in particular TCM industry; (2) the national, provincial and local development plans and strategies of pharmaceutical industry, in particular TCM industry and their influences on Tonghua; (3) the characteristics of the pharmaceutical innovation, the role of demand factors and markets; (4) local industry-support measures, and other China's TCM regions (see Appendix 4). Secondary data is also one source of empirical evidences and played an important role in conducting the longitudinal analysis.

The enterprise-level data was mainly collected through two channels. The first is semi-structured interviews with local companies, local policy makers, expert analysts and members of collective bodies directly involved in the implementation of local institutions and local structures of co-ordination for the developing activities of the cluster. Five in-depth face-to-face interviews with local officials and experts (four government officials and one local scholar specialized in the history of the Tonghua pharmaceutical industry) were the main source of information before my interviews with local firms. Each of these interviews lasted 2-3 hours (Appendix 1), by which I got the general information, including the list of firm names, firm addresses, and general managers or founders. With the support of two local government agencies, the Tonghua Pharmaceutical Industry Administrative Office and the Tonghua Science and Technology Bureau, I conducted thirty-five local company interviews. The number of my interviewed firms is about half the number of GMP (Good Manufacturing Practice) firms in Tonghua. The list of GMP firms was provided by the Tonghua City Administrative Office of Pharmaceutical Industry.

The companies chosen for my survey are basically middle and small-sized pharmaceutical enterprises. The reasons why middle and small-sized enterprises were chosen are that (1) it is easier to get access to them than to large enterprises, in other words, it is difficult to visit key figures of relatively large pharmaceutical enterprises; (2) second-hand enterprise-level data and materials of large enterprises are better available than that of middle and small-sized enterprises. I can use second-hand materials such as published data and enterprise websites to make up the deficiency of the first-hand data of large enterprises. At the same time, in order to make full use of each firm interview to obtain as much information as possible (both about the interviewed firm itself and others), I chose half of the number of GMP firms in the subregions. Considering that Changchun is the capital of Jilin province which hosts most of pharmaceutical and medical research institutes in this province, additionally, that Changchun is always the main technoligical source for Tonghua's pharmaceutical enterprises in history, I interviewed additional five firms in Changchun which have direct and important connections with Tonghua's pharmaceutical cluster. Three of them were acquired by big pharmaceutical groups in Tonghua, and the other two are research- oriented enterprises which have long-lasting research cooperation with Tonghua pharmaceutical enterprises. All firm interviews were conducted in June and July, 2007 (Appendix 3).

The semi-structured interviews with the company interviewees focus on the issues of (1) the organization of the productive activities of firms, including the changing ownership structure, spin-offs, and work experiences of the founders; (2) production and technology, including main strategies or projects, product and process innovations, sources of practical know-how, and knowledge about how to develop new drugs; (3) financial situation, for example, the financial sources at their starts, turnover, capital investments and other internal and external factors influencing firm development and the competitive environment in which the firms operate; (4) Information about other local firms. The enterprise-level relevant written documentation was collected both from the informants and other sources like company information from websites, annual reports and pamphlets, press articles and the internet.

I interviewed people in various positions including: company founders and entrepreneurial team members, scientific researchers, and industrial partners. In order to get to know the history of the interviewed enterprises and their founders, I firstly tried to visit key figures (founders and top managers). But it is difficult to conduct face-to-face interviews with the top managers of relatively large businesses (the chief executive officer). In these cases (6 firms), I interviewed middle-level managers or insider experts who were familiar with basic information of these interviewed enterprises. The lack of first-hand information of important historical events (for example, work experiences of the founders and the financial sources at their starts) can be complemented by the second-hand materials, for example, autobiographies of enterprise and entrepreneur, or the internet. For most of the relatively small-sized enterprises, I interviewed company founders or general managers. In these cases (29 firms), the interviews focused on letting the informant describe the information about the above four aspects, with a minimum of interruption by the interviewer. This type of narrative interviewing (Czarniawska, 1998, p: 29) was carried out in order to get closer to the actual events and the real history to avoid that personal views and theoretical perspectives influenced the data collection. All of the firm interviews were face-to-face and lasted around one hour.

From the results of the field survey one cannot draw strong conclusions, in statistical terms, on the evolution of this cluster. In order to get more information of local firms that have ever appeared in Tonghua's pharmaceutical sector, I had to turn to a second type of historical materials (enterprise autobiography and government documents and other collected materials). According to the list of Tonghua pharmaceutical enterprises that have existed especially in the early years of the cluster and which was provided by the Tonghua Pharmaceutical Industry Administrative Office, I searched their historical information. Besides interviews with enterprises, I rely on the existing historical records and other archives, including enterprise autobiography, local newspaper (Tonghua Daily) and government documents, to get as much information as possible about the foundation year, the closure year, and other aspects. But merely former state-owned enterprises had good writing stuffs, while the majority of small firms, especially the vanished ones, can't provide enough information. So some information has to be found through other channels, for example, through the websites of the current firms. All information is double-checked using multiple different sources to make sure that the information is as accurate as possible. The information of the entrepreneurs was collected in the same way.

Since some issues, such as interactions among actors, knowledge sharing, and institutional co-operation, are extremely complex, and some factors are hard to be coded, only open and face-to-face interviews and in-depth discussion with entrepreneurs, local policy makers, even local scholars and experts in the technological and administrative fields may capture the very qualitative nature of such interdependences. Such set of descriptive and qualitative information gathered through interviews was complemented with the data collected in a survey of the firms in the cluster.

Most interviews were taped and key contents of the interviews were transcribed in Chinese, as parts of the data analysis process were done after interviews. The collected data provided both narrative accounts of the process of the rise of the Tonghua pharmaceutical sector and factual descriptions of context, actors, and events from diversified sources. By combining the different sources of information and repetitively consulting informants (the two supporting government agencies —the Tonghua Pharmaceutical Industry Administrative Office and the Tonghua Science and Technology Bureau, and one local scholar), an in-depth description of the emergence of the pharmaceutical industry in Tonghua was made. Critical characteristics and events related to firm, institution and technology in Tonghua pharmaceutical sectors were identified through induction.

4.4 Database Construction and Study Process

Data collection and theoretical analysis was conducted in an interactive process as summarized in Table 4.1. By combining the different sources of collecting information, I have drawn on two databases. I have made a systematic effort to identify all the pharmaceutical firms that existed in Tonghua from the 1950s to 2005. The fundamental unit of the first database is a firm. The information such as its founding year, and founder, the closure year, present ownership, time of ownership transition, total staff, early and present main productions, main technological sources at the very beginning, and the current cooperators for new drug development, other significant events, was here included. The second database concentrates on entrepreneurs, including the name of firm, the name of entrepreneurs, native place, age, education experience and work experience, the founding year of their first new ventures. There is limited access to information on entrepreneurs of small enterprises, the number of entrepreneurs in the database is 62, while the number of enterprise is 104. In order to link the two databases, I chose the enterprise names as key words that existed in both databases. According to the two databases, I mapped the generative relationships of clustered firms (see Appendix 5). Furthermore, I made tables describing time, actors, and critical events. In order to offer theoretical explanations for the processes and events observed, observations that fitted with theoretical concepts and research question were identified (Borch and Arthur, 1995). The theoretical concepts and theoretical findings were formed and then adjusted to match the historical empirical evidences in a coupled process. As the analysis proceeded, the logical frame and theoretical findings were developed through deduction, using collected data. In addition, I presented an early analysis result of this empirical exploration at a seminar especially held for this study with the support of the Soft Science Institute at Jilin Academy of Social Sciences, in which five local researchers, five senior Tonghua enterprise managers, two officials of the provincial Science and Technology Bureau who are familiar with the intervention policy of government at central level and provincial level, attended. These attendees not only gave valuable comments, but also corrected or provided some facts, in particular information about policies and other region's pharmaceutical industry in Jilin.

Table 4.1: Summary of main steps in the data collection and analysis process

Step in data collection and analysis process	Data sources, collection, and analysis
Mapping the national context and Tonghua case	National level: attending policy, conversations, and documents, previous studies Tonghua: visits, conversations, and personal interviews, interviewed Jilin provincial government agencies (7) and Tonghua government agencies (4)
Case selection	Internet search and informal conversations, previous studies Identified general information Identified case informants through key informants
Interviews	Interviewed central informants over a 2 month period (interviews) Interviewed local Firms (35) Interviewed non-localFirms (5) Interviewed university professors (specialized in medical technology, 3 and familiar with the economic history of Jilin or Tonghua.
Document collection	Obtained enterprise plans, government documents, presentations etc. from interviewees Autobiographies of enterprises and entrepreneurs (3) Searched the Internet for web pages of enterprises and related government agencies, press articles, etc. Obtained 6 doctoral or master dissertation
Data transcription	Transcribed the interviews in Chinese (most from tape), focus on revealing the process
Databases construction	Database of enterprises (including 104 enterprises) Database of entrepreneurs (including 62 enterprises)
Mapping generative relationships of clustered firms	Mapping generative relationships of clustered firms according to the above two databases
Mapping central events over time	Wrote narratives about this process of firm change, technology and institutional transformation, and made tables describing time, actors, and critical events
Presenting preliminary analysis result	slightly adjusted factical evidences, in particular information about national and provincial regulations; Added information about other China's TCM region
Matching theoretical concepts	Working with theory and empirical data in an interactive process

Chapter 5 Overview of the Tonghua Pharmaceutical Industry

5.1 Introductory Overview of Tonghua

5.1.1 Location and History of Tonghua

The region of Tonghua, a mountain area with an area of 15195 square kilometers and a population of 2.3 millions (See Table5.1), is located in the southeast of Jilin province, facing the Democratic Republic of Korea across the Yalu River (see Figure 5.1). It covers five counties (Huinan, Liuhe and Tonghua, Meihekou and Ji'an, two country-level cities) and an urban area (Dongchang district and Erdaojiang district). "Tonghua city" I use in this dissertation often refers to a prefecture-level city if I do not deliberately note, do not confuse it with "the Tonghua county", its sub-geographical unit. The capital of Tonghua city is located in Erdaojiang district. As a city with a long history of human culture, Tonghua is the birthplace of Goguryeo Kingdom which had predominated over southern Manchuria (present-day Northeast China), southern Russian Maritime province, and the northern and central parts of the Korean peninsula for about 700 years between 37 BCE and 668 CE.

5.1.2 Tonghua as Natural Medicinal Materials Treasury

Tonghua city is located at the foot of Changbai Mountain, with a forest coverage rate of 62.9%. Consequently, it is rich in natural resources of Chinese medicine herbs. It's proved that there are 1,800 species of medicinal plants in this area, accounting for about one third of the national total volume. Among these precious herbs, the output value of ginseng and deer antler occupies 80% and 60% of the nation, respectively, and above 60% of the world. Therefore, the region wins a reputation as one of the "Five Natural Medicinal Materials Treasuries" (in Chinese, Tianran Yaoku) in China.

Table 5.1: The profiles of Tonghua and Jilin in 2005

	Tonghua	Jilin	(%)
Population(person)	2,263,120	27,160,000	8.33
labor force(person)	889,200	10,994,000	8.09
Area (1000 km^2)	15.6078	187.4	8.33
GDP (RBM ten thousand)	2,336,343	36,202,700	6.45
Primary Industry	412,943	6,256,100	6.60
Secondary Industry	1,062,051	15,808,300	6.71
Tertiary Industry	861,349	14,138,300	6.09

Source: Tonghua Statistical Yearbook, 2002-2005; Jilin Statistical Yearbook 2006

5.1.3 Industrial Structure in Tonghua

Historically, Tonghua was an agricultural area; even today the primary industry (including agriculture, mining industry, fisheries, aquaculture) is still the largest employment sector (see Table 5.2). After the foundation of the P.R.C, the entire northeast region has been developed into an important industrial base; however Tonghua did not nurture one of the key industrialized areas in Jilin province, since it had been an important military base during the long period of the tense relation between China and Japan following the foundation of PRC. As recently as the 1980s, Tonghua has embarked on the evident and pressing process of industrialization and urbanization. Nowadays, the industrial system of manufacturing, composed of smelting, machine building, electronics, timber processing, paper making, liquor distillation, textiles, pharmaceutical, and light industries, has been formed in this rising industrial city.

Table 5.2: Employment structure in Tonghua by Sectors（1991–2005)

year	Primary Industry	Secondary Industry	Tertiary Industry	Total
1995	584,369 (54.1%)	256,890 (23.8%)	238,217 (22.1%)	1,079,476
2000	577,859 (67.4%)	120,218 (14.0%)	159,319 (18.6%)	857,396
2005	453,057 (51.0%)	162,331 (18.2%)	273,812 (30.8%)	889,200

Source: Tonghua Statistical Yearbook, 2002-2005
Note: the numbers in brackets represent the percentage of the industries to the total.

Table 5.3：GDP structure in Tonghua by Sectors

Unit: RMB 10 thousand Yuan

Year	Primary Industry	Secondary Industry	Tertiary Industry	Total
1995	179,034 (22.1%)	324,567 (40.0%)	307,983 (37.9%)	811,584
2000	282,956 (24.1%)	445,204 (38.0%)	444,635 (37.9%)	1,172,795
2005	412,943 (17.7%)	1,062,051 (45.4%)	861,349 (36.9%)	2,336,343

Source: Tonghua Statistical Yearbook, 2002-2005
Note: the numbers in brackets represent the percentage of the industries to the total.

5.1.4 The Importance of the Pharmaceutical Industry in Tonghua

The pharmaceutical industry has grown up as the pillar manufacturing industry in Tonghua and has played an increasingly key role in both employment and economic wellfare, especially since the mid-1990s. The pharmaceutical industry, food and metallurgy industry are seen as Tonghua's three major pillar manufacturing industries, and their total output value reached up to RMB 19.31 billion Yuan in 2005, accounting for 82.6% of the whole output of above-scale industrial enterprises[46] in this area, with a profit of RMB 950 million Yuan which is equivalent to 86% of the total profit of above-scale industrial enterprises. Output value and profits of Tonghua's pharmaceutical industry held 36.6% and 44.6% respectively of Jilin province.

Table 5.4：Economic contribution of three major pillars by output value in 2005

	Output Value (billion Yuan)	Of the total output values of above-scale industrial enterprises (%)
Pharmaceutical industry	0.708	36.7
Food industry	0.185	30.3
Metallurgy industry	1.038	44.4
Total	1.931	82.6

Source: Tonghua Statistical Yearbook, 2002-2005

The pharmaceutical industry, following the metallurgy industry which employs over 17,000 people, is the second largest manufacturing sector for employment in Tonghua, with the number of the formal employees reaching 13,000 (Tonghua Statistical Yearbook, 2002-2005). However, according to the vice general director of the Tonghua City Science Technology Department: *It is estimated that the pharmaceutical enterprises in Tonghua employ approximately 30,000 salesmen, most of who work outside Tonghua. If taking into account this number, the pharmaceutical*

[46] The above-scale industrial enterprises refer to all state-owned and state-holding enterprises and non-state-owned enterprises whose annual sales income is above RMB 5 million Yuan.

sector will be the first largest manufacturing sector hosting employment in Tonghua. (Interview, No.G79 in Appendix 1)

5.2 The Pharmaceutical Industry in Tonghua

5.2.1 Age Structure

Table 5.5 illustrates the foundation periods of current pharmaceutical companies in Tonghua. There were three waves of firm creation in Tonghua's pharmaceutical industry. The first wave was from the second half of the 1960s to 1985, during which 18 firms were established, accounting for about 20% of the total pharmaceutical firms then. The second phase during the period of 1985 and 1995 is called the golden time of the creation of pharmaceutical firms in Tonghua. During that period, 29 pharmaceutical corporations were founded, equivalent to more than one third of the total number of the Tonghua pharmaceutical companies. The third peak period of the new startups was the period after 1999, with 25 new start-ups coming into existence since then in the increasingly competitive industry. The alteration of the number of pharmaceutical enterprises founded in different times reflects the dynamic characteristics of the local pharmaceutical sector which will be discussed in the following section.

Table 5.5: The foundation of pharmaceutical companies in Tonghua

Year of foundation	No. of firms	in % of the total
Before 1985	18	21.4
1986—1994	29	34.5
1995—1998	12	14.3
After 1999	25	29.6
Total	84	100

Source: The Tonghua City Administrative Office of Pharmaceutical Industry

5.2.2 Ownership Structure

The Tonghua pharmaceutical enterprises, similar to their counterparts in other regions in China, had been state-owned or collectively owned before the 1990s when the ownership reform happened, during which the ownership of these enterprises was successfully transformed into private entities through diversified ways, such as reorganization, merger, selling, leasing, and bankruptcy. By the end of 2005, all of the enterprises had ended up with the privatization process with the exception of one state-owned joint-stock company (Tonghua Jinma).

Table 5.6：Employment structure of the Tonghua pharmaceutical industry in 2005

	Pharmaceutical industry	% of whole Pharmaceutical industry	All manufacturing sectors	% of pharmaceutical industry to the whole manufacturing sectors
State-owed	198	1.5	3,540	5.6
Collective	165	1.2	6,445	2.6
Private	12904	97.3	40,814	31.6
Total	13267	100	50,799	26.1

Source: Tonghua Statistical Yearbook, 2002-2005
Note: the percentage is the the total employees engaged in the manufacturing sector

Table.5.6 indicates that the proportion of private firms in the number of employees is relatively high. The smooth restructuring of ownership led to a significant increase in the proportion of private investment, and this in turn promoted effectively the rapid development of the Tonghua pharmaceutical industry. If we take into account the location of Tonghua city (Jilin province is a typical old industrial area where the proportion of state-owned economy in the national economy is still large), we can see that Tonghua is the first mover in the privatization process in Jilin province.

5.2.3 Geographical Structure

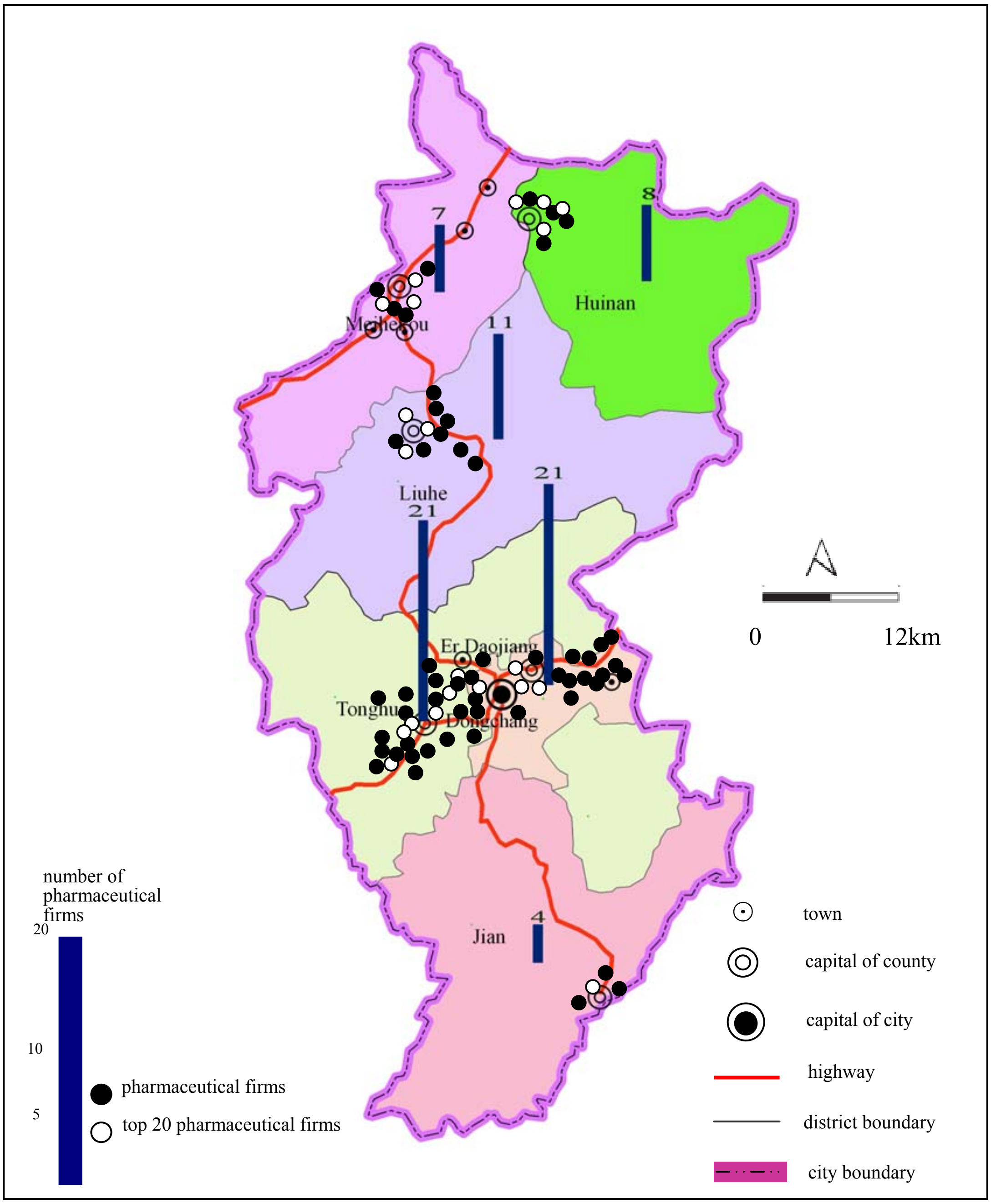


Figure5.1: Geographical distribution of GMP firms (cartography: Liang Jun)
Source: The Tonghua City Administrative Office of Pharmaceutical Industry
Note: The number of GMP firms at the end of 2006

Concerning the location of the GMP firms, we can see that the Tonghua pharmaceutical industry geographically concentrates in the Tonghua county and Dongchang district. These two areas host approximately half of the pharmaceutical companies in Tonghua city (See Figure 5.1). The spatial distribution of the firms composing the pharmaceutical industry in Tonghua reveals that the agglomeration of the sector is much more well-defined in geographical terms, and the pharmaceutical production is more and more concentrated in this area.

5.2.4 Firm Scale Structure

By the end of 2005, there were 84 pharmaceutical enterprises located in Tonghua, among which 71 were the Good Manufacturing Practice (GMP) firms. Some enterprises have developed into large-sized group corporations, like Xiuzheng, Dongbao, Wantong, and Zhenguo, and so on, and six enterprises pushed their ways into the list of 500 top of the National Independent Accounting Pharmaceutical Enterprises (Yiyao Gongye Duli Hesuan Qiye)[47] in 2005. As Table 5.7 illuminates, many large enterprises have emerged in the Tonghua pharmaceutical sector by recent years, but the vast majority of these enterprises is still small and medium-sized by sales volume.

Table 5.7： Firm scale structure by sales in 2004

Unit: RMB 100 million Yuan

Firm size	Number	Percentage
≥20	1	1.7
4--20	1	1.7
2--4	4	6.8
1--2	7	11.9
0.5--1	4	6.8
0..25—0.5	13	22.1
≤0.25	29	49.3

Source: The Tonghua City Administrative Office of Pharmaceutical Industry

5.2.5 Specialization in TCM industry

Table 5.8 shows that Tonghua City bends itself to TCM industry relatively. Although the latest data are not available, it is very clear from all the indications that the division of labor between industries has been consolidated in recent years. By the end of 2003, a total of 809 varieties had been produced in Tonghua, of which 759 were Prepared Chinese Medicine (PCM), while only 50 were chemicals. PCM is the final dosage form of TCM and is safe and without any side effects, while another form of TCM is crude Chinese medicinal materials, for example, crude herbal and natural animal parts and minerals. From the viewpoint of the number of producers, the companies manufacturing chemical medicines are a minority just with the number of

[47] Industrial enterprises with independent accounting system refers to enterprises engaging in industrial production activities and covers all state-owned enterprises (SOEs) with an independent accounting system and all non-SOEs with an independent accounting system and annual sales revenue in excess of 5 million RMB yuan.

six, five of them produced PCM also. Precisely speaking, only one pharmaceutical enterprise in Tonghua city is fully specialized in producing chemicals. According to statistics in 2003, Chinese medicine produced the output value of RMB 5.311 billion Yuan, with a profit of RMB 714.03 million Yuan, accounting for 95.9% of all output value of Tonghua's pharmaceutical industry and 98.4% of the total profit respectively. 5,000 tons of PCM, accounting for 40% of the output of Jilin province's Proprietary Chinese Medicine, is produced per year by local Chinese medicine enterprises. Consequently, it is safe to say that the current Tonghua pharmaceutical industrial cluster is specialized mainly in PCM, even though Tonghua also made or still is making efforts to utilize modern biotechnology to find out or produce bio pharmaceuticals.

Table 5.8: Production structure of Tonghua's pharmaceutical industry in 2000

Unit: RMB 10 thousand Yuan

	Chemical Medicine	Prepared Chinese Medicine
Output Value	8,098	274,470
Tax	2,835	74,357
Profit	1,996	51,365
Sales Revenue	6,298	201,608
Total Assets	68,456	700,548
Net Fixed Assets	9,714	100,617

Source: The Tonghua City Administrative Office of Pharmaceutical Industry

5.2.6 Growth Driven by the Domestic Market

Tonghua's pharmaceutical industry has been driven by the domestic market. There was only one business enterprise, Dongbao, engaged in exports of pharmaceuticals before 2003, with exports amounting to RMB 64.3 million Yuan, accounting for less than 2% of the total sales of the Tonghua pharmaceutical industry. And foreign capital accounts for only 1.7% of the capital in Tonghua City's pharmaceutical industry. This reflects the fact that the pharmaceutical industry in Tonghua city has a high level of inward-oriented economy, driven by domestic capital.

5.3 Tonghua's Pharmaceutical Industry: Non Knowledge-Based

A significant body of research and facts shows that the pharmaceutical, especially biopharmaceutical industry, whether in China or other countries in the world, is a knowledge-intensive industry and the pharmaceutical clusters tend to emerge in metropolitan areas, or knowledge-intensive regions (see Table 5.9).

Table 5.9: Selected (bio) pharmaceutical clusters developed or planned around the world

Name	Country	Location
East River Science Park	USA	New York City
Biotech	Germany	Munich
Bangalore Bio	India	Bangalore
Shanghai Biomedical Technology Industry Base	China	Shanghai
Thailand Science Park	Thailand	Klong Luang,
Dubiotech	United Arab Emirates	Dubai

Source: own elaboration

Among the outstanding pharmaceutical industrial clusters, Cambridge, the most important cluster in Europe, Heidelberg, one of the strongest in Germany, Aarhus in Denmark, Marseille in France, and Milano in Italy, are good examples. There are also strong empirical evidences for concentration of newly established firms around universities.

Metropolitan areas can offer all-round industrial and financial facilities, easy access to scientific and technological infrastructures and experienced professionals, convenience of communication with policy makers, and systematic communication mechanisms. In other words, metropolitan areas provide profuse resources of knowledge and more positive institutional context which would affect the dynamics of localised technological and managerial knowledge.

However, Tonghua's pharmaceutical industry is located neither in a metropolitan area nor in a knowledge-intensive region since local research resources in pharmaceutical production are not adequate. In other words, it is notable that this pharmaceutical sector does not benefit from the advantages stemming from a metropolis or knowledge area.

In Jilin province, research-oriented universities, such as Jilin University and the Northeast Normal University, are all located in the capital city, Changchun (see Figure 5.2; also see Appendix 6). There was no research-oriented pharmaceutical entitity, public or private, in Tonghua before 2000. Only entering into 21st , some local large pharmaceutical firms began to establish science-based laboratories, some of which are the results of collaboration with public research units. Therefore, in the process of the Tonghua pharmaceutical cluster development, especially at the early stage, the localised knowledge, instead of science-based knowledge from universities and research institutes, played an important role. In addition, today's pharmaceutical enterprises in the Tonghua cluster origined from small-sized enterprises, while other pharmaceutical clusters, for example Shijiazhuang Chemical pharmaceutical cluster, are the result of spinoffs from large-sized state-own enterprises that were established in 1950s. It means that it is very necessary to find the peculiarity and the strength of local mechanisms that determine the emergence and evolution of this huge agglomeration observed.

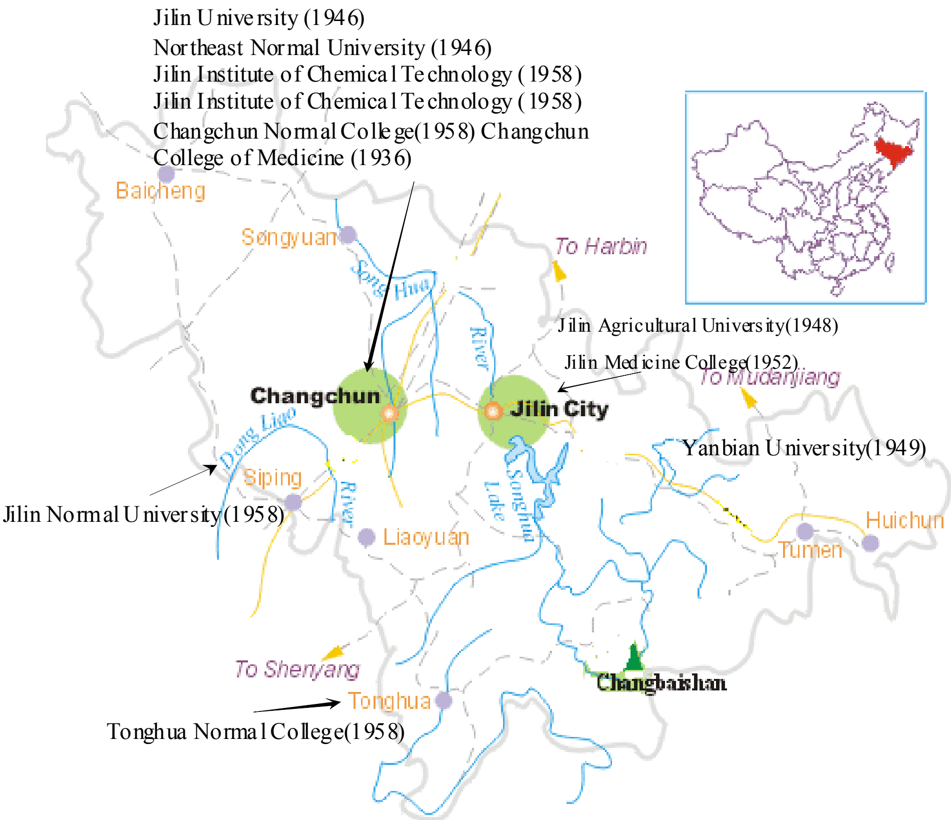
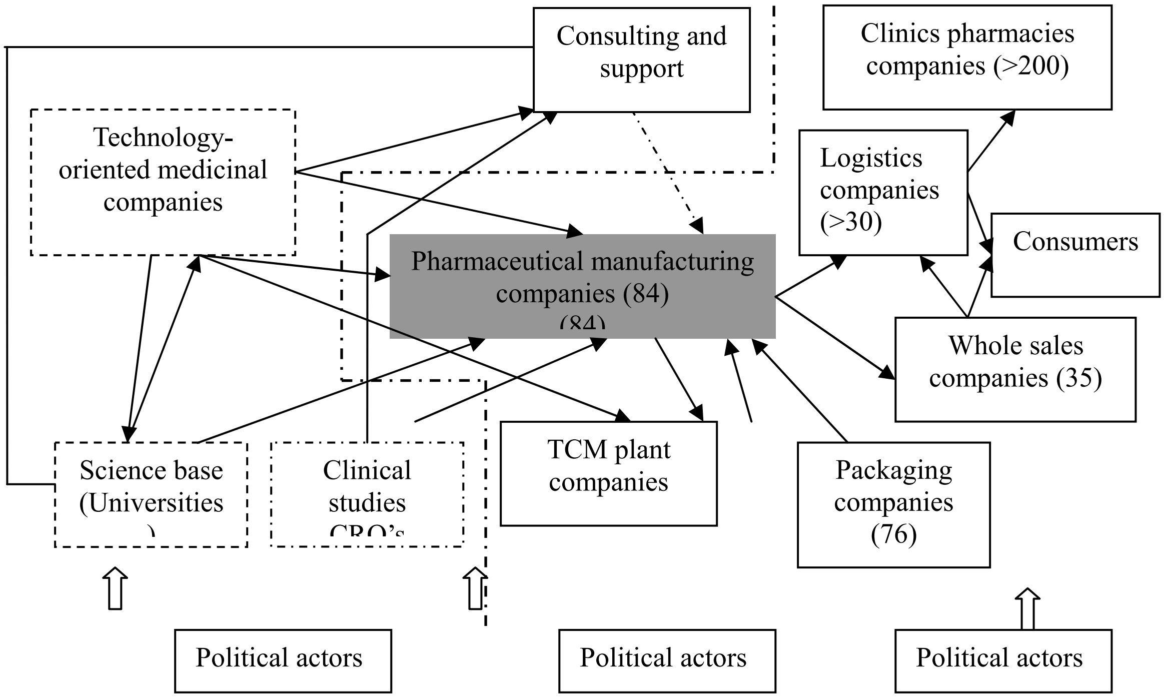


Figure 5.2: Location of universities in Jilin
Source: own elaboration

5.4 Conclusion

There are 84 pharmaceutical manufacturing companies. Here it is necessary to note that these research institutes are not the scientific laboratories for developing new drugs, but mainly specialized in production process innovation. More interesting, as the sector grows, other supporting or related sectors developed as well. There were 35 pharmaceutical whole sales companies, more than 200 Clinic pharmacies, and at least 30 logistics companies, 76 packaging companies (see Figure 5.3).

Figure 5.3: The actors of Tonghua's pharmaceutical industry



Note: Numbers in brackets represent the number of entities. Actors on the left side of the dotted line are located outside Tonghua

It is necessary to point out that the knowledge-intensive institutes such as research-oriented medicinal companies are not located in Tonghua, but they contributed a lot to the development of Tonghua's pharmaceutical industry. Because this group of pharmaceutical manufacturing companies forms the hard core of the Tonghua pharmaceutical sector, I will concentrate on them in this dissertation.

From the above introduction, we can find that the Tonghua pharmaceutical industry has the following characteristics. Firstly, the industrial structure is dominated by small and medium-sized enterprises, though some national well-known business groups exist in this place. Secondly, it is specialized in the manufacturing of TCM drugs, and in fact a location of manufacturing assembly facilities for the domestic market. Thirdly, the Tonghua pharmaceutical industry is not based on localised R&D knowledge, which is significantly different from its foreign counterparts.

This phenomenon leads to another question from where the sources of the competitiveness of this emerging cluster come. This issue might be explained by exposing to natural resources, but more attention should be paid to the reasons behind the phenomenon that the rich natural plants can be made full use in Tonghua, while it could not in other regions.

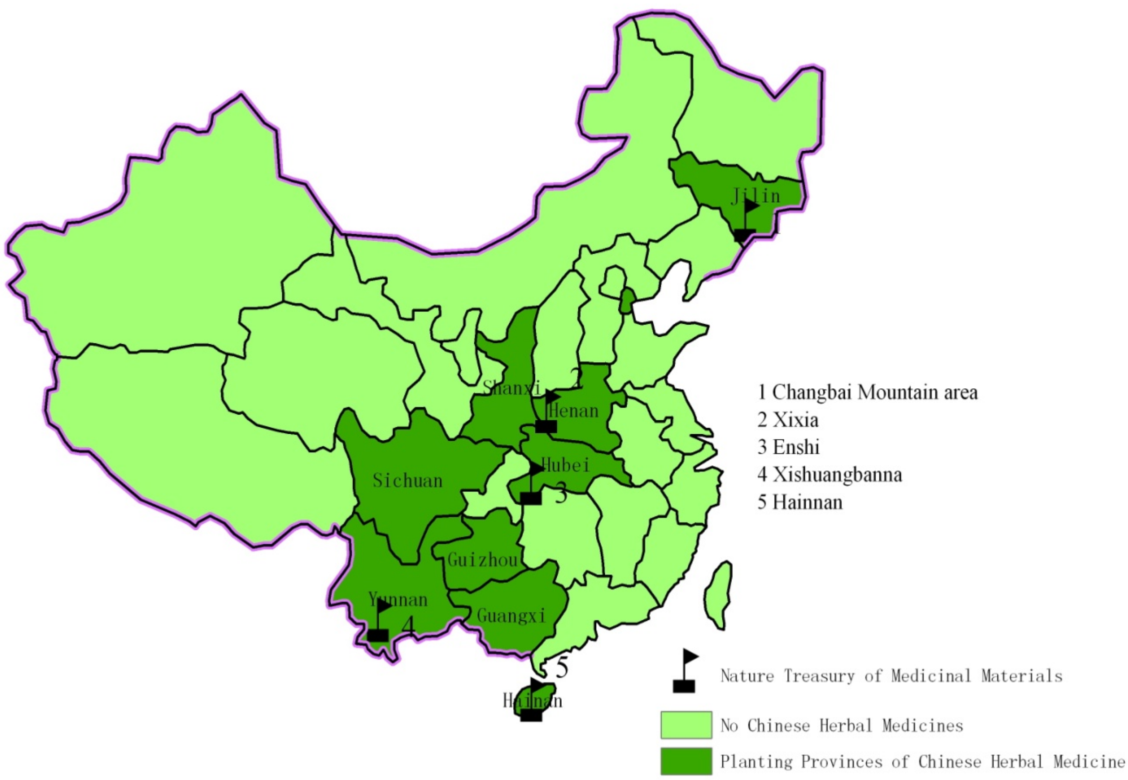


Figure 5:4 Provinces of Chinese herbal Medicine and natural medicinal materials
Source: Cui (2007)

Natural herbs are the main source of TCM, and grow in mountain areas. In China, they grow largely in Jilin, Henan, Hubei, Shanxi and Southwest China. Amongst them, there are actually five regions for natural medicinal materials in China, namely Xishuangbanna in Yunan province, Enshi in Southwest Hubei province, Changbai Mountain area in Jilin, Xixia in Henan province and Hainan, the largest island in southern China (see Figure 5.4). But only in two of them, namely, Tonghua and Hainan, the pharmaceutical industry occupies an important position in the local economy in terms of GDP and employment. In fact, there are merely two cities in the coverage of the Changbai Mountains, Tonghua and Dunhua, where the pharmaceutical economies are well developed. Although there are a few pharmaceutical firms in some other cities (e.g the neighboring city of Tonghua, Baishan City), they are not as good as those in Tonghua.

These bizarre realities reflect the fact to some extent that the success of Tonghua's pharmaceutical industry is not merely built on the advantages of natural resources. Although the role of rich resources can't be ignored, especially in the early stage, there are some other underlying reasons for the success. In reality, possessing abundant and cheap raw materials is no longer sufficient for the competitiveness of a city and a firm in the knowledge-based economy, and it must be supplemented, or even substituted, by cautiously increasing product quality, rapid and continuous innovation, and command of (strategic) technologies (Vet, 1993, p: 98) and good adaption to changing environments. Hence, I will go to the empirical study and explore the formation process and the mechanism of this competitive pharmaceutical sector by the lens of coevolution of firm, technology and institution.

Chapter 6 The Genesis of Tonghua Pharmaceutical Enterprises

The aim of this chapter is to explore the evolution of the population of enterprises in Tonghua's pharmaceutical sector. Just as I pointed out in Chapter 1.3.1, I select the firm as the basic unit of evolution and make use of the research method of business history, together with two other methods (the genealogical method and the approach of generative relationships), to identify the mechanism of the inheritance, selection, variation of different generations of firms and technologies and institutions (see Chapter 4.2). All empirical evidences were collected on the base of individual firms. In other words, this chapter is the groundwork for understanding the coevolutionary mechanisms of firms, technology and institution in the Tonghua pharmaceutical sector.

The chapter is organized in the following way. In Chapter 6.1, I try to answer the questions of why we concentrate on the creation of firms in studying the emergence of firms, and what is the theoretical base of the empirical discussion of the evolution of enterprises and their technologies. Chapter 6.1 also presents the typology of new firm entrants in China's transitional context. In Chapter 6.2, according to the change of the firm numbers, I divide the origin of Tonghua pharmaceutical enterprises into three different phases. Finally, in Chapter 6.3, I discuss the emergence of new firm organizations taking the changing national macro-institutions into consideration.

6.1 The Formation of New Firms in China's Industrial Clusters

6.1.1 The Creation of New Venture as an Impetus of an Industrial Cluster

As previously explained in Chapter 4.3, the development of the industrial cluster depends on the increase in both the amount of firms and the economic performance of individual firms (through innovation inside enterprises and collaboration between enterprises). The performances of individual firms are involved with technological improvement, which will be discussed more detailedly in Chapter 8. Here I will concentrate on the rise and fall of the firm numbers.

The creation of new ventures is actually a longstanding research concern in the studies of economic development, since new firms play a significant role in the economic and social well-being. New startups not only play the role of innovators, who often break old systems and create new ones, but also provide a large number of job opportunities. In particular, the creation of hi-tech new ventures has been viewed as a tool of creating and retaining cut-edge competitiveness of national economy for developed market economies, and a method of economic "catching up" for newly industrialized countries or a way of economic revitalization for transitional nations. New venture creation is at the core of the evolutionary thinking about economic growth, specifically in the formation of regional clusters of industrial innovation (Feldman, 2001), since startup firms are the embodiment of innovation, especially for radical new technologies, which are not easily absorbed into existing firms (Audretsch, 1995). So the relationship between industrial clusters and start-ups has become the research focus in the literature on the emergence and growth of industrial clusters in recent years (for a detailed discussion, see Feldman, 2001).

The evolutionary scholars, both from economics and economic geography, identify two main dynamics influencing the spatial evolution of industries, i.e. (entrepreneurial) spin-off and agglomeration economies (for a detailed discussion, see Boschma and Wenting, 2007, Klepper, 2002; Garnsey and Heffernan, 2005), considering that the founders of spin-off firms inherit the knowledge of the parent firms and transfer it to the new ventures; meanwhile clusters, where local incubators highly concentrate, become the entrepreneurial seedbeds for spin-offs. Moreover, agglomeration economies actually attract the new spin-offs to locate close to the parent firms. Hence, among the four types of new firm entrants which I will discuss later on, spin-off is seen as the most important mechanism for creating new ventures in the opinion of evolutionary scholars.

In Klepper's (2001) evolutionary framework, which accounts for spin-offs, he uses the funny metaphor of the entrepreneurial spin-offs as children and the past employers as parents. Because new spin-offs inherit and duplicate organizational routines and knowledge of their parent firms, Klepper claims that success leads to success, namely, those firms which stem from successful parent companies are more likely to be successful than others whose parents have not had so high performance (also see Boschma and Wenting, 2007). Furthermore, since employees who leave the parent firms and establish their own entities tend to locate near the parents, the spin-off process is basically expected to be a local phenomenon (Boschma and Wenting, 2007, p: 216). These assumptions are well justified by some top worldwide clusters, for example, the ICT sector in Silicon Valley, the US automobile industry in Detroit and wireless telecommunications around Aalborg. Hence, just as Dahl et al. (2005) argue, evolutionary scholars believe that the main driving force behind the generation of new firms is the initial success of the first firm, which eventually leads to the formation of clusters later.

6.1.2 The New Firm Creation in Historical Perspective

The arguments above mentioned may be true in general, but as disccussed in Chapter 2, the creation of new ventures is not only the result of the entrepreneurial activities of individual entrepreneurs, but also restricted by broader socio-economic environments. In fact, even in the mature market economies (e.g., Western Europe, North America and Japan) in which the entrepreneurial environment in terms of availability of venture capital, clarity of property rights and supporting services are more friendly to entrepreneurship in general, the specific requirements for the development of new industries (e.g, specialized infrastructures and institutional environments, as well as new technologies and markets, etc.) can't be met at the very beginning. In other words, market, technology and institution in favor of cultivating and nourishing new industries co-evolve with industries even in mature market economies, not to mention in transitional countries from former communist economies (including Eastern Europe, China and Vietnam ect.) in which general market economy-oriented legal and institutional settings have so far not been developed well hitherto. It means that the timing of spin-off should be taken into account in order to find out the impact of national public institutions related to private entrepreneurship on the origin and evolution of enterprises in transitional countries.

In addition, most of the literature on this issue is empirically based on the Western countries, so there is limited knowledge about the process of producing private entrepreneurship and new ventures in transitional nations from a long-term historical perspective. Although spin-off has become an increasingly important mechanism of economic development as legal environments have been improved, for example, the legalization of private property and the issue and implementation of an intellectual property law, we should note that spin-off firms have not appeared until the past decade (namly, approximately since the mid-1980s) in China. From a historical perspective the role of the existence of a large number of state-owned and collective enterprises in a transitional economy should not be ignored. Moreover, as there are differences in new venture creation between mature market and transitional economies, we accordingly should develop an alternative typology of new firm entrants.

6.1.3 Situating the New Firm Creation in China's Transitional Context

As pointed out in Chapter 6.1.2, the creation of new firms and business strategies of enterprises are to some degree influenced by the institutions. Therefore, it is impossible to understand the history-specific particularities of new firm creation without grasping the historicity and uniquity of particular institutional structures of a specific transition economy. Different from some sociological research on China and on transforming socialist economies more generally spoken (mostly associated with the work of Victor Nee, 1989,1992 and Andrew Walder, 1995,1998,2003, for their contributions to understanding China's transition see Guthrie, 2000) which gave greater emphasis on nation-level institutions such as private property rights and the legal system in the organizational changes in China, I would like to state that local institutions have a great influence on the timing in the emergence of new organizational forms and local entrepreneurship. So I will concentrate on the influence of national institutions on the development of the Tonghua pharmaceutical cluster and, at the same time, on the interaction between local institutions and local business over time.

To understand the evolution of the particular case of the Tonghua pharmaceutical cluster in the light of the types of new startups and their own background, it is necessary to select a relevant typology to differentiate them. However, since China has undergone significant changes in its property rights system, a large number of firms, which were transformed from state-owned or collective firms, had been existing for a long time before the transformation, even if the entrepreneurs or owners changed (which I call "the divided histories of business and entrepreneurs"). But in order to fully understand the evolution of firm organization in China' transitional period, we need some knowledge about enterprise ownership changes in China.

(1) The Particularity of Firm Organization in the Context of Chinas Transition

There are three basic forms of enterprises from the perspective of ownership: state-owned enterprises (SOEs), collective enterprises and private enterprises. The latter form emerged only after the reform and opening-up policy in 1978. The first two are often called "publicly owned enterprises". In fact, collective-owned enterprises are different from state-owned enterprises in some aspects, for example, they mainly covered the service and light industry, and their product price was determined by market (see Table 6.1). But it is notable that Chinese collective enterprises are characterized by two main features: vaguely defined property rights and significant involvement of government officials since most of them were established by (or supported by) local governments. In addition, some of them were initially private businesses before the foundation at the P.R.C and had been changed into state-owned enterprises, when they had grown up under the permission of central or local governments during the period of 1956 to 1978.

As regards state-owned enterprises, there is a noteworthy point. Different from the former Eastern European socialist countries (for example, Hungary), in which state-owned enterprises were controlled by the central government, the state-owned enterprises in China could be classified into two types of 'central SOEs' and 'local SOEs' (the term of Hu, 2005, p: 707), which were affiliated with national government and local governments respectively. There are four levels of sub-central government in China: provincial, city/prefectural, district/county, neighborhood committee/ township (Hubbard, 1995). The lower the government to which the enterprises were affiliated, the easier and earlier they were privatized in the following transitional period. "Local" in this dissertation refers to the scope of Tonghua city. Because the Communist Party of China interferes with economic life and the cadres could move between government agencies and the party organization, simply, "government" includes government itself and the party organization as well; government officials in this dissertation refer to officials both of government and of the Communist Party of China.

In fact, the transition of post-Communist economies to a market system has given birth to a nontrivial diversity in organizational forms and a plurality of property rights (Nee, 1992, p: 1). The firms with hybrid ownership represent an intermediate state, bridging between the publicly-held enterprises and private ones. In fact, hybrid organizational forms could be observed as well in other transitional countries, for example, "work partnerships" in Hungarian enterprises. Workers in these enterprises worked for the company during the day and used company equipment during off-hours to do entrepreneurial work (Stark, 1989).

Stark defines the recombinant property as a "*form of organizational hedging or portfolio management, in which actors respond to uncertainty in the organizational environment by diversifying their assets, redefining and recombining resources*" (Stark, 1996, p: 997). The contracted firms could be included in hybrid organizational forms. Hybrid firms lacked a well-specified structure of property rights and therefore high autonomy. Enterprises during the transitional economy were confronted with rapidly changing environments, which were characterized, on one hand, by weak market structures, poorly specified property rights and institutional uncertainty, and on the other hand, by the incremental replacement of the state's redistributive mechanism by market forces. So the hybrid firms had to establish personal social networks (for Tonghua enterprises, with local state) to reduce risk and/or "use resources and/or governance structures from more than one existing organization" (Borys and Jemison, 1989, p: 235). The emergence of this organization could be viewed as a flexible and temporal strategy to match the institutional chaos of efficiency and flexibility of individual firms.

(2) Typology of New Firm Entrants in the Transitional Context

Considering the particularities of transitional economies and my research concern, I will firstly distinguish local and non-local investment, according to whether investors have a local background or not. For the foreign-invested enterprises (that refer to the investment coming from outside of Tonghua, but not outside of China, in fact there are no investments from overseas in this local sector), three typologies of new entrants are often seen in: (1) greenfield vestment, i.e., setting up a new plant in the host country to produce goods locally; (2) acquisition of a local firm and its production capacity (M&A); (3) cooperation with a local firm by setting up a joint venture. The creation of new firms is relatively complicated. As for the enterprises established in the planned economy, we can classify them into state-owned enterprises and collective enterprises, according to the different ownerships. But as explained above, there is an additional organizational form of hybrid firms (e.g., joint ownership between state-owned and private firms) during the transitional period, for example, the contracted ventures (see Table 6.2). Almost all of the hybrid firms in the transitional period were transformed to private entities. In addition, we can find that there were some new startups in Tonghua, which can be divided into two different groups based on the experiences of their founders: new startups established by spin-off entrepreneurs who leave the job in incumbent firms in the same industry to found stand-alone companies or by diversifying entrants. Diversifying entrants refer to those preexisting firms entering a new industry through diversification strategies including cross-border acquisition, joint venture and constructing new establishments (Klepper, 2001; Helfat and Lieberman, 2002; Dahl et al., 2005). They tend to have no previous working experience in the same industry. The typology used in this dissertation is shown in Table 6.2.

Table 6.1: Summary of enterprises from the perspective of ownership in China's transition

	State Owned Enterprises	Collective Enterprises	Hybrid Enterprises	Private Enterprises
Ownership	State-Owned (Government as Delegate)	Collective (Local Government as Delegate)	Publicly Owned + Private	Private
Top Manager	Assignment by Corresponding-Level Government	Local Government Assignment	Contractors	Owners Determined
Producer Prices	Pegged with Intramarginal Delivery Quotas	Market Determined	Market Determined	Market Determined
Taxation	Expropriation of Surpluses	Uniform Value-Added Tax	Uniform Value-Added Tax	Uniform Value-Added Tax
Credit Eligibility	State Bank	Nonbank Capital Market	Nonbank Capital Market	Nonbank Capital Market
Wages	Government Determined	Collectively Determined	Market Determined	Market Determined
Residual Profits	Accrue to Government	Dividends to Collective-Retained Earnings For Reinvestment	Dividends to Contractor-Retained Earnings	Dividends to Owners-Retained Earnings
Labour Force	Assignment by Corresponding-Level Government	Self-Employment	Market Determined	Market Determined
Producer Prices	Pegged with Intramarginal Delivery Quotas	Market Determined	Market Determined	Market Determined

Source: own elaboration

Table 6.2: Typology of new firm entrants

	Entrant type	Main features	Entry period
Nonlocal-Invested Enterprises		the investment comes from outside of Tonghua, but in China	planned economy
	Greenfield Investment	setting up a new plant in the host region to produce goods locally	
	Merger & *Acquisition*	acquisition of a local firm and its production capacity	
	Joint Venture	cooperation with a local firm by setting up a venture	
Local--Invested Enterprises		Established by local investors	
	State-Owned Enterprises	Investment form local government, production according to government plan	planned economy
	Collective Enterprises	Investment from the Self-Employees but controlled by local government , market-oriented production	planned economy
	Contracted Ventures As Hybrid Firm	Contract ill-performing SOEs or collective enterprises, market-oriented production	transitional economy
	Transformed Ventures	transformed from established firms, e.g, former state-owned, collective ones or contracted venture to private ones	After the privatization
	De Novo Entrant	Newly established firms	After the privatization
	- Entrepreneurial Spin-Off	Founder(s) previously employed in the industry	After the privatization
	- Diversifying Entrant	Founder(s) no prior experience or contacts in the industry	After the privatization

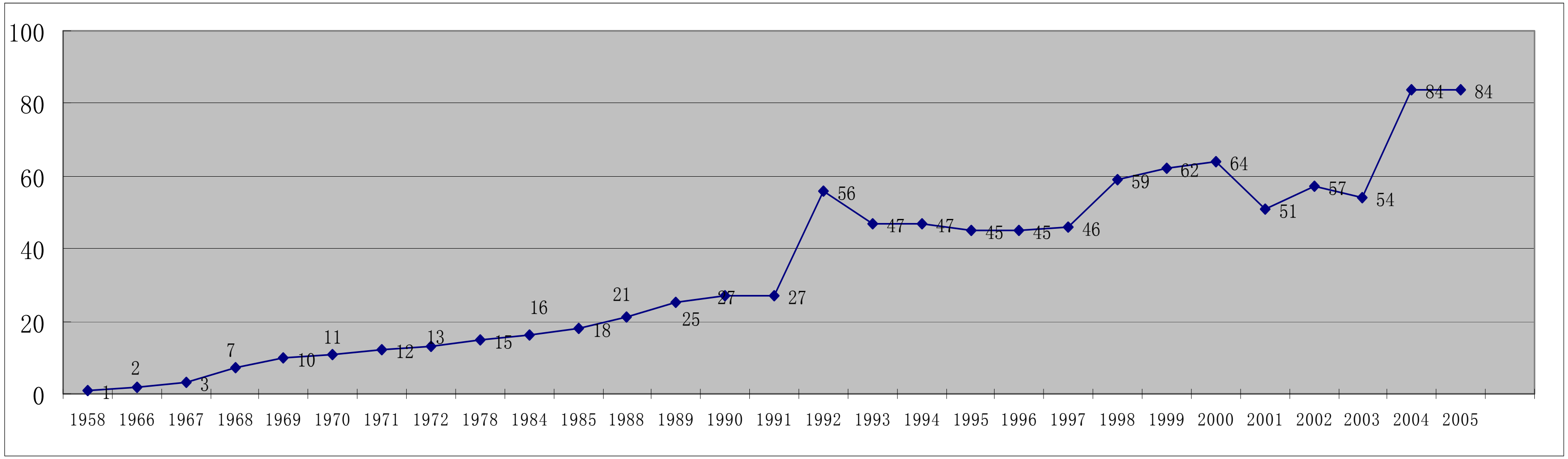


Figure 6.1: Firm number Tonghua pharmaceutical industry
Source: own elaboration based on collected data

6.2 Firm Organization and Institutional Changes in Tonghua's Pharmaceutical Industry

The development process of the pharmaceutical industry in Tonghua can be divided into four stages as follows: 1958–1984, 1985–1991, 1992–1997 and from 1998 onwards. Each of these stages is marked by a drastic rise in the amount of firms (see Figure 6.1), distinct entry strategies and national and local institutions. Considering the first years of China's reform and opening, it seemed to have had little effect on the Tonghua pharmaceutical industry, since the pilot policies were carried out mostly in South China coastal areas (Guangdong, Fujian provinces). So I extend the first stage of the Tonghua pharmaceutical industry development to the middle of 1980s. Furthermore, some political events, both local and national, had a great impact on the development of this cluster (see Chapter 6.2.2). During the second period the number of pharmaceutical firms increased, but in a slow manner. Almost all of the new enterprises were established by local government agencies, but for own economic benefits, and were soon contracted or privatized. After 1992 Tonghua city began to privatize the large-scale state-owned/collective firms in the pharmaceutical sector. At the same time a great number of new startups was built up. But due to the adjustments of national regulation on the medical industry, especially the implementation of GMP policy in 1997, some loss-making enterprises, including newly established ones, were acquired. So there is a rise and fall in the firm number in the last two stages.

6.2.1 Firm Creation and Organization in the Traditional Planned Economy

The Tonghua pharmaceutical industry is not knowledge-intensive, at least in terms of formal R&D inputs, but one of the high competition pharmaceutical clusters in China. It was a peripheral agriculutural economy before 1960. During the first development phase of the pharmaceutical sector, roughly from 1958 (the first year of SOEs from which the data are available) to 1984, the number of pharmaceutical plants went up very steadily without any exit. Here I have to point out that there were several TCM stores before the 1950s, which were small-scale and similar to modern family-run businesses in the ownership form, employing man-made methods, responsible mostly for local people's health care. I define the history before the 1950s as the prehistorical period, which will be investigated briefly as well.

The demand of basic drugs was hardly met in China during the first development stage over 1958 – 1984, in particular, in its early part (from 1950s and 1970s). There were a few small pharmaceutical plants which were not capable of producing local bulk drugs before 1950s due to the lack of required technological capabilities. Hence, the Beijing Central government decided to directly intervene in the production of basic drugs to insure the health security of the people. Some giant pharmaceutical enterprises were established, specialized in manufacturing chemical pharmaceuticals, for example, the North China Pharmaceutical Factory in Hebei province and Taiyuan Pharmaceutical Factory in Shanxi province (see Chapter 3.4.2). They consisted of the first generation of central SOEs in the pharmaceutical industry that was dominated by the central government. At the same time, Beijing Central government encouraged sub-national level state to build up new pharmaceutical firms, mostly for local people's health care, which were called "local SOEs" in pharmaceutical industry. In these contexts, Tonghua city government as the only financial investor started to construct its local pharmaceutical sector. So the first generation of state-owned pharmaceutical enterprises were erected from 1950s to 1970s in Tonghua. In addition, the missing intellectual protection system was helpful for the first generation of state-owned pharmaceutical enterprises to gain 'kown-how' on pharmaceutical manufacturing, no need to pay. Because of the absence of a patent regime before the 1980s, there was no intellectual protection in China, which enabled state-owned pharmaceutical enterprises to learn from and imitate their domestic counterparts. From a long-term point of view, the first generation of local government-held enterprises served as the platform for the development of this pharmaceutical cluster in the succeeding stages, in the sense that they provided technological leadership for local pharmaceutical production and stimulated entrepreneurial skills related to the pharmaceutical industry in Tonghua.

Compared to the central pharmaceutical SOEs established in the same period, the first generation of state-owned pharmaceutical firms in Tonghua was marked by the direct investment of the local state, not by the central one. Somewhat different from the traditional Soviet model of socialist enterprises in which the enterprises were highly controlled by central government, the creation of the Tonghua pharmaceutical enterprises and their early growth were pushed by local states to a great degree (referring here to the city, county or township-level states), not directly by the central government (for the classification of enterprises in the planned economy in China, see Hu, 2005). The local state did not only offer financial support, but also had the ultimate decision-making power for significant events, including the entry and exit of enterprises, product development and the rise and fall of the positions of the staff. The factory directors as the representatives of local government were in charge of daily management and operation, and obeyed the orders of the local government.

More specifically, entering the 1950s, the first generation of publicly owned enterprises (in the forms of state and collective ownership) was erected by government's direct investment. Although collective enterprises were different from their state-run counterparts in the ownership form, they followed a similar management model of state-run enterprises. Hence, both state-run and collective enterprises provided employees with similar welfare of housing, healthcare, child care and education. According to government orders, these enterprises produced and then delivered products to local medical stations (state-owned commercial pharmaceutical organizations, see Chapter 3,2.4). The publicly owned enterprises cared more for production quantity than for production value, following the traditional socialist enterprises model which could also be observed in the planned economies of the former Soviet Union and of Eastern Europe. What the pharmaceutical manufacturers needed to do after production was to deliver the drugs to local state-owned pharmaceutical wholesale agencies, through which pharmaceuticals were distributed (See Figure 6.2 and Figure 3.1 in Chapter 3.2.4).

Objectively speaking, the first generation of enterprises, together with technology accumulation during the first stage, had provided a platform for the later development of the pharmaceutical industry in the local area, and even other areas in Jilin province as well. At least the early state-owned enterprises trained a large number of pharmaceutical talented managers and technologists, some of which transformed later into private entrepreneurs or advanced managers.

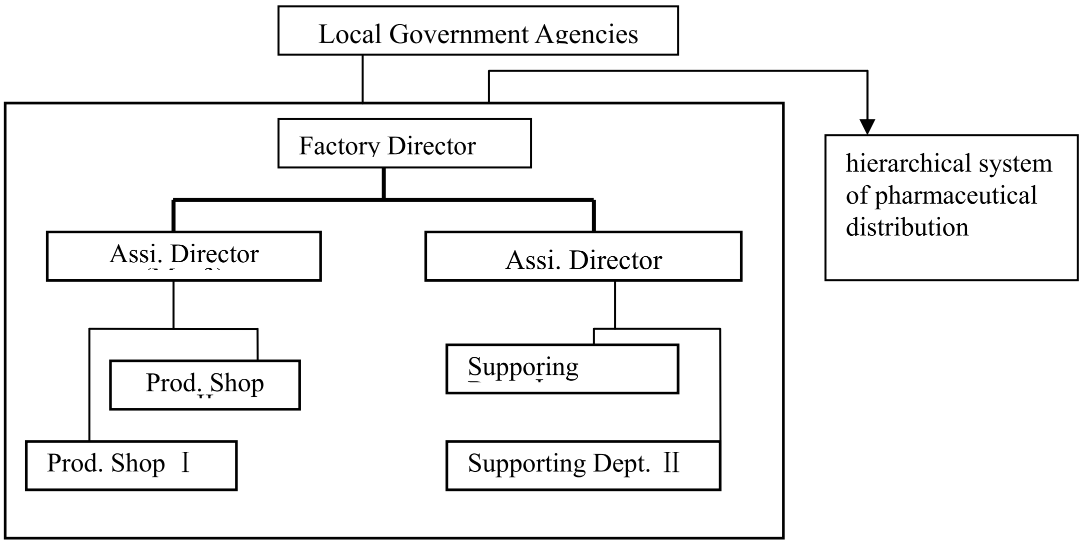


Figure 6.2: Firm organization in the traditional planned economy
Source: own elaboration

6.2.2 Changes in Firm Creation and Organization during the Early Reform Period (1985-1991)

The second stage (1985–1991) and the third stage (1992–1997) as well were very critical in developing the pharmaceutical industry in Tonghua, during which, the whole China underwent momentous national institutional changes, such as the ownership transformation, the strength of intellectual protection, fiscal and administrative decentralization and so on (see Chapter 3.2). With investment liberalization, competitive pressures in the domestic market heightened and then new business opportunities for some regions were produced. It was at that period that Tonghua opened the window of opportunity for the TCM industry. During the second stage, the rapid growth of Tonghua’s pharmaceutical industry was largely based on micro-enterprise management innovation and organizational innovation (for example, the emergence of the contracted enterprises and private organizations), which reflected the powerful influence of changing national institutions on local industry in transitional countries. During the third stage, this cluster was partly driven by smooth transformation of enterprise ownership with a lower rate of umployment, and partly by the advance of local technological capabilities. From Figure 6.1, we can find that the increasing number of pharmaceutical enterprises during the mid-1980s and the early 1990s marked the second period of rapid growth of Tonghua’s pharmaceutical industry, in which a great deal of new pharmaceutical start-ups were built up in Tonghua, and these newly established enterprises found a new and highly profitable sector, ginseng-based invigorants. The market niche allowed Tonghua firms to successfully enter the TCM industry. I will explain this aspect in Chapter 8.

There were two significant events that happened around 1985 which greatly influenced theTonghua pharmaceutical industry: the fiscal decentralization ("eating from separate kitchens", a system of central-local revenue sharing) and the reduced scope of the administrative jurisdiction of the Tonghua Prefecture (Hunjiang City has not been under the leadership of the Tonghua Prefecture after then). In the new fiscal system, more and more expenditure responsibilities was transferred from higher-level governments to lower level governments, on one hand, and devolved functions, on the other hand, by gradually transfering authority for decision-making, finance and management to quasi-autonomous units of local government with corporate status (fiscal decentralization). Local budgetary revenue was in general not enough to cover the expenditures, so local governments were allowed to collect off-budget revenues in order to tight over the fiscal shortfalls (Zhang, 1999). Thus local government had to create and cultivate new revenue sources. As a consequence, "creating revenue" became the most popular phrase in China and the subnational governments scrambled to establish new enterprises to ease their fiscal pressure, as what can be termed as "local state corporate" (Lin, 1995; Oi, 1992) or "industrial firms"(Walder, 1995, 1998) (for a more detailed explanation, see Chapter 9.4). Against this background, many local government agencies in Tonghua established their own small pharmaceutical enterprises with the sole objective of creating extra income for employees. At the same time, the rapidly growing economy in China and enhancing health awareness brought about together the drastic increase in China's pharmaceutical industry, especially in the invigorant sector. The new ventures seized a huge market opportunity (ginseng-based invigorants, see Chapter 8.3) which was largely neglected by "old" enterprises. This leads to a question of why almost all local government agencies in Tonghua were involved with the highly profitable sector when they were confronted with a large number of industrial opportunities. The answer could be ascribed to the strong social networks of "pharmaceutical enterprises and local state" that originated at least in the planned economy. I will go back to this aspect in Chapter 9.4.

From a short-term point of view, the economic performance of these state-owned pharmaceutical firms established before 1980s was significantly enhanced mainly because a series of micro-enterprise management reforms were introduced. The micro-enterprise management reforms which targeted to improve the economic performance of enterprises in the existing regulatory framework of public ownership, were extended to all subprovincial-level governments in the mid-1980s (see Chapter 3.2.2). The micro-enterprise reform effectively and rapidly enhanced the economic performance of pharmaceutical companies before long (which will be explained again in Chapter 9.4.2). Therefore, the Tonghua pharmaceutical industry was not only characterized by the great expansion in number of firms but also by the rapid growth of the pharmaceutical economy during that period.

From the viewpoint of firm organization there were also some changes in Tonghua's pharmaceutical sector. The most visible one is that the established enterprises began to adopt a new firm organization, what I would like to call "quasi-profit-seeking enterprises". Furthermore, a new entry model emerged, namely the entrepreneurial spin-off (but affiliated to the state-owned enterprises in appearance). The number of this kind of new startups was, however, very limited at that time. Hence, I will concentrate on the first form of organizational innovation here.

Given the fiscal pressure of local government and relaxed regulation on micro-enterprise management, enterprises in Tonghua, both state-owned and collective, introduced a series of reform strategies of enterprise management, including "the factory director responsibility system" and "the contracted managerial responsibility system" (both dealt with the "government-enterprise" relationship), and carried out the contract-based mechanisms inside enterprises (see Table 6.3). Entering the period of micro- management reform, enterprises enjoyed a freedom of decision-making (in production, marketing, investment and profit distribution) and could retain a small portion of their profits. In the new system of enterprise governance, the factory directors (managers) as representatives of the factories made economic contracts with local states, which clarified the responsibilities and benefits between both sides; similar contracts existed between firms and its subunits (see Figure 6.3). Thus this organizational form could be seen as a quasi-market enterprise in becoming a more market-oriented economic unit.

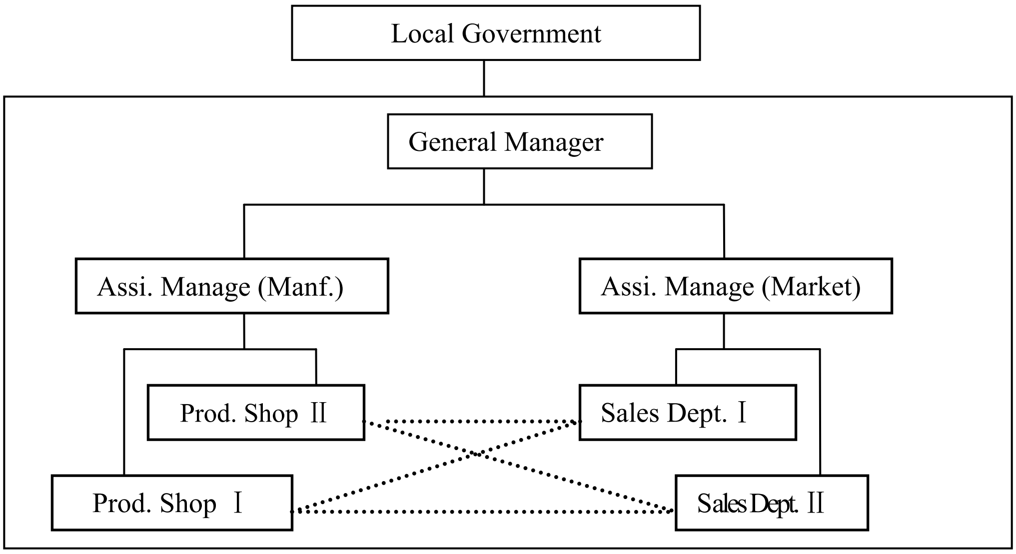


Figure 6.3: Organizational form during the early reform period
Source: own elaboration
Note: The dashed line represents price-based transactions between both sides, and the solid line denotes the bargaining based contract relationship.

The enterprise reform was not fully based on today's market mechanism, but on bargaining between firms and government, firms and their subunits (see Table 6.3), and contributed to transform the SOEs into profit-seeking businesses. As a matter of fact, these new policies resulted in the growth of the Tonghua pharmaceutical economy, at least in a short term. From a long-term growth perspective, this early reform of micro-enterprise management of Tonghua's pharmaceutical firms served as a platform for the following stages, in this sense that the existing firms obtained market-oriented management knowledge through learning-by-doing, and consolidated the coupled coalitions between local government and pharmaceutical firms. This sound "enterprise-local state" relation provided the relational platform for the following privatization of local state-owned and collective enterprises.

Table 6.3 Characteristics of firms during the early reform period

Internal market mechanism	**Operational autonomy**
• the contractual relationship between business and government	• enterprise management autonomy
• the contractual relationship between the upper and lower levels of firms	• production unit's autonomy
• contractual relationship between internal business units	• the autonomy of staff
Incentive mechanism	
• operators: economic performance of firms • employees: performance in production • technicians: performance in production development	

Source: own elaboration

6.2.3 Firm Creation and Firm Organizational Change during the Late Reform Period (1992-1997)

Tonghua's pharmaceutical industry during the period 1992 – 1997 became more tumultuous, largely because a host of strategic government policies were implemented. The most significant government policy was the large-scale privatization of state-owned enterprises, i.e., the "grasping the large and letting the small go" policy. It is important to note that economic performance of local government-owned enterprises increased in the previous period owing to the micro-enterprise management reform, but their share in this local sector shrank due to the phenomenal rise of newly privatized enterprises. Additionally, all local pharmaceutical enterprises in Tonghua were not large-scale state-owned enterprises (that were formed by Beijing government and were forbidden to be privatized). This means that almost all local government-owned pharmaceutical enterprises in Tonghua could be privatized. As the regulation on the pharmaceutical market became more rigid and intellectual protection rights became stronger, Tonghua's pharmaceutical enterprises became more active in improving drug safety and effectiveness. In addition, some privatized pharmaceutical enterprises began to create and accumulate their firm-specific advantages, for example, based on new product brands and the (re)development of new TCM drugs. In brief, this dramatic growth of the local sector could be attributed to the smooth and low-cost transformation from a publicly-owned-enterprise-dominated economy to a fully private sector.

Deng Xiaoping's southern tour speech in 1992 fledged the private economy in China. As a result, the number of pharmaceutical enterprises in Tonghua increased by 20 in merely one year. After the huge growth in 1992, the firm number in the Tonghua pharmaceutical cluster stabilized around 46 in the period 1993-1997, during which some ill-operated enterprises were merged or acquired by private pharmaceutical ones. The ownership reform was completed at the end of the 1990s, when the SOEs-dominated ownership system was transformed into a private ownership structure.

As far as the entry mode during that time is concerned, investment by local government agencies was no longer a viable strategy. However, a new entry model, joint venture, emerged as a main strategy that was often adopted by entrepreneurs who came from different regions. The reasons for this would be: (1) Joint venture with local entrepreneurs is a good way for non-local entrepreneurs to reduce the risks caused by local formal and informal institutions since they can make full use of strong social networks of their partners; (2) local entrepreneurs can share firm-specific capability, in particular, of marketing, brands, research and development.

But the most often-seen form of "new" start-ups in Tonghua between 1992 and the end of 1990s was the "contracted enterprise". At that period, the "grasping the large and letting the small go" policy was conducted. In fact, these contracted enterprises were erected as early as 1985 and began to go private. Different from other pharmaceutical regions where poorly-performed enterprises were directly sold or went bankrupt, Tonghua city government adopted a flexible and gradual way instead, namely, turning small SOEs and collective enterprises into "contracted ownership". These contracted enterprises were seemingly public in the form of ownership (which I call "red cap" enterprise, see also Chapter 9.4), but once they succeeded financially they became private entities later on. This alternative way was of importance for the entrepreneurial level and for the local industry level, too. It reduced the operational cost at the very beginning because the entrepreneurs who contracted firms did not need to create a new firm from scratch, rather leased production equipments and site of the contracted enterprise. More importantly, the contract entrepreneurs accumulated experience during the contract period, which helped to reduce firm growth uncertainty. For the local industry level, large-scale public investment by local government agencies before 1990s was fully utilized in a smooth fashion.

The firm organization of contracted enterprises is different from the foregoing-mentioned "quasi-profit-seeking enterprises". In the "factory director responsibility system", operational control of an enterprise was vested by contracts between the government and enterprises (not individuals), namely, the economic performance of factories was not directly related to the increase and decline of personal wealth, but to ups and downs of personal position. But in the new contracted ownership system, the contractors tend to put a given amount of money in pledge, and they could get the profits if they achieved success, while they would pay for a loss and lose the pledge in case of a failure. Once the contracted workshops or plants succeeded in the market they could change into "becoming private" in the form of ownership, otherwise they would have to be returned again to the "old" system or further contracted to other entrepreneurs. The action of contracting ongoing loss-making enterprises was actually venturesome, not only economically. Hence, contracted enterprises were in essence private and played a function of 'safety nets' in the outerwear of public ownership ("wear red cap") to reduce political risk in the circumstances of political and legal uncertainty.

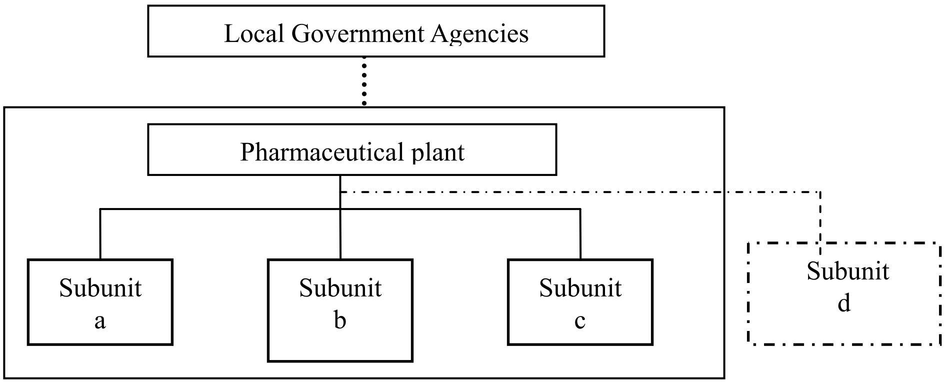


Figure 6.4: Contracted ownership

Source: own elaboration

Note: the subunit (d) was contracted out, in reality private-owned.

There were two contract systems: partially contracted ownership and wholly contracted ownership. The former tended to happen in relatively large state-owned enterprises in which one or more production subunits or workshops were contracted, while the latter occurred normally in small state-owned enterprises and collectively enterprises. These contracted enterprises were run through market mechanism, since they were organized independently on the base of price mechanism, buying and selling on the market. Many of today's private pharmaceutical enterprises were transformed from contracted enterprises in the 1990s. Xiuzheng Group is a good example of the wholly contracted enterprises (for this story of Xiuzheng Group, see 6.2.4).

6.2.4 Firm Creation and Firm Organizational Change (1998 onwards)

Tonghua's pharmaceutical sector underwent notable changes since 1998. Apart from the remarkable increase and decrease of the amount of firms, acquisition and entrepreneurial spin-off became the popular entry modes.

Due to the implementation of Good Manufacturing Practice (GMP) in 1997, coupled with increasing market competition, some SMEs fell in a serious financial situation. More than ten small and loss-making pharmaceutical enterprises were acquired, mostly by local enterprises during the period from 1998 and 2001. As a result, the number of firms dropped from 64 in 1999 to 51 in 2001. It is worth noting that the drastic fall of the firm number did not lead to serious social problems such as large-scale unemployment that was often seen in other region's industrial re-organization. This can be ascribed to the sound collaboration of local government and local entrepreneurs, which I will explain in detail in Chapter 9.4. Here I concentrate on the change in firm organization.

After the tormenting period, the Tonghua pharmaceutical cluster continued to grow in terms of firm number and output value. The formation of new pharmaceutical ventures was characterized by multiple forms, including the transformation from SOEs or collective enterprises, entrepreneurial spin-off and acquisition. The new entry mode of acquisition could be divided into three types, according to whether acquired companies and acquiring companies were local or not. The first type is that local companies acquire local companies. This kind of acquisition happened relatively early, mainly in the latter period of ownership transformation to the private enterprise-dominated pharmaceutical economy. The main objective of this kind of acquisition was to rapidly expand production capacity. The second type is that non-local firms acquired local small loss-making firms. These acquiring companies were also mostly specialized in the pharmaceutical industry before they entered Tonghua. The acquisition was a less risky and economical way of acquiring incumbent pharmaceutical firms with GMP Certification rather than going the risky way of establishing new firms involving huge financial resources. The third type is that local giant pharmaceutical companies acquired non-local companies. Objectives of such acquisitions are more complex in nature. Apart from the conventional motivation of gaining market access and expanding production capacity in a short term, two strategic objectives were either to eliminate competition of similar products or to get access to specific strategic assets of the acquired firm such as new products and research capability. Since I will deal with access to firm-specific capabilities of product development as motivation for acquisition in Chapter 8.5, I will concentrate on other kinds of acquisitions (whose motivations are the expansion of production capacity, market access and the elimination of competition).

Table 6.4: Typology and motivation of acquisitions

Typology of Acquisitions	Motivation
local firms acquire local firms	rapidly expanding production capacity
non-local firms acquire local small loss-making firms	Access to nationally certified manufacturing facilities
local giant pharmaceutical companies acquire non-local companies	market access and expanding production capacity eliminating competition access to acquired firm-specific strategic assets

Source: own elaboration

The new mechanism of creating new startups and entrepreneurial spin-offs and attracting investment from different regions or industries began to function in the late1990s (the temporal ordering of these forms will be made clear in Chapter 7.4). With the development of local enterprises, non-local investments (from outside Tonghua but in China) were attracted to the Tonghua pharmaceutical sector, mainly through acquisition of poorly operating small state-owned enterprises. For instance, Beijing Jinkaiwei Group entered into Tonghua by acquiring Kai Wei Pharmaceutical Co. Ltd. Secondly, new startups were created by local entrepreneurs from other different technological fields like real estates development industry. The forms of attracting investments either from other regions in China (mostly in the same province) or from other industries could be seen as an agglomeration mechanism, as Boschma and Wenting (2007) observed in the automobile industry in Great Britain. The mechanism of entrepreneurial spin-off also began to play a role in creating new ventures, since some new pharmaceutical startups were created by the entrepreneurs who worked in the same industry (for this kind of examples, see Chapter 7.3.3).

The firms transformed from public owned enterprises, spin-off firms and attracted firms from other regions and sectors occupied one third of the total existing pharmaceutical enterprises, respectively. The reason behind the emergence of the new forms of firm creation could be ascribed, first of all, to the formation of the social and legal environment in favour of private enterprises. At the same time, the emergence of agglomeration mechanisms and entrepreneurial spin-offs shows that market-oriented mechanisms of allocating economic resources began to function. Additionally, in the case of Tonghua, this local pharmaceutical sector has grown into the first-class TCM industrial cluster in China; having a good reputation across China was helpful to attract firms from other regions and sectors to this local sector.

Entering the late 1990s, a new firm organization form, the enterprise group, emerged in this local sector. The emerging giant TCM enterprise groups in Tonghua are mainly Xiuzheng, Daodong and Maoxiang Group. Among them the most splendid one is the Xiuzheng Group. With having acquired some local loss-making state-owned pharmaceutical enterprises in large scale around 2000, including Tonghua City Pharmaceutical Factory, Liuhe Chuangqing Chemical Pharmaceutical Company Ltd, Xiuzheng Group's production capacity expanded within a short time. In order to control well high-quality, high-grade upstream raw materials, Xiuzheng Pharmaceutical Group also acquired some upstream enterprises to provide TCM raw materials. For example, a large-sized spotted deer breeding company was acquired in 2004 as an affiliated plant to produce deer velvet and deer blood. Deer velvet (the generic term of the male Elk) and deer blood have huge medicinal value and have been used in TCM for over 2000 years.

After 2005 Xiuzheng Pharmaceutical Group launched a new strategy of "going outside Jilin", mostly through acquisition. In September 2005 Xiuzheng Pharmaceutical Group acquired Kuangxi Pharmaceutical Co. Ltd. in Sichuan province (in Southwest China), jointly with China North Chemical Industries Corp. (NOCINCO), a state-owned holding company with a headquarter in Beijing. This reorganized company would leverage advantages of Xiuzheng Group in management and marketing networks to improve its economic performance. This acquisition provided Xiuzheng Pharmaceutical Group with easy access to the established market of the acquired company, over-the-counter (OTC) drugs, for instance, anti-hypertensive drugs. In addition, Xiuzheng Pharmaceutical Group announced that 200 million RMB would be invested to expand the reorganized company to China's southwest industrial base of Xiuzheng Group. The main objective of this investment was to utilize Chinese wildlife resources in Sichuan mountain areas as medicine materials to meet the growing demand in Chinese Southwestern TCM market. According to the vice director of the office of product planning at Xiuzheng Group,

"If this plan could be achieved, the total industry capacity of Xiuzheng Pharmaceutical Group Pharmaceutical Group would be doubled, with an expected total output value of 3 billion RMB" (Interview, No.1 in Appendix 2).

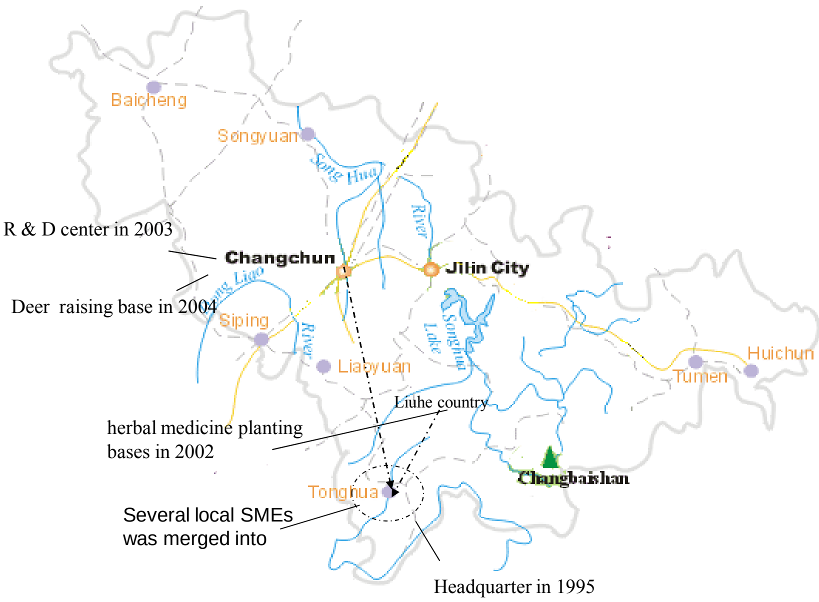


Figure 6.5: Expansion of Xiuzheng Group in Jilin province

6.3 The Origin of the Pharmaceutical Enterprises in Tonghua

The main task of this section is to construct a genealogical tree of selected Tonghua pharmaceutical enterprises (shown in appendix 5) based on collected information of all the firms in the cluster and on their history. It is especially noteworthy that almost all the studies on the origin of firm creation have depended on the carrer experience of firm founders and the history of the firms themselves. The organizational change of the Tonghua pharmaceutical firms is summarized in Figure 6.6.

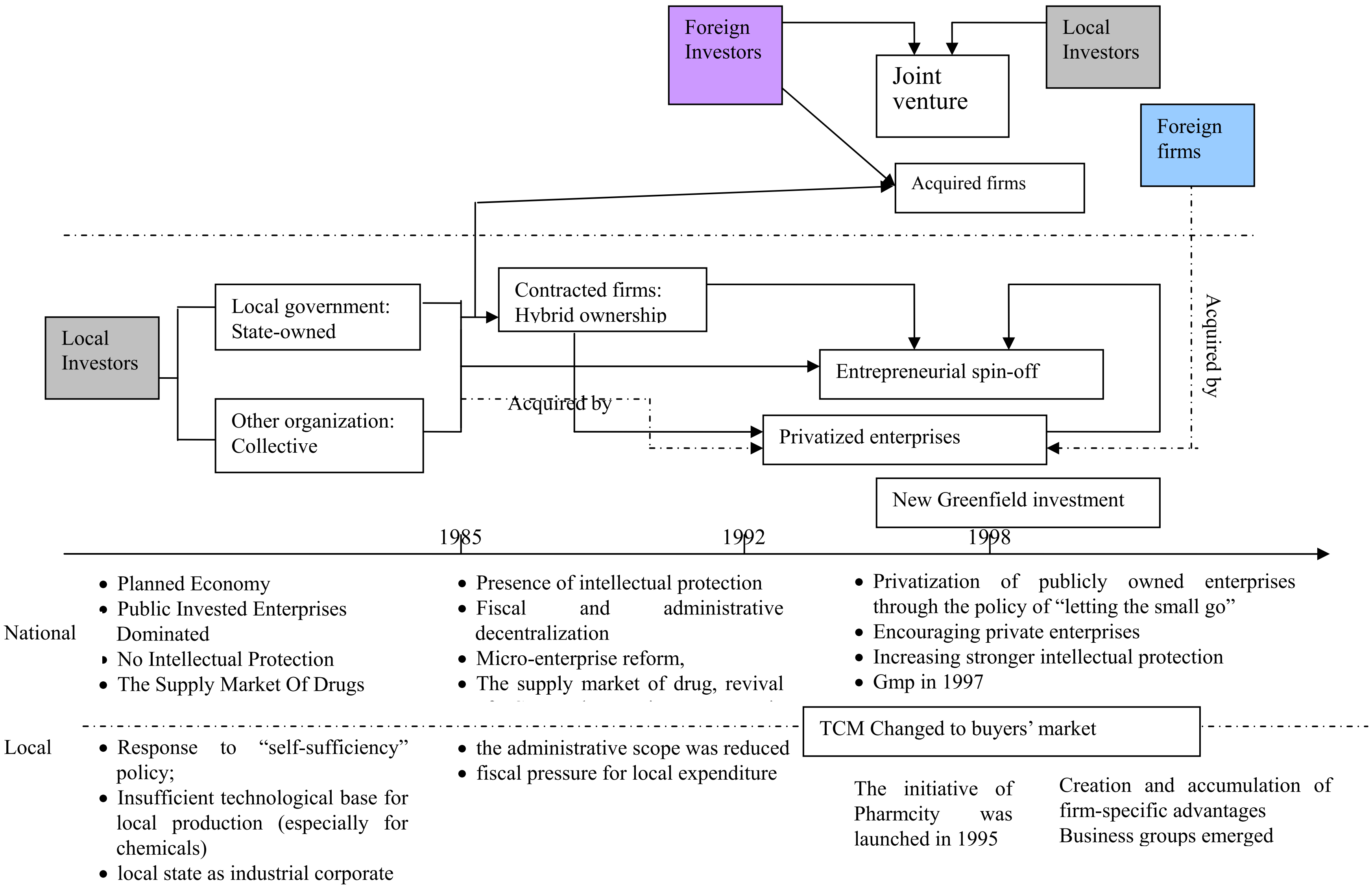


Figure 6.6: Evolution of Firm Organization in Tonghua Pharmaceutical Industry

6.3.1 The Early Generation of Tonghua's Pharmaceutical Enterprises (-1985)

The origin of Tonghua's pharmaceutical industry can be traced back at least to the second half of the 19th century, when several family-run TCM stores already existed. For example, Deyuan Yang established the Yongcheng TCM store in 1875 with 30 employees selling self-made Chinese herbal products. There were three large TCM stores in Tonghua then (the other two were Jishenghe and Faxin) with a total of around 150 employees by 1950, mainly selling hand-made medicines.

Shortly after the Chinese Communist Party came into power in China, the private ownership was abolished (1953-1956) and then these stores' production workshops and equipments were restructured to establish the first "modern" pharmaceutical enterprise (in term of machinery production), Tonghua Commercial Parmaceutical Plant, in 1958. Later in 1969 this plant was renamed Tonghua City Pharmaceutical Factory and has now been merged with Xiuzheng Pharmaceutical Group.

In the 1960s the industrial system of pharmaceutical manufacturing in China was greatly improved through public sector investments, and most of the newly established large state-owned pharmaceutical enterprises were located in metropolises (also see Chapter 3.4.2). However, the domestic demand for essential drugs was not met at that time, in particular in rural or peripher areas. In addition, since Tonghua lies in a remote mountain area through which epidemic diseases used to spread, Tonghua city government struggled with the lack of necessary medicines for a long time. In response to the central government's call for self-sufficiency policy, which encouraged basic drugs to be produced locally, five pharmaceutical plants were set up by the local government.

The plants specialized in producing chemical medicines, among which are Tonghu County Pharmaceutical Plant (which was renamed as Baishan Pharmaceutical Plant later) and Tonghua City Qianjin Pharmaceutical Factory and Tonghua County Raw medicine Factory (renamed as the Baishan Pharmaceutical Plant in 1984). The predecessor of Tonghua County Pharmaceutical Plant was Tonghua City Hospital's preparation room, and it was separated from the hospital in 1967, while the Tonghua City Qianjin Pharmaceutical Factory became a joint venture of a small collective pharmaceutical plant (Hongwei) and a state-run Chemical plant (Tonghua City Comprehensive Chemical Plant) in 1968. Tonghua County Raw Medicine Factory was founded by Tonghua County Medical Bureau in 1969. At the very start the plant produced chemical medicines such as streptomycin, but because of the lack of required technological capabilities it turned to produce ginseng-based invigorants after 1973. Two new chemical pharmaceutical enterprises were established in first two years of the 1970s: Ji'an County Pharmaceutical Factory by a local government agency (Ji'an County Light Industry Bureau) in 1970, and Meihekou Pharmaceutical Factory established by a local state-owned medicine wholesales enterprise (Meihekou Medicine Station) in 1971.

There were two other pharmaceutical plants set up during the 1960s and specialized in Traditional Chinese Medicine, Baishan No.2 Pharmaceutical Factory and Meihekou No.1 Pharmaceutical Factory. The former one was founded on the base of the production technology of a local health school (Tonghua City health school) in 1969, and the latter was reconstructed in 1969 from a Chinese herbal medicine store (Shancheng Town Chinese herbal medicine store).

It is worth noting that Tonghua city was a military post before 1980 since it is located near the Chinese – North Korean border, and the garrison troops set foot in the pharmaceutical industry in the 1960s and 1970s. These plants were "57" Pharmaceutical Factory in Liuhe County (laterly renamed as Liuhe County Shuangqing Pharmaceutical Factory) in 1966, Meihekou Sanhong Pharmaceutical Factory in Meihekou County in 1968, Liming Pharmaceutical Factory in 1968, and Xinyu Pharmaceutical Factory in 1969. Almost all of this kind of plants had no technologically experienced parent enterprises in the pharmaceutical industry, except for Liming Pharmaceutical Factory, which was transformed from a workshop of military hospital (206 Hospital) in 1968.

From the above discussed proofs, it is safe to say that the years around the 1970s witnessed the first hot wave of the creation of pharmaceutical plants. The characteristics of this hot wave could be summarized as follows. (1) The rise of local pharmaceutical enterprises could be seen as the local response to the huge need of basic drugs over China; (2) the pharmaceutical enterprises were created by local drug administrative and regulatory authorities for public benefits, not for own economic well-being (for the macro-institutional background see 6.2.2), which is significantly different from the investment incentives of local government agencies in the TCM industry in the 1980s; (3) a new chemical sector emerged during this period. Athough the chemical sector as a whole finally failed (largely because of the lower local technological base and the competition with TCM industry for local financial and labour force resources), the emerging TCM industry benefited a lot from it. I will refer to this aspect in Chapter 8.1.3.

There are a few newly established pharmaceutical plants in the 1970s. In the first half of the 1980s, however, five new pharmaceutical plants were erected, with the result of increasing the number of pharmaceutical plant up to 18. Among them were two, founded by the local garrison, namely, Changcheng Pharmaceutical Factory[48] in 1984 and Meihekou Shanbao Pharmaceutical Factory in 1985, and another two were erected by local government agencies i.e., Liuhe County Chinese Medicine Factory by Agricultural Bureau in 1980, and Baishan No.5 Pharmaceutical Factory by Tonghua County Light Industry Bureau in 1985. Furthermore, Huinan County Ginseng & Deer Pharmaceutical Factory, was founded by a factory specialized in deer raising. All of these new pharmaceutical plants were specialized in TCM, which was the local response to a huge demand of TCM in China' domestic market.

There were 18 pharmaceutical enterprises by the mid-1980s (see Figure 6.1) and the pharmaceutical industry had already become one of the pillar industries in Tonghua city. Its output value, sales and profits and taxes reached RMB 256.65 million Yuan, RMB 2.176 million Yuan, and RMB 1.216 million Yuan, respectively, with a total of 1347 employees. The economic growth of Tonghua pharmaceutical enterprises in the middle of the 1980s could be partially ascribed to the increasing demand. Firstly, the high-speed economic growth after the reform and opening-up policy enable people to pay more for health care; Secondly, China's education, not only higher education, which had been interrupted by the Cultural Revolution (from 1966 and 1976) was resumed, the increasing level of education was helpful to raise people's awareness of health. Thirdly and the most importantly, the value of TCM has been re-affirmed by China's government entering the Deng Xiaoping time. For a long time, the Chinese government had paid more attention to Western medicine, especially during the Cultural Revolution period. The remarkable evidences are that the number of doctors in TCM was reduced by half, from half a million in 1958 to a quarter of a million in 1978; and that the number of national TCM colleges sharply decreased, from 23 to 5 during the same period. However, the importance of TCM was emphasized again in China after Deng Xiaoping came to power (in 1977).

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[48] It was transferred to the local government in 1998

Decreasing poverty rates, increasing education levels and refinding the medicinal value of TCM contributed together to the rapid growth of the whole pharmaceutical industry, in particular increased market shares. Tonghua enterprises seized this huge and (re)emerging market opportunity to develop the TCM products based on ginseng and other national herbs. Tonghua city was the earliest region in developing large scale ginseng products, which not merely opened up a window of opportunity for the following development of TCM drugs, but also provided it with an initial advantage.

6.3.2 The Second Wave of New Start-Ups (1985-1992)

China's central government began to carry out fiscal decentralization in 1984, and the scope of the administrative jurisdiction of the Tonghua prefecture was reduced in 1985. According to the new public fiscal policy, the expenditures of governments, state-owned enterprises and other public departments (for example, education) had to be assumed by public revenues at the corresponding level (for a detailed explanation of its influence on local economic development, see Chapter 9.2). As a result, in Tonghua as well as in other regions in China, the local state had to seek new sources of economic growth to easy fiscal pressure. Thus, various government agencies in Tonghua built up a large number of TCM enterprises and expected higher profits and taxes from the TCM industry. For example, Baishan No.5 pharmaceutical plant (later transformed to Dongbao Group) was established by Tonghua County Government in 1985. Liuhe TCE plant and Liuhe longgangshan pharmaceutical plant became an independent entity from Liuhe Changqing pharmaceutical plant around 1986. Baishan No.6, No.7 and No.8 pharmaceutical plants came into being in 1987.

Tonghua city made determined decisions to develop the pharmaceutical industry as the pillar industry around 1987, when a lot of human and financial resources were put into this promising field. It is notable that a large number of local government agencies were entangled into this sector at that time, in particular in the production of tonics based on natural herbal plants (for example ginseng), which was a highly profitable industry in the second half of the 1980s. But the so-called public agencies were not administrative authorities of the pharmaceutical industry, and they established new pharmaceutical ventures under the name of their own organizations in collective ownership just to promote own economic welfare. Against this background, six new pharmaceutical plants were born within one year in 1988. They were Yayuan pharmaceutical plant (laterly transformed to Goldenhorse Group) founded by one department of Erdaojiang district government; Tonghua City No.2 pharmaceutical plant (purchased by Wantong Grounp later), Huinanhuifa pharmaceutical plant and Linhai pharmaceutical plant by Tonghua County Economic and Trade Bureau, Changliu pharmaceutical plant by Changliu primary school and Huinan County Pharmaceutical Factory co-founded by Jilin medical staff secondary school (in Changchun) and Huinan County government.

Over the next few years Huinan Biochemistry pharmaceutical plant was set up by Huinan County government in 1989, Liuhe Tianli pharmaceutical plant was transformed from Liuhe County Deer Raising factory in 1991, Tonghua County Shiyan pharmaceutical plant was founded in 1991, Fangda pharmaceutical plant and Hengan pharmaceutical plant were built up by the Tonghua Township Enterprises Bureau and Tonghua City Grain Bureau respectively in 1992.

6.3.3 The Privatization Process of Public Firms and the New Generation of New Start-Ups (1992-1997)

As mentioned before, different from the "big bang" path of Eastern Europe and the former Soviet Union, especially Russia, the process of privatization in China was not finished overnight, but was conducted gradually through continual pilot experiences. Tonghua city launched the historic course of ownership transformation in 1992, after then almost all pharmaceutical firms in Tonghua had been transformed to private ownership. This raises questions of who took over the transformed enterprises. The take-over of the local government-owned enterprises must involve substantial resources, not restricted only to financial resources. The most significant resource was the relational resource. Only those local elites (namely both local government officials and top-level enterprise cadres) who had a strong social network, in particular with local government, could take over the transformed enterprises since their strong social network provided easier and more access to the scarce resources. The strong social network not only endowed them with the priority of taking over these enterprises at a cheaper price, but also enabled them to raise required financial resources for the taking–over. Furthermore, these new established pharmaceutical companies were private in ownership from their beginning. Local cadres raised the needed funds, firstly by borrowing from extended families and kinship networks, later through public share issues (after the mid-1990s). From the above-mentioned aspects the importance of social networks in coordinating and negotiating various interested actors during the process of firm creation and growth should be recognized. I will especially deal with this aspect from the perspective of an institutional approach in Chapter 9. Here I just want to give some empirical evidences.

Today's two influential pharmaceutical companies that rise to the top 100 China's pharmaceutical enterprises by sales, Xiuezheng Group and Wantong Group, can be taken as example for illuminating the process of privatization. The predecessor of Xiuzheng Pharmaceutical Group was the attached pharmaceutical plant of the Tonghua Chinese Medicine Institute. This small plant could not afford the wages for their employees in 1995 because it fell into an extremely serious, difficult financial situation, with accumulated liabilities as high as 4 million Yuan RMB and estimated fixed assets of 250,000 Yuan RMB. Xiu Laigui, a middle-level leader at Tonghua City Traffic Police Bureau who had a sound relation with the director of the local authority of medicinal industry, took over this plant at a very low cost but under the condition that all of the employees would not be fired[49]. This plant was transformed into a limited liability company in 1996, still remaining a state-owned firm, and was later transferred into a private firm at the end of 1998. Owing to innovation in market and improved product quality (for this aspect, see Chapter 8.3.2), Xiuzheng rapidly developed at an annual growth rate of 1,876% in terms of total revenue between 2000 and 2004. It contributed 169 million Yuan RBM to the state taxes, accounting for 8.2% of total taxes by all private enterprises in Jilin province in 2001. Nowadays Xiuzheng has grown into a big group with nearly 10,000 employees and total assets of 4.8 billion Yuan RMB and has entered into the top 10 China's pharmaceutical enterprises by sales.

Similar to Xiuzheng Group, Wantong Group also went through the process from a state-owned plant (Tonghua City No.2 pharmaceutical factory establish in 1988) to a contracted enterprise and then to a private entity. In 1997 Pan Shoude who was the top manager of a local Optical state-owned enterprise with rich experience in marketing, raised a total of 2 million RMB (this number was large for the individual family at that time) from families and friends to contract Tonghua City No.2 pharmaceutical factory, which owed the banks more than RMB 7,000 million and countless wages at that time.The TCM market shifted from the supply side to the demand side in the early 1990s and the increased competition in TCM industry compelled pharmaceutical

[49] In the course of reform of state-owned enterprises, irregular payment of staff salaries was a frequent phenomenon in poorly managed enterprises. Therefore, solving the employment problem was an important matter for governments.

enterprises to pay more attention to the demand side. The many years working experience of marketing enabled him to be more sensitive to the needs of the market. Through innovation in marketing and in product (re)development, just in the first year after being contracted, Wantong pharmaceutical factory developed into one of the local star firms and today jumps into the list of the top 100 pharmaceutical enterprises in China.

These two groups have one thing in common, i.e., both Xiu Laigui and Pan Shoude did not have any experience in working in the pharmaceutical industry before they gallantly adventureed on contracting ill-run pharmaceutical factories. Xiu Laigui was a middle-level leader at the Tonghua City Traffic Police Bureau, while Pan Shoude was the manager at a state-run store specializing in selling watches and glasses. They attached greater importance to the market demand and drug quality which allowed them to establish firm-specific advantages in marketing. In particular, Xiuzheng Group has now established a strong marketing network and brand advantage.

It is necessary to note that the state-owned enterprises that were contracted by Xiu Laigui and Pen Shoude were relatively small and loss-making before. But there is another kind of contracted state-owned enterprise which was relatively larger, for example, Dongbao, Changlong, Huaxia and Ji'an. Most of the local relatively large SOEs or SOEs with relatively better economic performance were taken over by the managers who had been working in the contracted firms for many years (for a detailed discussion, see Chapter 7.3.3). This reflects the timeline in privatization of different kinds of state-owned enterprises (which I will deal with in Chapter 7.4). Put simply, the loss-making and small pharmaceutical enterprises were on the list of the first groups to be privatized. If its ownership was collective, the pace of privatization would be accelerated. Those relatively large state-owned enterprises, especially with good economic performance, would be privatized later.

During this period of privatization of SOEs there were also a small number of new entrants coming into Tonghua's pharmaceutical industry. The main forms of the creation of new pharmaceutical enterprises during this period include joint ventures and entrepreneurial spin-offs. Non-local enterprises often adopted the mode of joint venture with local enterprises to enter Tonghua. For example, Yujin Pharmaceutical Co. Ltd was co-founded by one local company and four non-local companies (one is Shanghai Institute of Plant Physiology of Chinese Academy of Sciences) in 1993. Yujin

Pharmaceutical Co. Ltd and two non-local pharmaceutical companies (Dalian Tianwei Pharmaceutical Co., Ltd., Dalian Yawei Pharmaceutical Co., Ltd.) jointly established Hongtaomao Pharmaceutical Co. Ltd in 1996. At the same time one could observe that a few entrepreneurs left their origins to run their own business in the same industry. The experience of Zhang Shouli and his colleagues is a good case here. They left Qianjin Pharmaceutical Factory and established a new entity – Xinghua Pharmaceutical Limited Liability Company – in 1997. There is an additional case, namely, Tonghua Chanyuan Institute of Burn Scar which was founded by a doctor from a local military hospital (No. 206 Hospital). In addition, local government officials began to set up their own pharmaceutical companies through acquisition or greenfield investment. For example, Liu E, a former Tonghua County government official, created Shenyuan Pharmaceutical Company in 1993. I have a special section on this aspect in the next chapter.

6.3.4 The Fourth Wave of New Entrants (1998-1999)

The period from 1998 to 2003 witnessed big ups and downs in terms of the population of firms in Tonghua's pharmaceutical cluster. The firms' number jumped up to 59 in 1998 and continued to increase to 64 in 2001, but dropped to 51 in 2001. The reason of firm closure was mostly connected to a new national regulation, according to which, the pharmaceutical enterprises should meet GMP standards, or else, they would be forced to exit. As a result, some small and ill-performed enterprises were forced to merge or become acquired, or went directly bankrupt. Despite the fact that some young and small enterprises, especially those TCM enterprises which were established around the mid-1990s in Tonghua, could hardly survive in this increasingly competitive market, while some new firms were erected. Although most of these newly established enterprises were created by local entrepreneurs, a considerable number of new firms was created by non-local investors. More importantly, from the viewpoint of time sequence, the spin-off mechanism and the ability to attract non-local investments to Tongua (agglomeration economy) began to play an unprecedented significant role in the term of new firm number.

Some new non-local entrants tended to invest in this local pharmaceutical cluster through acquisition of poorly operating small enterprises. Acquisition is a good strategy for non-local entrants to gain an entry platform, mostly for the expansion of production capability. The acquired firm in turn leveraged the acquiring firm's product development and marketing infrastructure or social network to achieve further national growth and expansion in the long run. For instance, a health food company from another significant pharmaceutical cluster in Jilin province (Aodong) founded Liuhe Zixing Pharmaceutical Co. Ltd, through wholly purchasing Luotongshan pharmaceutical factory (i.e. Changqing NO.2 pharmaceutical factory that founded in 1992, renamed as Luotongshan in 1993). Jingzhuzangyao Group, a company specialized in TCM drug in another province, acquired Boshile Pharmaceutical Co. Ltd in Liuhe County. These acquisitions were all conductive to get access to nearby raw materials and to improve pharmaceutical equipments of the acquiring enterprises. In addition, the acquired firm can make use of social networks of acquiring enterprises to seek valuable resources. A good case here is Beijing-based Jin Kai Wei Group which acquired Weide Pharmaceutical Company and then formed Tonghua Kai Wei Pharmaceutical Co. Ltd. With the help of its Beijing eadquarter, Tonghua Kai Wei developed a cooperation relationship in research and development with Beijing Jinbencao Herbal Medicine Science and Technology Development Ltd which was located in the largest medical research area in North China (Haidian District Hi-tech Development Zone in Beijing).

Among the enterprises founded by local entrepreneurs, some were spin-offs, while others were established by entrepreneurs without previous industrial experiences. According to my field survey, the new startups during this period were established through greenfield investments. Spin-off entrepreneurs here refers to those low or middle-level managers and engineers who used to work in this pharmaceutical cluster and subsequently opened their own operations in this sector (Dahl, et al., 2005; Klepper, 2001). Spin-off entrepreneurs usually gain entrepreneurial experience that provides them with capabilities needed when self-employed. Examples for entrepreneurial spin-offs in this TCM cluster would include the following entities: (1)Yang Tianyu, the former director of Tonghua City No.2 Pharmaceutical Factory, created Guruite Pharmaceutical Ltd. after Wangtong Group purchased the majority shares of Tonghua City No.2 Pharmaceutical Factory and took over its equipments imported in the 1980s from Germany. (2) Liu Peng, who had been working at the marketing department of Xiuzheng Group for a long time, built up Shenghe Pharmaceutical Co. Ltd. (3) Wei Zhenglin, who worked as a senior manager in Golden Horse Pharmaceutical Company for a long time, founded Zhenglin Pharmaceutical Company in 2000. (4) Du Jinxin, an experienced pharmaceutist who he worked at the Tonghua City Center Hospital for approximately 20 years, set up Fengyang Pharmacutical Co., Ltd. But three years later this small plant went bankrupt.

From a comparative point of view, the economic performance of these enterprises as a whole is still not as good as that of the transformed enterprises today. The following reasons could explain this: firstly, competition in the TCM sector after 2000 became increasingly fierce because some relatively larger pharmaceutical enterprises had already created firm-specific advantages that could hardly be imitated by their rivals; secondly, the social network of spin-off entrepreneurs is not as strong as that of local cadres, which limited the resources they can mobilize. From this aspect, we can find that the social network is important, not only in creating new firms, but also in the development process of firms (see Chapter 9.3).

New pharmaceutical enterprises in the Tonghua TCM cluster were founded by entrepreneurs without previous industrial experiences, mostly from the local real estate industry. For instance, Zhou Xujie set up Tengda Pharmaceutical Co. Ltd. in 2002 by buying the operating license from a bankrupt pharmaceutical enterprise. Wang Xingtong founded Jiuming Pharmaceutical Co. Ltd. on the base of a plant which used to produce veterinary drugs in 2003. Another small company, Jiafeng Pharmaceutical Co., Ltd., which has disappeared now, was erected in 2001 by Wangpin who did not have working experience in pharmaceutical sector. These pharmaceutical enterprises are in a worse financial situation compared to the above mentioned entrepreneurial spin-offs, and now are still on the brink of bankruptcy. Besides the reasons indicated above, another main reason for this is that these entrepreneurs did not accumulate enough industry-specific knowledge and location-based social network (for a detailed explanation, see Chapter 7.1.4).

Several small-sized private pharmaceutical companies were set up during this period, such as Hongjiu Pharmaceutical Co., Ltd. and Baixing Pharmaceutical Co., Ltd. in 1998, Siwei Pharmaceutical Co., Ltd. in 2001. We only know that these companies were set up by local entrepreneurs. Other data and information about their backgrounds are not available.

Chapter 7 The Origins of the Pharmaceutical Entrepreneurs in Tonghua

This Chapter will concentrate on the evolution of Tonghua's pharmaceutical entrepreneurs, through which we also can understand the coevolutionary process of firm, institution and technology, and figure out who links these entities and in what ways. There are at least three reasons that can explain why I study the coevolution of firm, technology and institution in an industrial cluster in the transitional countries through the lens of entrepreneurs. Firstly, the study on entrepreneurship is fundamental for the process of economic change (Gunther McGrath, 2003), even in transitional countries. Secondly, as Schmupeter (1934) said, entrepreneurs are habitually the innovators not only of new technologies, but also of new institutions, and even more important, new technologies and institutitons together in turn open the way to new markets and higher productivity. In the transitional context, entrepreneurs not only introduce new products, production methods, markets supply of new materials or parts, but also create new institutions and new organizational forms. Finally, it is widely acknowledged that entrepreneurship is a critical element in the formation of clusters, playing a role of organizing and coordinating various resources and mobilizing social networks.

This chapter aims to provide empirical evidence for the origins of the entrepreneurs in the Tonghua pharmaceutical industry to examine the relationship between prior experiences of entrepreneurs, the temporal sequence, the mode choice of entry and the economic performance of their private enterprises. Based on what discussed this chapter, the co-evolution between enterprise and institution will be examined in detail in Chapter 10.3. Here, I do not want to analyze in detail the initial factors at the level of the entrepreneur as individual person, which definitely influence the motive of the entrepreneurs to start their businesses. Instead, I will focus on the historical trajectory of the entrepreneurs in the Tonghua pharmaceutical cluster. The collected data of the entrepreneurs' work experiences (CVs) will offer us clear clues to understand where they came from and where/what they are doing. Thus, this chapter is crucial to explain how entrepreneurship evolves in the transtitional context.

7.1 Entrepreneurs in China's Transitional Contexts

7.1.1 Placing Entrepreneurship in Real Historical Context

Different from existing researches identifying characters of entrepreneurs such as innovativity, creativity, leadership, being a risk-taker and so on (for example, Pistrui, 2001), this section will focus on the formation process of entrepreneurship in the transitional Chinese context. According to my theoretical framework, the entity and its surroundings influence each other over time (which we might call "coevolution"). Entrepreneurs are the most dynamic actors in developing clusters into complex adaptive systems, where entrepreneurs and the external (institutional and technological) environments co-change over time. Entrepreneurs can play a role of "creative destructors" when "old" environments do not match new changes (for example, in technology and institution); namely, they exercise intentionally strategic actions and construct new external conditions that facilitate their business operation through "trial and error". The new environments in turn contribute to the development of industrial clusters. Thus, I totally agree with Geoffrey and Wadhwani (2006) that entrepreneurship research should place more attention to the historical particularity, temporal and geographic context of entrepreneurial processes, their effects on industry structure and the competitive dynamics of firms. Accordingly, a dynamic and historical perspective will be employed in this chapter to understand the formation of the entrepreneurship in Tonghua's pharmaceutical cluster over time.

In fact, some scholars have similar arguments. For example, Acs and Audretsch (2003) view entrepreneurship as what happens at the intersection of history and technology. These ideas are actually not original, but they have widen and deepen the use of Schumpeter's historical methods (1947) in the entrepreneurship study. The dynamic and historical approach to entrepreneurship is in concert with evolutionary economics, in particular with a co-evolutionary study. A co-evolutionary analysis of institutions and organizations would be a powerful tool to deliver deep insights into the machnisms of the entrepreneurship affecting the long-term changes in social and economic institutions as well as in their own organizations (for example, the seminal work of Murmann, 2003). Fundamentally, placing entrepreneurship in real historical context – the broader industrial, economic and social settings – is critical for drawing sensible generalizations about entrepreneurial behavior. In other words, an understanding of the historical context helps us to be clearly aware of the spatio-temporal particularities of entrepreneurship which vary significantly over time and places. The implication for studying entrepreneurship in transitional nations is that a theoretical generalization being valid in the context of American or European capitalism may not be applicable to entrepreneurial behavior in the context of transitional countries. Likewise, because the Eastern and Southeastern Asian countries (China, North Korea, Vietnam, Laos and Cambodia) and the former Central and Eastern Europe and Soviet Union adopted different ways of transforming from the centrally planned economic system to the market economy, for simplicity, gradualism versus shock therapy, each transitional country has its own spatio-temporal particularities of entrepreneurship. When one studies the formation of entrepreneurship, he must place more attention to country-specific contexts. Of course, I here do not deny the imporance of theoretical generalization of country-specific entrepreneurship. Indeed, it will enrich the empirically-based theory of entrepreneurship.

7.1.2 Why the Founders of Enterprises

Although there is no generic definition of entrepreneur, the attempts to distinguish entrepreneurs from small business owners or managers have discovered significant differentiating features of entrepreneurs (for a review, see Carland et al., 1988). Entrepreneurs are commonly described as individuals who can tend to bear high risk and have a high need for economic achievement. From this sense, three kinds of individuals should be seen as entrepreneurs in the context of China's transtition: firstly, enterprise contractors in the early reform, who were willing to accept a high level of political and financial risk to take over loss-making state-owned enterprises; fecondly, those who transformed state-owned or collective enterprises into private entities; and lastly, the founders of new business ventures (see Chapter 6.2 and 6.3). Despite that I do not want to deny the roles of other social class groups (for example, professional managers, scientists, industrial workers and traders) in the rise of an industrial cluster, I will concentrate on a specially important group of entrepreneurs who play a major role of mobilizing and coordinating a variety of resources to create local wealth.

The following reasons may explain why I focus on the entrepreneurship in studying industrial clusters in China: Firstly, the entry mode and growth rate of SMEs, especially at their early stage, are strongly influenced by the resources and the abilities of their founders. Compared with their western competitors, the pharmaceutical companies in Tonghua, even in China, are very small and young. Thus, it is the professional manager that tends to be in charge of daily operations in Western pharmaceutical companies, while the role of day-to-day management is almost played by the enterprise founders of pharmaceutical companies in Tonghua. This means that an entrepreneur in a Tonghua pharmaceutical company is both capital owner and manager of daily operations and the firm's fate is greatly influenced by its entrepreneur(s). Secondly, through the lens of the enterprise founder we can study the evolution of other factors (e.g, institution and technology). In the case of China's transitional period, entrepreneurs are not passive products of (institutional) structural constraints, but innovative actors who draw on preexisting resources to innovate (for example hybrid firm, firm organization, new products) and to create economic value. The foundation and operation of enterprises undoubtedly require various resources, for example, technological and financial ones. Entrepreneurs have not only various social and political identities, but also relatively stronger social networks, compared with other people. The strong social network gives the entrepreneur an enormous leverage in coordinating different interests and mobilizing resources. Thirdly, Tonghua's pharmaceutical cluster is a small community, in which most of entrepreneurs are previous enterprise cadres and government officials. These local political and economic elites have known each other for a long time and trust each other and thus formed strong social networks. These networks mediate the access to non-economic resources and affect their economic strategies. Thus the founders of new or transformed enterprises in Tonghua play an equally important role as government in coordinating economic activities.

To be honest, my purpose is not to identify the particularities of China's entrepreneurs during the transitional period, even if this issue is equally important and also associated with my study, but I will document the historical footsteps of the present entrepreneurs in the Tonghua pharmaceutical sector. Before going into the details, it is necessary to take a brief look at the enterprise cadre system and make a difference between enterprise cadres and entrepreneurs.

7.1.3 From Cadre to Private Entrepreneurs

Because of the mutation of the political system from Capitalism to Socialism, there has been no existence of a private enterprise or joint venture with foreign capital during the period from the end of the socialist transformation in 1958 to the beginning of the reform and opening-up policy in 1978. Therefore, there was no (private) entrepreneur in China during that period. Those who operated and managed the state-owned or collective plants were not entrepreneurs but enterprise cadres. Enterprise cadres worked in industrial enterprises but shared the social status of the state cadres as government officials. Enterprise cadres are essentially different from private entrepreneurs, as Table 7.1describes.

During the planned economic period enterprise cadres (factory directors) were designated by the government at the corresponding level and had the same social status as party-state cadres (government officials). They operated the enterprises according to the governments' production plan rather than market demand, and they were more concerned about production volume than production cost or the market itself. In the context of the planned economy the enterprise cadres could move from industrial enterprises to government agencies. Namely, if the enterprise was effectively operated and managed, especially in terms of production volume, the enterprise cadres would be promoted to a higher level of position in the party-state system or enterprises. The motive of enterprise cadres was to gain a higher position, in particular in the party-state system (see Figure 7.1).

Table 7.1: Differences between entrepreneur and enterprise cadre

	enterprise cadre	entrepreneur
social status	hired employee	boss or founder of own enterprise
rewards	fixed rewards according to work years and position	uncertain rewards
time	a manager with running the business over a long period of time	an entrepreneur start-up process is involved with the start-up process
risk	no risk	Risk taking
main task	routine day-to-day management of the business, follows rules & procedures, obedient to government	initiators of change founder of new ventures
relation with government	enterprise cadre is assigned by government	entrepreneur can't move into government

Source: own elaboration

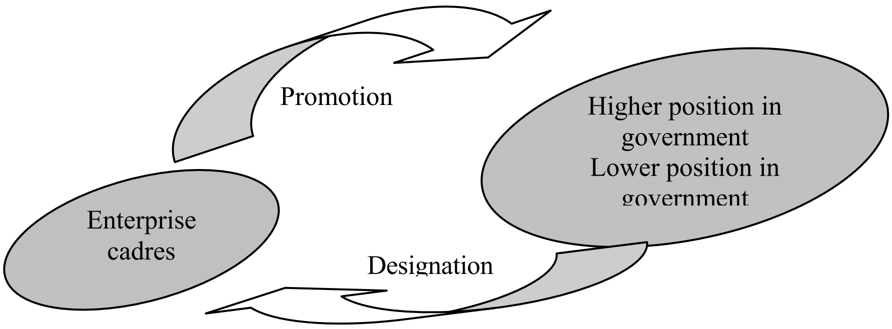

Figure 7.1: Cadre movability between enterprise and party-state system
Source: own elaboration

Under the old system of the "iron rice bowl", the enterprise cadres enjoyed stable and admirable wages and welfare in light of their posts but not the economic performance they achieved. The enterprise cadres had rather limited space to change work units except for government's arrangement. Therefore, we can venture to say that (private) entrepreneurship did not exist during that time. But it is notable that some of the trained enterprise cadres in the planned economy became later entrepreneurs who played a role as the engine of an economy as Schumpeter indicated very early in *the Theory of Economic Development (1934).*

One of the most important outcomes of implementing the reform and opening-up policy was that local Schumpeterian entrepreneurship was ignited. But what should be emphasized here is that the process of formation of China’s entrepreneurship was not finished overnight, but was a gradual process. The formation trajectory of Tonghua’s pharmaceutical entrepreneurs was very strongly path dependent, in the sense that some of today’s entrepreneurs in the Tonghua pharmaceutical cluster were an enterprise cadre in the planned economy, and then a contractor of hybrid firms (red cap enterprises) at the very beginning of economic reform and finally to the founder of today’s private enterprise. In doing so, they accumulated rich pharmaceutical industry-specific business experience and established strong and sound connections with the local state and pharmaceutical researchers. Each step had a strong influence on the next step and each new step was involved with new innovations in organization, technology and institution. Entrepreneurship played an important role in creating new paths of organization, technology and institution and coordinating them. Accordingly, it is safe to say that the formation of pharmaceutical entrepreneurs was a combined result of path dependence and path creation. Hence, an in-depth tracer study on this gradual process from enterprise cadres from the planned economy to private entrepreneurs would be important and meaningful to understand the complex process of the formation of the Tonghua TCM cluster. I have to say that it is so difficult to strictly classify entrepreneurs in my empirical study. The first reason is that information about their career experiences is incomplete; the second one, their experiences are extremely diversified, for example, some of them used to work for the industry as well as for government. Thus we can’t figure out which experience has more influence on their current occupation due to the absence of enough personal interviews to judge.

7.1.4 Heterogeneity of Entrepreneurs in Social Networks and Knowledge

According to my field survey, I found that the founders of private pharmaceutical enterprises mainly come from the following social groups before the privatization of SOEs: former enterprise leaders, technicians, middle-enterprise managers, government officials and entrepreneurs from different regions and industries. As summarized in Table 7.2, as these enerprise founders had different career experience, they were heterogenous in the structure of their social networks and knowledge. Here social network can be classified into three types, according to the functions of a social network: production-related guanxi network (links to suppliers, product users, business partners, universities), environment-related one (links to local political decision-makers); market-related one (general customer relations built through marketing, trademarks, clubs).

Table 7.2: Entrepreneurs' heterogeneity in social networks and knowledge

	Social Network With			Knowledge		
	Local Government	Technical Personnel	Market	Firm Management	Technology	Market
Enterprise Leaders	★★★	★★★	★★	★★★	★	★
Enterprise Contractor	★★★					
Technician	★	★★★	★	★	★★★	★
General Manager	★	★★	★	★★	★	★
Government Official	★★★	★★		★		
Entrepreneurs From Different Areas		★★★	★★★	★★★	★★★	★★★
Local Entrepreneurs From Different Industries	★★					

Source: own elaboration

Note: ★= weakest ties or least knowledge; ★★★= strongest ties or most knowledge

For example, the former government officials have the closest ties with local government agencies, but have no pharmaceutical industry-specific ties and knowledge. However, the top leaders of state-owned enterprises kept a strong relation with the local state since these economic elites were assigned by local government and worked in industrial enterprises as state cadres, and so they held the pharmaceutical industry-specific knowledge and networks (for example with the academic community). As I have argued in Chapter 6.1.3 the changing national and local institutions determined when and how new firms were formed. Here I want to extend this argument and state that the previous experiences of entrepreneurs determine to a large extent their entry mode as well as their enterprises' economic performance. Different from the spin-off scholars (for example Steven Klepper), who focus more on the capabilities and knowledge of entrepreneurs themselves, I place my emphasis on the role of social networks entrepreneurs have, especially with local government. The reason for this is that in a transition economy, characterized by weak markets, poorly specified property rights and institutional uncertainty, the social network became a powerful tool to get access to resources and technology. Here I will link the previous experiences of entrepreneurs to how and when they created new firms, and then compare the economic performance of their enterprises.

7.2 Who Are the Entrepreneurs of Tonghua's Pharmaceutical Industry

Table 7.3 (see p. 185) illuminates different types of entrepreneurs in the Tonghua pharmaceutical industry in the different phases, in which institutions changed. 7.2.1 Contractor Type Entrepreneur

The group of contractor type entrepreneurs could be seen as the first generation of private entrepreneurs because they took political and financial risks to partially or fully contract those state-owned or collective poorly-performing enterprises in the transitional period. This kind of contracted enterprises or workshops was semi-privatized in formation of ownership, which I called “red cap enterprises” (RCEs) earlier. “Red cap enterprise”, a typical form of hybrid firm in China’s transitional period, refers to the reputation a private enterprise enjoys by becoming attached to a government department or a public-owned enterprise and doing business in the name of a state-run or collective run enterprise. RCEs were under collective titles but in reality private. It is an intermediate property form that falls between market and hierarchical forms of organization (Williamson, 1991). Reasonably speaking, the hybrid organizational form was illegal, because RCEs partially operated in the private economy; yet, the private economy was forbidden in China at that time. But the formation of these hybrid firms were tolerated and even encouraged by local and even central governments because the Beijing central government saw them as a promising way to introduce the market mechanism with little cost to the state, and local governments believed that it was a new financial resource to ease its fiscal pressure. That illustrates that during that time the national formal and informal institutions were not friendly to private businesses, for example, in denying private enterprises’ business licenses. Contract entrepreneurs were forced to search an alternative firm organization which retained features of the preexisting governance structure to avoid various political risks in the transition economy (Nee and Cao, 1999). In the case of Tonghua, local governments have actually had an ownership stake in this kind of Tonghua’s pharmaceutical enterprises (see Chapter 6.2.2).

The emergence of the hybrid firms could be an innovative response in the transition to an efficiency-oriented economy. That is, on the one hand they made use of market forces that were incrementally replacing the state planning mechanism to struggle against pressures for efficiency and flexibility in rapidly changing

Table 7.3: Summary of the evolution of the entrepreneurs in Tonghua's pharmaceutical industry

Time	National Institution	Local Institution	Type of Entrepreneurs	No. of cases	Performance
In the mid-1980s	Fiscal decentralization Micro-enterprise reform, The private economy was formally accepted, but not by social members ; Entrepreneurship in South China was gradually formed	Local government as industrial corporates Pharmaceutical industry as the focus of industrial development in 1985; Market-oriented firms emerged	Contractor entrepreneurs	6(16)	★★★★
After 1992	The "socialist market economy" was formally endorsed as China's reform goal for the first time. The private economy became wildly accepted in China	The initiative of pharmcity was launched in 1995 local entrepreneurship began to gestated	Experienced Technicians and Managers	6 (6)	★
After the mid-1990s	Privatization of small and medium-sized state-owned enterprises The GMP policy began to implemented in 1997	Local capital market was developed Encourage cadres to do business (Xiahai) Local infrastructure (for example transportation, communication and information) was greatly improved Local entrepreneurship was formed	Enterprise leaders	11 (26)	★★★★★
			Government official	7 (7)	★★★
Around 2000		Local competition shifted national domestic market	Entrepreneurs from other regions	6 (6)	★★
			Local entrepreneurs from other industries	4 (4)	★

Note: the number in the brackets is the number of corresponding entrepreneurs in the entrepreneur datebase environments (Nee, 1992), on the other hand, these hybrid organizations still wore the "read coat" of state or collective enterprises and then have certain transaction cost advantages over alternative governance structures. More important, the hybrid ownership form created unique opportunity for private enterprises to learn how to adapt new economic performance-oriented environments and circumstances. Hybrid firms were efficient to a great degree during transition, but they would ultimately become costly and disappear.

Actually, once the Beijing central government formally endorsed the legitimacy of this intermediate firm organization, private ownership became widely accepted in China. RCEs took off the "red caps" and became private in the ownership, which enabled them to obtain the legitimate management rights and defined the property rights as well. Thus in the later process of taking off the red caps, there was no private property rights infringement that was commonly seen elsewhere across China. A number of current enterprises in Tonghua's pharmaceutical cluster, including the two largest firms, Daobao Group and Xiuzheng Group, were ever contracted in the transitional period.

The contractor type entrepreneurs not only created a new firm organization (hybrid firm), but also initially found a huge market niche (the ginseng-based tonics) a short time after the reform and opening-up, which opened up a window of opportunity for the subsequential development of TCM industry at the beginnings of the 1990s. More important for the whole cluster, they triggered local entrepreneurship and local competition in the following ways. (1) Their entrepreneurial activities firstly and clearly challenged and eroded the pharmaceutical market monopoly of state-owned enterprises, gradually, over time, rather than in one abrupt shift, which made some space for private economy; (2) their early commercial success during the period of the contract business (1985-1992) attracted a large number of new and established enterprises to the new sectors (initially, the ginseng-based tonics), which also brought competition (firstly in product and market, afterwards in technology) to this cluster. As a consequence this group of contractor type entrepreneurs is very important in nurturing local private entrepreneurship and creating local industrial advantages in the TCM sector.

The story of Li Yikui, who is the founder of today's Dongbao Group, represents the first generation of contract entrepreneurs who took over ill-performing state-owned enterprises in the mid-1980s. After four years' study in biology in the Beijing University (the top university in China), Li Yikui became a technician at Tonghua Baishan General Pharmaceutical Plant and worked there for as long as ten years. Because his working plant was not willing to commercialize his research results of ginseng royal jelly, he left this plant and contracted a small and loss-making plant in 1985. However, this plant was a market-oriented industrial firm, even still in the form of state-owned ownership. As I pointed out in Chapter 6.3.1 the mid-1980s witnessed the first wave of economic growth in China, increased education and health awareness. In addition, the important medicinal value of TCM was acknowledged at that time. These factors led together to a huge market of drugs, especially of TCM. Thanks to being familiar with pharmacy, additionally to the growing market of ginseng-based tonic industry, Li Yikui transformed this plant into the production of ginseng royal jelly (a healthcare product based on ginseng), making use of rich resources of ginseng in Changbai Mountain. But it was increasingly difficult for small enterprises, even state-owned ones, to obtain bank loans, because China's government began to restructure and commercialize state-owned banks into market-orientated, for-profit organizations at that time. So Li Yikui had to search an alternative financial source to start his new project. Surprisingly, he obtained the main funding capital from ginseng trades, at the very beginning RMB one million Yuan. In order to start the ginseng trade business the plant raised RMB 60 thousand Yuan from the entire staff and loaned 20 thousand Yuan from banks. Tonghua Baishan pharmaceutical tonic plant was upgraded in 1985 to Tonghua Baishan No.5 pharmaceutical Factory. Li Yikui, after serving as the director for 8 years, became the chairman of the board, since the reform of ownership took place in 1992. Today, this small business has grown up as a national well-known enterprise in China.

There are two other cases for the first generation of contract entrepreneurs. One is Yang Ziqing, and the other is Zhang Yucai. With a ten years working experience in Tonghua Baishan No. 3 Pharmaceutical Factory, Yang Ziqing, together with two other colleagues, was assigned to build up a pharmaceutical packaging plant affiliated to Baishan No. 3 Pharmaceutical Factory in 1984, which produced pharmaceutical drugs packaging for Baishan No. 3 Pharmaceutical Factory. Because of outstanding performance, Yang Ziqing was promoted to be the director of this plant in 1986. But attracted by the success of Li Yikui, he also contracted a small collectively owned pharmaceutical enterprise (Linhai Pharmaceutical Factory) in 1988. In 1999 Linhai Pharmaceutical Factory became a fully private entity. Yang Ziqing became one of the owners and is still the chairman and general manager of the company until today.

Zhang Yucai, the founder of Yu-Jin Pharmaceutical Co., Ltd., has almost 40 years of experience in the pharmaceutical business, similar to Yang Ziqing. In 1988 he contracted a tablet production workshop of Baishan No.1 pharmaceutical plant in which he had already worked for about 20 years. After being operated successfully for two years, this workshop was separated from the parent enterprise and expanded to form a new independent enterprise, Baixueshan Pharmaceutical Plant, which was subsequently acquired by a listed company headquartered in Changchun city. In 1993 Zhang Yucai founded a private pharmaceutical business, Yu-Jin Pharmaceutical Co., Ltd. It was reported that this company has cooperated with Shanghai Institute of Biological Sciences (SIBS) of the Chinese Academy of Sciences (CAS), which is one of the important public life science research institutions with first class of high-quality biotechnology talents in China (for the cooperative form, see Chapter 8.4.2). The cooperation brought a rich fruit, a new drug (injection recombinant staphylokinase that is used for thrombotic diseases, especially acute myocardial infarction thrombolytic).

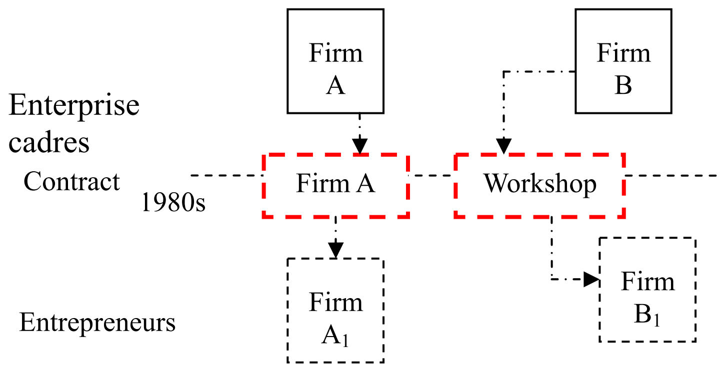

Figure7.2: The model of contractor type entrepreneurs
Note: the dashed-boxes represent that the entity itself does not exist.

The story of Xiu Laigui could be seen as a representative of the second generation of successful contract entrepreneurs, who contracted local government-owned enterprises during the mid-1990s. Unlike the first generation of contract entrepreneurs who have a long-term experience in the pharmaceutical industry, the second-generation of contract entrepreneurs did not have any industrial experience. But the contracting enterprise offered them a chance to enter the pharmaceutical industry at a relatively cheaper price, compared to other forms of creating new start-ups. In addition, their previous management experience, although of foreign sectors, may have contributed to their success.

Xiu Laigui, the founder of Xiuzheng Pharmaceutical Group, contracted a small pharmaceutical factory affiliated to Tonghua City Pharmaceutical Industry Research Institute in 1995, after he had worked in Tonghua City Bureau of Transportation for more than ten years. The plant had a huge debt when it was contracted (RMB 200 thousands). This loss-making factory became a local small giant, whose output value achieved more than 2.1 billion in the same year, equivalent to one third of the entire pharmaceutical industry in Tonghua.

Dong Qiyu, who was the director of a local large chemical fiber plant and had accumulated rich management experience, contracted the Baishan No.4 Pharmaceutical Factory, which was at a difficult stage by the mid-1990s. After the shareholding reform in 2001 Dong Qiyu became a major shareholder and chairman of this company.

After having done business for approximately ten years in southern China, Han Yanhua returned to his hometown, Tonghua, and operated a pharmaceutical business by contracting a state-owned pharmaceutical firm, the Fenglin pharmaceutical Factory, which pertained to Tonghua County Ginseng and Antler Company in 1998. After three-year trial operation, he wholly bought out this entity, and transformed it to a new title, Huachen Pharmaceutical Co., Ltd.

7.2.2 Enterprise Leaders Type

Many of the entrepreneurs in the Tonghua pharmaceutical cluster were former top managers of state-owned or collective enterprises (enterprise leader) in this sector. Here, I use the term of “leader”, not “manager” to underscore their highest position inside enterpises. This group constitutes a major part of entrepreneurs in the Tonghua pharmaceutical industry. There is a big difference between contractor entrepreneurs and enterprise leader entrepreneurs in the sense that the earliest private entrepreneurs (contractor entrepreneurs) who have own entities, although in the hybrid form of ownership, appeared around 1985, while most of all enterprise leaders became private entrepreneurs after 1995. The reason why these excellent enterprise elites became private entrepreneurs after 1995 includes at least the following points. Firstly, because the Beijing central government’s attitude to the private economy became very clear-cut and state-owned and collective enterprises were allowed to be privatized after 1992, so possesing a private entity was no longer politically risky. Secondly, Toghua city government launched a strategic action – “to construct the Pharmcity” – in 1995, and then began to privatize state-owned and collective pharmaceutical enterprises on a large scale. The close relation to the local state enabled local economic elites (together with the political elites, local government offices) to be the main beneficiary during ownership transformation. From a long-term evolution this group plays an important role in developing this industrial cluster. Specifically, in order to ensure local fiscal revenue under the fiscal decentralization, the local government selected capable managers to run enterprises. Once some managers failed, they would probably be replaced by others. The inner selection and competition amongst enterprise cadres before privatization made it possible that these survivors among the top managers or directors were more appropriate and more competitive. In addition, these economic elites' stronger social network with local government, which was formed before privatization, allowed them to more conveniently utilize the local government-sponsored privatization programs to transfer the ownership of state assets to themselves, at least at a cheaper price. This phenomenon can also be seen in other transitional countries with a socialist regime background (Rona-Tas, 1994; Nee, 1989).

According to whether these entrepreneurs were the former managers of state-owned enterprises in the planned economy or not, we can identify two subgroups of "enterprise leader entrepreneurs". As noted above, the first subgroup consists of entrepreneurs who formerly were enterprise directors before privatization, but are now the owners of the same enterprise (whom I would like to call " 'inside'entrepreneurs"). In the model of enterprise leader type entrepreneurs, as Figure 7.3 shows, the entrepreneur of $Firm_A$ belongs to this type. Among the top 10 Tonghua pharmaceutical enterprises in terms of output value in 2004, four enterprises' entrepreneurs can be classified into this subgroup. The second subgroup of the enterprise leaders type entrepreneurs were also enterprise leaders but did take over enterprises in which they never worked before ('oustside' entrepreneurs). The entrepreneurs of $Firm_B$ and $Firm_C$ in Figure 7.3 could be included into this subgroup.

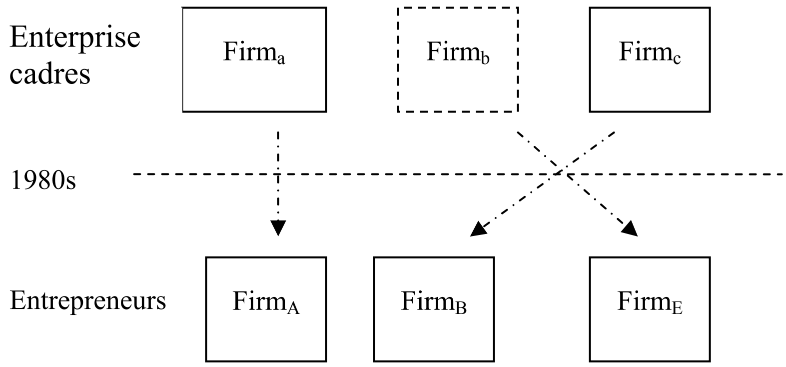

Figure 7.3: The model of enterprise leader type entrepreneurs

Note: the dashed-box represents that the entity itself does not exist. The enterprises with the same letters represents that the enterprise with a capital letter was transformed from the enterprise with the same lowercase letter.

They were Zhang Yisheng of Ji'an Yinsheng Pharmacutical Co, Zhang Hong at Huinan Changlong biochemical Pharmaceutical Co., Ltd. and Liu Peng at Huinan huifa Pharmaceutical Co., Ltd. Because I did not have access to any information about Zhang Hongbiao's work experience, I will take the others as examples to illuminate the characteristics of enterprise leader entrepreneurs.

Zhang Yi-sheng accumulated rich experience in business management since he had held a position of director of a Casting Plant for a long time. In addition, serving for the local state as the vice-director of Ji'an County Employment Bureau (the middle level officals in the local party-state system) helped to strengthen his interpersonal network with local government officals. In 1994 Zhang Yi-sheng was assigned by local government as the director of the Ji'an pharmaceutical factory that was founded in 1970. The plant was changed to a wholly state-owned limited company in June 1997. One year later he bought this company from the local government together with his six colleagues and turned it into a private limited liability company. Today Ji'an Yinsheng Pharmacutical Company has evolved to a star enterprise in Jilin province, ranked the second largest one by profits in 2004 in Tonghua city.

Similarly, Liu Peng was assigned to Huinan County Ginseng & Deer Pharmaceutical Factory after graduating from secondary school. When Huinan County No.2 Pharmaceutical Factory was merged into Huinan County Ginseng & Deer Pharmaceutical Factory, Liu Peng, then vice director of Huinan County Ginseng & Deer Pharmaceutical Factory, was promoted to become director of the newly merged plant. The state-owned enterprise was converted into a private one in 2000. This company was renamed Huinan huifa Pharmaceutical Co., Ltd. later, and was listed as one of the top 10 Pharmaceutical enterprises in Tonghua city in terms of profits in 2004.

Hua Yu-qiang, today's Chairman of the Board of Huaxia Group renamed by Tonghua Baishan Pharmaceutical Factory, had been working in this enterprise for his life. He was the factory director and led the enterprise' reform from the SOEs governance system to the contracting system, and finally to the governance structure of private-owned enterprises. In 1997, Tonghua Baishan Pharmaceutical Factory was transformed to joint-stock enterprise, in which state-hold shares were still kept at that time. Three years later the company was fully privatized and renamed to Huaxia Group. This transformed enterprise has now become a large pharmaceutical company consisting of six subsidiaries in the subfields of the pharmaceutical sector, such as production, sale and cultivation of Chinese Herbal Medicine.

There are some other entrepreneurs in the Tonghua pharmaceutical cluster who used to hold a top position (as factory directors) before the ownership reform. They are Wei Xiaoming at Changcheng Pharmaceutical Co., Ltd., Zhang Yong at Shenlong Pharmaceutical Co., Ltd., Liu Yuming at Yongkuang Pharmaceutical Co., Ltd. and Yan Zhonghui at Liuhe Tianli Pharmaceutical Co., Ltd..

So far I gave some examples of the first subgroup of enterprise leader type entrepreneurs, here I will turn to the second subgroup. Although somewhat different from the first subgroup, the entrepreneurs in the second subgroup used to be factory directors as well, but took over or reorganized other factories in which they had never worked before. This kind of entrepreneurs tended to take over pharmaceutical factories on the verge of bankruptcy. According to my survey in Tonghua, the number of the second subgroup of enterprise leader type entrepreneurs is very low (only three). Liu Yan is a good example for this subgroup. He was very familiar with new drug development since he studied in Beijing Medical College and then worked in the pharmaceutical industry. He was the vice factory director of Liuhe County Chinese Medicine Factory and was in charge of production and development. After leaving this factory he raised funds from friends and colleagues to buy a loss-making state-owned pharmaceutical enterprise, the Longgangshan Pharmaceutical Factory, and renamed it to Zhongchen Pharmaceutical Pharmaceutical Co., Ltd. in 2000.

In this group of enterprise leader type entrepreneurs, the number of "'inside' entrepreneurs" who took over their previous working enterprise is larger than that of "'outside' entrepreneurs" who never worked in the enterprises they took over before.

Some reasons may explain these striking phenomena: Firstly, only those pharmaceutical enterprises with serious financial problems could be taken over by outsiders, and it was almost impossible for the outsiders to take over well-performing pharmaceutical enterprises, because their owner (local government) was not willing to take the risk of losing taxes. Secondly, the sound economic performance consolidated the relation between the existing enterprise cadres and the local government, which undoubtedly increased the difficulty of outsiders' contracting this business.

7.2.3 Experienced Entrepreneurs of New Ventures

Different from the two types of entrepreneurs discussed above who did not really create new entities and transformed the established SOEs or collective enterprises to private ones, the experienced entrepreneurs of new start-ups started their private business not by transforming publicly owned enterprises, but by establishing new companies from scratch. According to their prior employment position and know-how, these entrepreneurs can be divided into two types: technicians, and high-level managers.

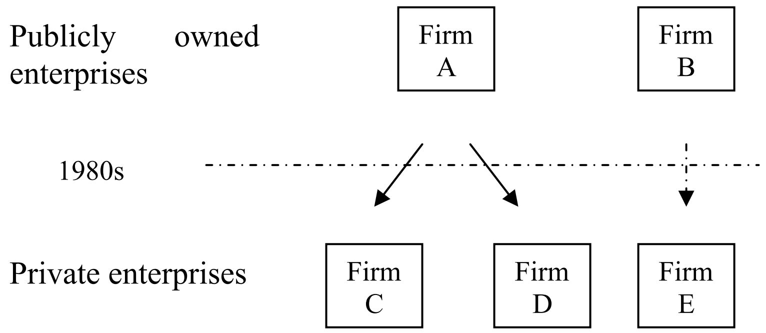

Figure7.4: The model of experienced entrepreneurs of new ventures
Note: The dashed arrow denotes that the entrepreneurs of new ventures work as managers in the previous pharmaceutical enterprises. The solid arrows mean entrepreneurs of new ventures were technicians previously.

The high-level manager type of entrepreneur here refers to those employees who worked as general manager and were responsible for the operation of the whole pharmaceutical venture, while the technician type of entrepreneur had a long-term experience in producing or developing drugs, and thus has had long-term interactions with scientific community in the pharmaceutical sector before creating his/her own pharmaceutical business. Almost all entrepreneurs of this group emerged after 1995. In addition, the number of this kind of entrepreneur is relatively lower. This seems to illuminate some characteristics of the Tonghua pharmaceutical cluster, which are different from the Western pharmaceutical clusters.

Firstly, the Tonghua pharmaceutical cluster actually is a concentration of pharmaceutical manufacturers in which the access to productive resources was more important, at least before 2000, while advanced pharmaceutical clusters in the Western nations depend more on R&D-based knowledge, where the access to technological resource concerning new drug development and promotion is the most important. Secondly, the Tonghua pharmaceutical cluster emerged in a weak institutional environment, for example, the absence of venture capital, thus entrepreneurs in Tonghua had have to turn to personnal connections to acquire such economic resources or reduce political risk. This leads to the third difference, the social network (especially with the local government during the transitional period, now with the academic community) matters much more than the capabilities of firms themself. If we take a look at the fact that because experts in technology did not have stronger relational network compared to top-level enterprise cardres, the economic performance of their pharmaceutical firms was relatively lower, we can better understand how much important social network in firm growth China's transition was.

Technician Type Entrepreneurs

Zhenguo Wang's entity seems to be an exception in the whole group of new pharmaceutical firms established by experienced entrepreneurs, and it ranked amongst top 20 pharmaceutical companies by 2004 sales. His success is perhaps due to his multiple social identities before he established this new venture. Zhenguo Wang has a rich experience in the pharmaceutical sector, since he learned how to treat diseases when he was an armyman (from 1973 to 1977) and later the deputy director of Tonghua Baishan Pharmaceutical Plant (from 1977 to 1983). He was promoted to a higher position of the local government (Secretary of Tonghua Municipal Party Committee Office) in 1984 and then he developed a strong relational network with local government. Thus in some sense he is not a pure technician-type entrepreneur. He made a surprising decision of giving up his admirable and stable government job and set up a medicine institute in 1986, Tonghua Changbai Mountain Drug Institute. His action of resigning the job in government was very early and he is the first generation of industrial businessmen in Tonghua. During the middle of the 1980s the TCM industry was faced with a huge demand, the social network that benefits from his mixed social identities helped him to overcome the entry barriers (for example, the access to business license). The first mover advantage, together with the advantages owing to his diverse career backgrounds (for example, strong social network with local government and being familiar with pharmacy) was helpful for his early commercial success. In addition, he built up anti-cancer hospitals, and all products were sold only through these hospitals. This unique business mode enabled him to gain monopoly profits and effectively avoid the competition of latecomers from which other Tonghua pharmaceutical firms suffered. Today his small institute developed into an industrial group with 12 branches and offices in more than 300 cities at home and abroad and ranks among the top 500 private enterprises in China.

There are other two pharmaceutical enterprises established by local pharmaceutical experts. One is Tonghua Chanyuan Institute of Burn Scar that was founded by Xu Baohua in 1996, a doctor from a local military hospital, No. 206 Hospital. This institute was renamed to Tonghua Chanyuan Medicine Technologies Ltd., but its financial situation is relatively weak today. The other one is Fengyang Pharmacutical Co., Ltd., founded around 2000 by Du Jinxin, a pharmacist with approximately 20 years working experience in Tonghua City Center Hospital. This small plant went into bankruptcy shortly after its establishment. The poor economic performance of these two pharmaceutical enterprises established by local medical experts seems to illustrate that those entrepreneurs who merely had much knowledge of the new drug development did not have more advantages any longer in the context of China’s transition. Firstly, their very weak relational network with local government and financial institutions made it basically impossible for them to take over the SOEs or collective enterprises during privatization because governement and enterprise cadres had stronger relational ties with local state; secondly, the lack of experience in marketing and business management makes it increasingly difficult to survive in a competitive drug market.

Manager Type of Entrepreneurs

Different from enterprise leader entrepreneurs—the special group of entrepreneurs in post-communist countries who transformed their own social identity from the top magagers of state-owned enterprises (as government representatives) into private entrepreneurs, manager type of entrepreneurs worked as middle or low-level managers in the Tonghua pharmaceutical sector, and left their previous employer and build up their pharmaceutical enterprises. The number of firms established by this kind of entrepreneurs is relatively lower and their performance as a whole is not good. The reason might be that this kind of pharmaceutical enterprises occurred after the mid-1990s. These lower-level managers have had less advantages in taking over state-owned or collective because the social network of lower-level managers with local government was very weak, almost all of the established pulic enterprises were taken over by local government officials and enterprise leaders during privatization. Thus lower-level managers who wanted to posses their own private bussiness had to establish a new enterprise, which was (and still is) costly. The implementation of GMP policy since 1997 worsened the financial difficulties of small and middle pharmaceutical enterprises. Furthermore, lower-level managers merely had internal enterprise management knowledge, and the lack of economic access to other economic resources, for example, loans and marketing channels, made them to become less successful in the increasingly competitive TCM market. As a result, the new pharmaceutical entities inevitably went into bankruptcy, as the following cases will show.

There are only three cases of this kind of manager type entrepreneurs. After Tonghua Qianjin Pharmaceutical Plant went into bankruptcy, its production site and manufacturing equipments were taken over by Dongbao Group in 1996. Zhang Shouyi, the former director of this plant co-founded Xinghua Pharmaceutical Co., Ltd. together with his colleagues in 1997. Yang Tianyu has a similar experience as Zhang Shouyi. When Tonghua City No.2 Pharmaceutical Plant was purchased by Wantong Group in 1996, Yang Tianyu, the director of this closed factory created his own private business, Guruite Pharmaceutical Co. Ltd. which is currently a subsidiary company of Wantong Group. Wei Zhenlin, who worked as an advanced manager in Golden Horse Pharmaceutical Company for some years, founded Zhenglin Pharmaceutical Company in 2000.

7.2.4 Entrepreneurs from Different Industries

There is another group of local entrepreneurs, inexperienced entrepreneurs who had no industry experiences in the pharmaceutical sector, neither in technology nor in firm management. According to their career backgrounds, I will divide this group into two subgroups, government official entrepreneurs and entrepreneurs who came from different industries, technologically unrelated to the pharmaceutical sector.

Government Official Entrepreneurs

The government official entrepreneurs in the pharmaceutical cluster are those who previously had higher-level positions in the local party-state system and now run their own private enterprise. Compared with other kinds of entrepreneurs, this subgroup has three remarkable features. The first point is that they entered the private pharmaceutical sector relatively late, after 1995; the second is the number of government official entrepreneurs is relatively large, compared to the expert entrepreneurs of new ventures (see Chapter 7.3.3), but not higher than that of the contractor entrepreneurs and enterprise cadres entrepreneurs; the third is that the economic performance of their pharmaceutical enterprises in whole is not so good.

There are at least some reasons why so many local political elites in Tonghua became private entrepreneurs by taking over SOEs. Firstly, the rule of how to privatize SOEs was not standardized and unified by the Beijing government, so local states were largely responsible for industrial reorganization and privatization. This made it possible for local political elites to make use of their strong social network to preferentially privatized SOEs. Secondly, government bureaucrats and party officials had worked for a long time in the local government bureaucracy, and they formed strong social networks with other members of local community of political elites who are still in local government. This allowed former government officials to maintain an overwhelming advantage in taking over state-owned SOEs. However, as time went by, the fundamental market economy-oriented institutions began to emerge and flexible market-based pricing mechanisms replaced the rigid traditional planned allocation mechanism and became the dominant mechanisms for economic allocation, local political elites inevitably became less favored in getting access to marketing channels and the research community because they had not developed the strong social networks with the communities concerned before. This is why firms of local political elites did not outperform the enterprises transformed by top-level economic elites. Local economic elites not only had as strong social networks with local government as political elites had, but also developed social networks with industrial communities of TCM.

Now I am going to give some examples on this type of entrepreneur and I will return to the social factors behind the success of Tonghua's pharmaceutical industry in Chapter 7.4. Two of the most impressive government official entrepreneurs are undoubtedly Dong Guozhi and Du Weijing, who used to serve for the government as vice-mayors (the highest-ranking officer in the local bureaucracy) and started their own businesses later. After resigning in 1995 Dong Guozhi established his own enterprise in Zhuhai, a southern city which offered a better entrepreneurial environment because the economic reform and opening up was earlier. Du Weijing worked as vice-General Manager in a local big pharmaceutical company, Tonghua Dongbai Group, and then founded Tianma Group in Tonghua in 1997. Now Tianma Group has grown into a local star enterprise with five subsidiaries.

Liu Licheng had helped Jinma Pharmaceutical Group Co., Ltd. to become a listed company in 1997 when was the director of the Tonghua City Planning Commission. After that, he joined into Jinma Pharmaceutical Group as vice president in 2000. Later he obtained a controlling stake in Jinma Pharmaceutical Group by buying a great deal of state-owned shares.

Wang Ping, the former director of the Property Administrative Office at CPC Tonghua Municipal Party Committee, together with a retired deputy secretary of the municipal party committee, co-founded Weide Pharmaceutical Co. Ltd., which was acquired by Beijing Jinkaiwei Group.

Baixing Pharmaceutical Factory, a small and collective-owned enterprise and the predecessor of Baixing Pharmaceutical Ltd., was affiliated with the Tonghua City Bureau of Foreign Trade, and reached the edge of bankruptcy by the late 1990s. The leader of this Bureau then raised about RMB 4 million Yuan from families and friends and bought out this plant in 1998.

Ju Hongfu, the former leader of the Township Enterprises Bureau, has a similar story. He purchased Fadang Pharmaceutical Factory which was directed under the control of his bureau at the end of 1990s.

It seemed easy for the powerful people in local banking and other financial sectors to enter the Tonghua pharmaceutical sector in the late 1990s in which almost all state-owned or private MSEs had more or less difficulties in financing. Wang Xuefeng was the governor of a national bank in Tonghua for a long time and thus he was familiar with commercial loan procedures. Meanwhile, he had accumulated a strong personal network with local government agencies, which allowed him easier access to the business license of a pharmaceutical company. Wang Xuefeng obtained bank loans to establish a new pharmaceutical company, Dongsheng Pharmaceutical Ltd. A similar story happened to Li Huaijin, who had also been the governor of Huinan County Construction Bank before he collected funds from this bank in 2002 to privatize Jilingyaozhuan Huinan Pharmaceutical Factory, which was established in 1988.

Zhang Hong seems to be a particular case. On the one hand he had worked in government agencies for many years as well, though not at the top level in the local bureaucracy. On the other hand, since he studied pharmaceutics in a university and used to serve in the Tonghua City Health Bureau, he was familiar with pharmacy. These factors together contributed to his commercial success in the pharmaceutical sector. He bought a small enterprise on the verge of bankruptcy in 1999. This loss-making factory has now grown up into one of the small giants in the pharmaceutical sector.

Entrepreneurs from Technologically Unrelated Industries

As the TCM sector in Tonghua grew, it attracted some local investment from from other industries and the new startups were set up by these businessmen who had worked in other industries technologically unrelated to the pharmaceutical sector before they entered the TCM industry. The number of this kind of entrepreneurs I can find is only six, almost all of which appeared around 2000 and their economic size in total is relatively small. This seems to show that industry-specific knowledge and social relations (with the pharmaceutical research community) have become increasingly important after 2000 and were not easy to be replicated by the external entrants. Thus the acquisition of the established enterprises became the main entry model by external entrants to overcome these barriers (see Chapter 6.3.4). The stories of the six entrepreneurs, who come from technologically unrelated industries, are as follows:

There are three real estate developers who entered the pharmaceutical factory. These are Yu Longyao, Zhou Xujie, and Wang Xingtong. In 2000 Yu Longyao wholly purchased a township enterprise, Hengsheng Biochemical Pharmaceutical. This new enterprise disappeared from the sector, however. Zhou Xujie bought the business license of a bankrupt pharmaceutical plant and founded Tengda Pharmaceutical Company around 2002, but it was already declared bankrupt in the same year. Wang Xingtong also purchased the licenses of Jiuming Pharmaceutical Factory and established Jiuming pharmaceutical company in 2003.

There are some businessmen from other technologically unrelated industries. For example, Li ping, born in Tonghua, did business in the electronics industry in South China. He returned to his hometown in 1999 and then acquired a loss-making collective-owned plant (Liming Pharmaceutical Factory). Long Deming, a former transport businessman, acquired Jinhui Pharmaceutical Company (the offspring of Baishan No.3 Pharmaceutical Factor) around 2002. After making much money from the paper-making industry, Guan Baoshu acquired Baishan No.8 Pharmaceutical Factor (which was established in 1987) and renamed it into Mingtai Pharmaceutical Company in 2003.

7.2.5 Entrepreneurs from outside Tonghua City

This group of entrepreneurs to be discussed in this section is different from the above-discussed groups of local entrepreneurs in this sense that they came from regions outside of Tonghua city (but still from China). Therefore I would like to call them "non-local entrepreneurs". The number of the enterprises established by non-local entrepreneurs is very limited, only five. This group has the following characters: firstly, the entrepreneurs in this group are not local people; secondly, all of them have rich experiences in the pharmaceutical or technologically related sectors; finally, they entered the Tonghua pharmaceutical cluster through acquiring loss-making enterprises (for the entry mode choice, see Chapter 6.2.4 and Chapter 6.3.4).

Boshi Le-Pharmaceutical Company and Sanzhu Zhongyao Company among them are branches of non-local companies. Today's Boshi Le-Pharmaceutical Company was acquired in 1997 by Jizhu Group, a pharmaceutical and health food company. Likewise, around the year 2000 Sanzhu Zhongyao Company was transformed from a TCM plant by a medicinal group that came from outside.

Chunsheng Guo, an entrepreneur from another pharmaceutical region in Jilin province (Dunhua city), owned a health food company before he acquired Luotongshan Pharmaceutical Plant in 1998. The acquired company was established in 1992 and was in a very bad financial situation before.

Weida Huang, a professor in Fudan University, had already set up Shanghai Yi-sheng Biotechnology Company before he acquired a loss-making company in 2003 (Tonghua Yisheng company that was established in 1998). Similarly, Wanming Zhang is also an expert in the field of TCM from Shanghai, and acquired a small pharmaceutical factory in Tonghua (Yongyuan Pharmaceutical Company) around 2000.

7.3 Government Official Entrepreneurs in the Tonghua Pharmaceutical Industry

As I have argued in Chapter 6.2.1 and Chapter 7.1.1, the entrepreneurial behavior of new firm creation is, to a large extent, an embedded phenomenon, strongly dependent on a country's contextual conditions. In transition countries the most important factor influencing when and in what ways the new private enterprises are created is the changing national (formal and informal) institutional environment, concerning the ownership reform, regulation of labor markets and financing. But we can find that the time and entry mode choice of the creation of new firms varies a lot throughout the same country. This means that the local context has a very important influence on the features of the entrepreneurial behavior in new firm creation. In the case of the Tonghua pharmaceutical industry, the formation of local entrepreneurship-friendly institutions could be in part ascribed to one special group of entrepreneurs, the former government officials. Although the economic performance of their private pharmaceutical enterprises as a whole is not so good (see Chapter 7.3.4), the entrepreneurial behavior has been of great significance to the emergence and development of the Tonghua pharmaceutical industry.

Although I have already discussed the special group of government official entrepreneurs in Chapter 7.2.4, it is very necessary to make a detailed description of the formation of this special group of entrepreneurs, by which we can better understand the social factors behind the success of Tonghua's pharmaceutical industry and the role of the special group of government official entrepreneurs.

Historically, there are three waves of local political elites moving from top or middle leadership positions in various government agencies to local private firms. The first wave took place around the mid-1980s. Some state officials entered into the business in the pharmaceutical industry, a sector with tremendous profit potential at that time. Wang Zhaoguo's entrepreneurial experience, discussed above, is very representative. The second wave emerged after the Southern Cruise of Deng Xiaoping in 1992, which unleashed an unprecedented wave of economic growth and political relaxation in the course of Chinese economic reform. It was the ideological breakthrough that inspired some elites who had gained a quite high position in local governments to start private business.

It was reported in one local newspaper (Meihekou Daily, Sep.2, 1992) that Gong Chuanren resigned from the post of County Magistrate (the top-ranking official at the county-level bureaucracy) and then owned and operated three private enterprises in the territorial range of his previous authority. When talking about this adventurous choice, this ex-governor said without hesitation that his decision was encouraged by Deng Xiaoping's speech during his inspection tour. In the same year, Sun Huanzhong, the head of the neighboring county (Huinan county), gave up the government job and then establish new firms in Zhuhai and Dalian. Now he is Deputy General Manager of Tianma Pharmaceutical Company created by a former Vice Mayor. Although some of their new startups were neither related to the pharmaceutical sector nor based in Tonghua, they ignited local passion to create an own business.

During that period some ex-government officials went into business successively. Different from the late government official entrepreneurs who have their private pharmaceutical business, the first generation of official entrepreneurs did not enter the Tonghua pharmaceutical industry, perhaps because this sector was not as strong in the early 1990s as afterwards. From a long term viewpoint, "going to the sea and doing business" of local party-state cadres was helpful to nurture the entrepreneurship-friendly social atmosphere in Tonghua.

The local government's positive attitude to the brain drain from the local party-state system and further to the private economy aggressively encouraged more government officials to create or join the private pharmaceutical enterprises. Initiated in 1995, the revolutionary strategy "to build up the Pharmcity" dramatically promoted the development of Tonghua's pharmaceutical industry. At the same time, Tonghua city government encouraged government officials to go into business, which accelerated the breakup of the traditional ideology of viewing work in government as the first choice. In 1996 the "Regulation on Encouraging the Municipality Staff to Lead Loss-making Enterprises" explicitly offered some preferential policies to those government officials who were willing to do business, including remaining in position and (still) receiving their wage from local state in three years. The formal policy stimulation aroused the wave of government officials to go into business.

The third wave occurred after 2001. According to incomplete statistics, a total of 141 officials went into business, either in private or state-owned enterprises, as advanced managers or as new entities' founders. The statistics also show that eighty percent of the former government officials joined local private pharmaceutical firms. The reason why this sector became the first choice of local political elite to go into business could be that this sector was the largest private economy in Tonghua, with expected high profits. The pharmaceutical enterprises established by former government officials are rather few in number during that time. This reflects that market competition became increasingly fierce and the barrier to the pharmaceutical sector in China rose since intellectual property rights began to be strict and became well protected, and Good Manufacturing Practices Standards were issued and implemented.

Regarding the role of the local political elite in this sector, we can at least find two important aspects. Firstly, their entrepreneurial behavior contributed to the formation of a local entrepreneurship's friendly culture. In the traditional Chinese Confucian culture the government officials belong to the highest social classes and are regarded as the outstanding social elite who have a great influence on China's life. In the case of

Tonghua, the other social classes were well aware that the national institutions became friendlier to the private economy mainly through local high-ranking government officials landing jobs in the private sector. This means that the entrepreneurial behavior of the local political elites was helpful to kindle considerable enthusiasm of local people for private entrepreneurship.

Secondly, not only do they contribute to nurture local social norms friendly to the private economy, but they also play an important role in forming local industrial policies which are particularly favorable to the pharmaceutical industry, since government official entrepreneurs have strong ties with their previous colleagues and can lobby the local government. In fact, the formation and the successful implementation of the two strategic policies in the history of Tonghua's pharmaceutical industry, pharmaceutical industry as the focus of industrial development in 1985 and the Pharmcity in 1995 (which I will explain in Chapter 10.2), partially benefited from the closer dialogue of local government and government official entrepreneurs.

7.4 Conclusion

I agree with Nee that the "*analysis of China's transition to a mixed economy must also view the state as a primary actor in establishing the institutional arrangements required for the growth of markets and the rise of entrepreneurship*" (Nee, 1989, p: 171). The genesis of Tonghua's pharmaceutical entrepreneurs reflects well the influences of the temporal sequencing of national institutions, related to restructuring or privatizing publicly owned enterprises and encouraging the development of the private economy. It is true that China's national institutions have facilitated resurgence of private entrepreneurship. But what I am arguing with particular emphasis is that although the state (actually, the central government) can change formal institutions such as rules and laws rapidly, it seems to be difficult to change the mindset of some institutional actors such as decision makers in state-owned banks and other agencies, local cadres, tax officers and government officials (Yang, 2002) to a private economy-friendly mental attitude, at least in the short run. This means that the renewal of private entrepreneurship in China can be ascribed to the effects of the national institutional changes, on the one hand, and can be seen as the result of the social process of locally accepting private entrepreneurship, on the other hand. The local social environment largely determines when and in what way private entrepreneurship was formed. Thus, here I want to link the temporal sequence of the different types of private entrepreneurs in Tonghua with the institutional changes affecting entrepreneurship, both informal and formal, to testify that not only formal institutions (namely, the central government as its representative), but also informal institutions (for example, social capital, guanxi) have great influence on the formation of entrepreneurship in China. At the same time I will take the geographical dimensions of institutions into account, both national and local.

In the traditional Chinese culture of Confucian doctrine, the merchants have always been ranked at the bottom of the hierarchy of social classes (with the exception of China's coastal regions, for this point, see Wei et al., 2007), and the lowest position of the merchants in the official Chinese social hierarchy was further cemented in the Maoist period. Creating one's own business still carried negative social connotations (Lao and Sohmen, 2001), even entering the 1980s.

It is Deng Xiaoping's consolidation of power in 1978 that paved the way for the resurgence of the private economy and has introduced serial regulations which allow various non-state entities to come into being, including the urban nonagricultural individual economy in 1981, rural individual businesses in 1984 and private enterprises with more than eight employees in 1988 (Young, 1995). But the private economy should not be encouraged. Across the whole country the private economy only took off in the coastal regions (particularly in southern Guangdong province and southern Zhejiang province) in the early 1980s (Hubbard, 1995), while the private economy in Northeast China (one of China's old industrial regions where the state-owned economy is still holding an overly high proportion in the regional economy) did not occur on a large scale until 1992.

In the case of Tonghua city, because of the pressure of the fiscal decentralization, some local government agencies have invested as local industrial companies in the TCM industry to make up for the inadequacy of public finance. In the intensified competition caused by the increase of new entrants into this sector, some of the small state-owned, especially newly established collective enterprises teetered on the brink of bankruptcy in the 1980s. The introduction of a fully-fledged "contract responsibility system" to the Tonghua pharmaceutical sector in the middle of the 1980s greatly increased the profits of state enterprises by transforming them into self-supporting economic cells in a short time. At the same time some enterprise directors contracted ill-performing state-owned or newly established collective enterprises and became the first generation of private entrepreneurs in Tonghua (contractor entrepreneurs). Although these contracted companies were registered as a collective enterprise or legally affiliated to the state-owned enterprises and appeared in the ownership form of publicly owned enterprises, they were essentially private (see Chapter 6.2.2). After the middle of the 1990s, when the private economy was widely accepted in Tonghua, the hybrid firms were transformed and legally recognized as private entities.

Two events, taking place in the year of 1992, were very meaningful to China's economic reform and the formation of a conducive atmosphere for private entrepreneurs. One was Deng Xiaoping's southern tour speech of "both plans and markets are economic means"; the other is the Fourteenth Party Congress. In the party congress the "socialist market economy" was formally endorsed for the first time as China's reform goal, which tends to be viewed as the second emancipation of the mind campaign (the first wave is in 1978). In the mid-1990s, impelled by phenomenal coastal economic development based mainly on overseas private capital and local entrepreneurship, people across China had developed a considerable passion to create their own enterprises. In brief, the private economy became widely accepted in whole China after 1992.

In Tonghua the move of local bureaucratic-political elites to the private economy during the mid-1980s, together with other local factors (for example, the strategic objective of the Pharmcity that was put forward), contributed to the formation of a conducive social culture for private entrepreneurs. Thus creating one's own private enterprise started to be accepted by the local government and social members in the early 1990s, which resulted in a hot wave of creating private pharmaceutical enterprises in Tonghua. Some experienced technicians and managers began to leave the state-owned enterprises to create their own enterprises. The increasing number of new pharmaceutical enterprises in Tonghua shows that the period was a golden time for creating private entrepreneurs.

China carried out the "grasping the large and letting go the small" policy around 1995. The large-scale privatization of small and medium-sized SOEs began to be carried out around 1997 in Tonghua. During the small SOEs privatization period local enterprise cadres and government officials had considerable power and privileges in transforming public enterprises to private assets and their social identity changed from state cadres to private entrepreneurs, since both the economic and political elites had their advantage from social networks with the local government. When market mechanisms replaced the government's forces in the allocation of resources, bureaucratic-political elites lacked social links with industry-specific communities, in particular with pharmaceutical researchers, and the enterprises of the former government officials began to show a decline in economic performance in the increasingly competitive environment. Only enterprise cadres were able to establish strong social network with local government and with the TCM industry-specific communities at the same time (for example, pharmaceutical research, and salesmen), so their enterprises are the most competitive today.

Around 2000, Tonghua started to attract investments from other regions and different industries, which means that the agglomeration economy started to drive the growth of this pharmaceutical cluster. The economic performance of the investment from technologically unrelated industries as a whole is the worst in the Tonghua pharmaceutical sectors. The reason for this could be that these entrepreneurs did not build-up the pharmaceutical industry-specific networks and knowledge before they entered this sector. For the investment in this sector from other industries, its economic performance is determined to a great degree by acquisition of companies. If the acquiring company has a strong market competition competence, the acquired entity operates well; otherwise, it could be on the verge of bankruptcy.

Chapter 8 The Evolution of Technology in Tonghua's Pharmaceutical Enterprises

This chapter aims to provide empirically observed evidences of the evolution of technology in Tonghua's pharmaceutical enterprises, and proceeds as follows. In Chapter 8.1, I will give the working definition of technology and classify it into three categories, new product development technology, production/process technology, and management technology. The next four sections show the descriptive evidences of the evolution of technology in Tonghua's pharmaceutical enterprises. In Chapter 8.6 I will develop a causal explanation of technological change in Tonghua's pharmaceutical enterprises from a coevolutionary perspective.

8.1 Defining Technology at the Micro-Level of Enterprises

Togday, nobody can deny the importance of technology in economic and social development, and the production and diffusion of new technology is a hot topic in the literature on industrial clusters. Industrial clusters are conceived mainly as a viable way to foster innovative performance, the theory of industrial cluster emphasizes the importance of non-trade linkages and collaborative relationships among clustered firms which are potentially useful for the creation and diffusion of new technology. But I will go to the micro-level dimension of technological change – individual firms, on which I will explore the dynamics of technology in the Tonghua pharmaceutical industry. Before starting the empirical study, it is necessary to define what kinds of technologies are to be discussed in this dissertation.

Technology is a much more complex bundle of knowledge, which can be embodied in an extremely varied range of artifacts, people, procedures and organizational arrangements. An easy way to classify technologies is to associate "technology" with different production activities, for example product design, manufacturing processes and organizations. Accordingly, there are at least three categories of technology at the micro-level of individual firms. One involves some form of new-to-market innovation (e.g. in-house R&D and patenting), which can be called "new product technology"; the second includes the use of embedded technologies, for example, acquisitions of machinery, equipment and software, which may be termed "production technoloy"; the third contains organizational and marketing-related strategies such as staff training, which could be named "enterprise management technology” (OECD, 2008).

New product technology encompasses the skills, knowledge and routines involved in generating new products. In the case of the pharmaceutical industry, technology is often based on the stages of discovery/basic research and clinical trials. Nowadays, in order to ensure the efficacy and safety of new drugs, a great deal of approaches and technologies are required, respectively, for investigating complex biological systems, measuring drug effects and predicting outcomes, and so on. Although the new drug development technology can be represented by physical media, such as documents or videos, it is characterized as “tacit knowledge”, highly personal and hard to be formalized.

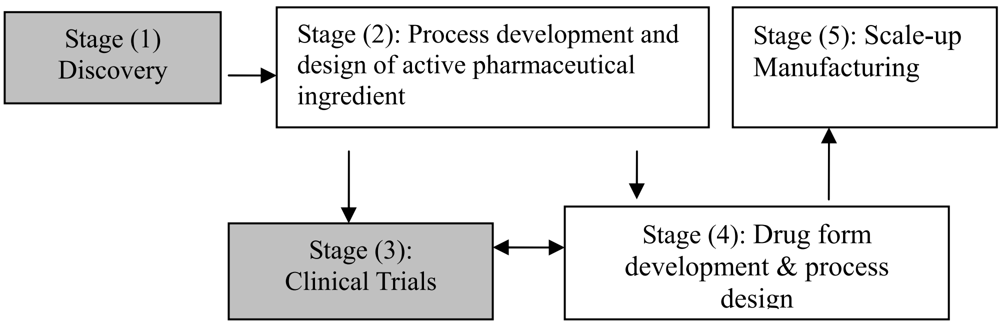

Figure 8.1: Technologies in the pharmaceutical development and production

Note: Stage (1) and Stage (3) are involved in new product technologies; Stage (2), Stage (4) and Stage (5) are involved in production technologies, but all are involved in management technologies.

Production technology involves those product-related skills and knowledge needed to make established products efficient with existing plant and processes. This kind of technology can be identified with machinery. Hence, the development of new acquisition and the installation of new machinery can be included in the innovation of production technology. For the pharmaceutical industry, the objective of production technologies is to transform laboratory-scale production to full-scale factory production and to solve challenging formulation and processing problems for drugs. In practice, they are involved in the conception, design, construction, and operation of manufacturing plants, also in the conception, design, scale-up, manufacturing, and labeling and packaging processes in the conversion of chemical and biological raw materials into pharmaceuticals**.** These technologies are mainly involved with pharmaceutical engineering and enable firms to monitor raw materials inputs, schedule production, control output quality, maintain and replace machinery. This kind of technology is relatively easy to be standardized and coded, for example, Good

Manufacturing Practice (GMP), a worldwide recognized standardized guideline for the control and management of manufacturing and quality control of pharmaceutical products that must be observed during manufacturing in China.

Management technology is to organize an enormously variable range of elements in production systems, and involves those skills and knowledge needed in the aspects of the procedures and organizational arrangements inside enterprises. For a pharmaceutical enterprise, management technologies are involved in each aspect of operational procedures, for example, financing, investment, marketing, technology management, personnel, managing materials, and quality control.

It is noteworthy that in the case of the TCM industry, the development of TCM drugs involves the redevelopment of "old" TCM prescriptions, which requires not only production technologies for the conversion of the dosage form, but also some technologies for measuring the efficacy and safety of new drugs. This means that new TCM drug development draws largely from existing stocks of the TCM knowledge embodied in existed TCM drugs or prescriptions.

As Bell and Albu (1999, p: 1717) pointed out, very few components of technologies are "ready-made" and the introduction of some elements of technology requires the interactions with other elements of technology. Namely, the use of technology is the process of creative problem-solving and innovative re-configuration of knowledge. Furthermore, technologies are rooted in a specific set of change-generating resources or capabilities which are located within the structure of technology-using firms, and the sources of technology are not limited to technology-using firms. Customers and competitors, for instance, may be much more important sources of technology. Consequently, the learning process plays an important role in building and strengthening firm capability.

8.2 The First Generation of Enterprises

As documented above (in Chapter 3.1), before the second half of the 19th century in China, Traditional Chinese Medicine (TCM) was the only way to preserve and protect people's heath and prevent diseases. The TCM stores as the business organizations performed an important function of pharmaceutical production and sale, and were usually owned and operated by families. Although there was no legal intellectual property protection at that time, the key recipes for drugs and key production technique were strictly controlled by the core family, and were very difficult to reveal. In other words, in family-owed TCM stores, for example, the three large TCM stores (Yongchengqing, Jishenghe and Faxin) mentioned earlier, the core of the pharmaceutical technology (recipes of drugs) as key technological secrets was governed only by the core family (commonly, the head of the family and the eldest son), and these valuable recipes were passed down through generations, while the ordinary knowledge (for example, forging, stewing, roasting stir-frying steaming and heating during the processing of herbs) was transferred through a master and apprentice relationship.

China didn't significantly develop the chemical medicine sector until 1950, thus both TCM and chemical medicine have been massively manufactured in Tonghua since the 1950s. Even some small cities like Tonghua got highly involved in producing chemical medicine. In fact, before 1980, only two of the already established plants were specialized in TCM. This is partially because the Western medicine was imagined as a more effective, faster and safer approach to disease treatment. Finally due to insufficient local knowledge for production of chemical medicines, some initially specialized chemical-pharmaceutical plants were forced to convert into TCM ones, which I will explain later on. Here I want to discuss the main accesses of the first generation of enterprises to how to produce drugs. Here, I need to point out that the technology that Tonghua has been seeking for is not technology about developing new drugs (what I might call R&D-based knowledge), but on how to manufacture pharmaceuticals (production knowledge).

8.2.1 The Technological Origin of the First Generation of TCM Plants

For the first generation of TCM plants, the experienced parent entities familiar with TCM could be seen as the main external source of technologies, at least at the very start. Here I take Tonghua Commercial Pharmaceutical Factory and Meihekou No.1 Pharmaceutical Factory that specialized in TCM as examples to illustrate this point. The former was transformed from the "old" TCM stores mentioned above (Yongchengqing, Jishenghe and Faxin), while the latter was an offspring of a Chinese herbal medicine store. The common point of them is that their parent entities had got a good command of how to develop and manufacture TCM, even in a hand-made way. Tonghua Commercial Parmaceutical Factory is a very good example, which I will explain in more detail later. From a long-term perspective, these two early established TCM plants in planned economy times provided a seminal base for the following accumulation of a common pool of localized knowledge in the Tonghua TCM industry during the planned economy, which in turn became the “knowledge base” for the rapid growth in transitional and post-privatization period.

Let me turn to Tonghua Commercial Pharmaceutical Factory to explain how the new entities benefited from their experienced parent entities in the perspective of technological succession. The first state-owned pharmaceutical plant, Tonghua Commercial Pharmaceutical Factory, was the result of the combination of three old family-owned TCM stores, namely, Yongchengqing, Jishenghe and Faxin. The factory was erected on the original site of Yongchengqing TCM store and took over 150 employees who previously worked in these three private TCM stores. These employees could be seen as the seedbed of the establishment and growth of the first state-run plants, at least technologically. Some of senior pharmacists were able to develop new drugs and improve old--aged preparations based on their rich experiences that originated from their previous family-run TCM stores. Four new drugs developed during the 1960s and 1970s were good examples: two were directly developed by veteran pharmacists, namely, a medicine for Rheumatoid Bone pain developed in 1969 and a medicine for asthma developed in 1976. The other two (i.e., the oral liquid ginseng royal jelly in 1976 and a new Chinese medicine for cold and cough in 1979) were developed by well-trained young pharmacists. They received university education in medicine and pharmaceuticals, but an internal training system of enterprise, especially the “master- apprentice system”, was undoubtedly helpful for these young university graduates to learn more about the production process of Chinese medicine in practice.

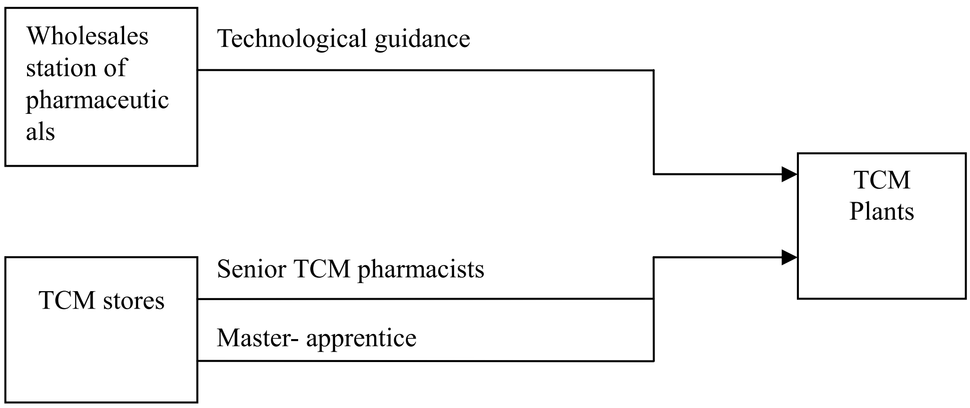

Figure 8.2：Knowledge Transmission of the Early TCM Plants and Parents

Different from the first state-owned plant, the other plants got production technologies mainly from pharmaceutical commercial organizations. For example, Meihekou No.1 Pharmaceutical Factory was established by 18 women who were family members of the employees of Meihekou Medical Station, a state-owned pharmaceutical commercial organization. These women had no direct experience with any subfield of the TCM sector. However, this factory was an affiliated plant of Meihekou Medical Station, and could receive regular technical guidance from this medical wholesales station. In the early years, the main products of this small plant were simple Chinese medicine products such as prepared slices of Chinese crude drugs and ginseng extract powder.

8.2.2 The Technological Origin of the First Generation of Chemical Medicine Plants

The technological sources of the first generation of chemical medicine plants in Tonghua are more complicated. We can divide these plants specialized in chemical medicine into two basic groups worth discussion. The first one consists of the off-springs of experienced institutions of chemical medicine, such as Western medicine hospitals, health schools, and so on. Similar to the TCM enterprises during the same period, these new established chemical medicine plants gained pharmaceutical production technology from their parent entities. Tonghua County Raw Medicine Factory (namely, the Baishan Pharmaceutical Plant) is a good example of those pharmaceutical factories which were the descendants of hospitals. This plant was erected in 1967, and most of its technicians previously worked in the preparation department of the Tonghua County Hospital. At its initial stage, it produced some simple products for this hospital in a very small scale, such as glucose injection. Similarly, Liming Pharmaceutical Plant was born from a hospital in 1968, and its main founders had served at 206 Hospital for a long time.

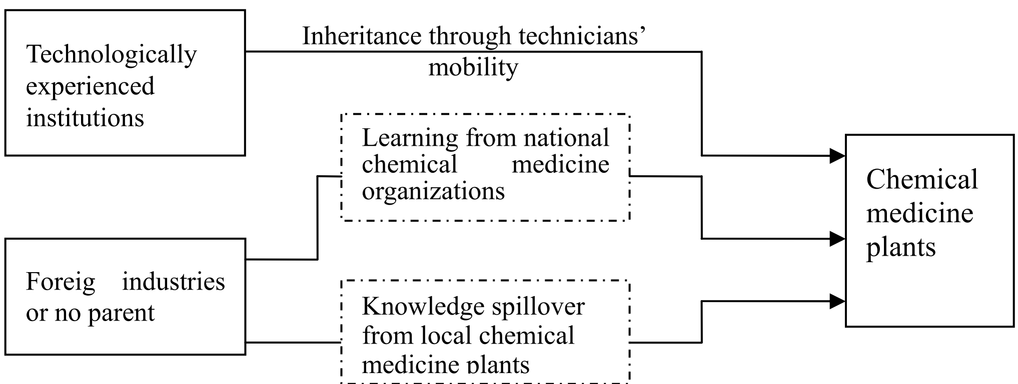

Figure 8.3： Knowledge sources of the early chemical medicine plants

Not all chemical medicine plants of the first generation in Tonghua, however, were derived from institutions in the pharmaceutical sector, and these compose the second group of chemical medicine plants. For the enterprises in this second group, learning from each other through local government-controlled labor mobility and learning from their domestic counterparties outside Tonghua were of great importance for getting know-how in pharmaceuticals. Accordingly, at least three external technology sources can be distinguished.

Firstly, owing to the absence of a patent system in China and the relative easy access to knowledge on how to produce, improve and develop drugs before the 1990s, learning from each other frequently happened between the local state-owned pharmaceutical enterprises. Those enterprises which were established from the scratch had to seek technical help from the state owned large-sized pharmaceutical enterprises across China, mostly in Changchun and the neighboring provinces. Ji'an County Pharmaceutical Factory, a relatively larger state-owned pharmaceutical factory, is a good case here.

Ji'an County Pharmaceutical Factory was converted from a chemical enterprise (an insecticide factory) in 1972. Although the new firm made use of some equipment of its predecessor (e.g. fermentation facilities), there undoubtedly exist huge technological differences between agricultural insecticides and human medicine. In order to learn how to manufacture oxytetracycline (a type of antibiotic which is used to treat bacterial infections), this new state-run plant sent technicians for many times to large-sized state-run pharmaceutical factories (for example Dalian pharmaceutical factory in Dalian, north China, Shanghai No.3 pharmaceutical plant in Shanghai). After external learning and constant trials, they successfully produced qualified oxytetracycline products. Later, the product quality was greatly improved under the personal guidance of 7 engineers and technicians from Wuhan Antibiotics Factory.

Secondly, the proliferation of technology among local pharmaceutical firms also contributed to the growth of this cluster, which could be reflected in the form of mobility of technical personnel with rich experience in developing and manufacturing drugs. Different from the free mobility of labor in today's China, personnel mobility in the planned economy was tightly controlled by the government. In other worlds, only the government had the right to determine how and on what scale personnel mobility took place. However, although employees could not freely choose working places as their children do nowadays, such kind of “compelled” personnel mobility also contributed to the diffusion of technology and knowledge, especially tacit knowledge, from an already established firm to a new one.

It is estimated that five plant-level leaders, forty one middle-level management cadres and technical cadres were transferred from Changqing Pharmaceutical Plant to the newly establised plant between 1984 and 1988. Among them, three plant-level leaders, eight middle-level management cadres and technical members and fifty front–line production workers were transferred directly to Changqing No.2 Pharmaceutical Plant when it was established in 1987. These human resources became the new plant’s seedbed for its subsequent development. This model of knowledge transmission based on the local government-dominated personal mobility constituted the dominant mechanism of technology diffusion among Tonghua’s pharmaceutical firms during the planned economy period.

Last but not least, the linkage of local pharmaceutical enterprises with external knowledge institutions made up for the insufficient local knowledge. Let me take Changqing Pharmaceutical Factory as an example to explain it. In order to improve the management quality and technology, Changqing Pharmaceutical Factory frequently organized semi-full-time television courses and invited university professors, mostly from Changchun (the capital of Jilin province), to give a variety of courses ranging from pharmaceutical sciences and engineering to enterprise operations management such as quality, production, inventory management, accounting. At the meantime, this factory adopted the strategy of “sending out”, namely sending promising young employees to colleges, which partially filled up the shortage of well-trained pharmaceutical talents in Tonghua, since the higher education was broken by the Cultural Revolution (1966-1976). By 1985, Changqing pharmaceutical factory had sent more than 20 young employees to pharmaceutical universities and colleges in Jilin province or a neighbor province (Liaoning), such as Yanbian Medical College, Shenyang Pharmaceutical University, and Changchun College of Chinese Medicine. After taking three or four years training courses on how to produce and develop drugs, these well-educated members returned and then became the technical backbone of the plants.

It should be noted that the above mentioned three mechanisms, in particular staff mobility among publicly-owned firms, were also adopted by TCM enterprises at the same time. In addition, both Western medicine and TCM enterprises made use of two common training forms in the early period, namely, irregular in-house short-term courses and the regular “master-apprentice” training system. The two learning mechanisms were popularly adopted during the period from 1983 to 1988 all over China. The in-house short-term courses, including quality testing, quality management, and cost management, were taught by advanced staff or university professionals. The master-apprentice system is a traditional way by which tacit knowledge can be transferred into practice. In the planned economy period, young employees usually worked under the guidance of the masters. The apprentice usually worked with his/her master for several years, and in a long-term daily contact, he or she attained the level of skills by regular practices, which is nowadays termed “learning-by-doing”.

8.2.3 Summary of Technological Origins of the First-Generation Enterprises

China's science and technology system followed the Soviet Union model, in which public research institutes monopolized the R&D activities and state-owned enterprises were delegated to production functions. The divide between R&D and civilian industries was prevalent in China during the planned economy (see Chapter 3.2.3). Against this background, the first generation of Tonghua’s pharmaceutical plants had the following character as a whole: (1) TCM plants had produced traditional products based on historically accumulated knowledge, especially by senior pharmacists, without great advance in production varieties or quality; (2) in the subsector of Western Medicine, the plants had to seek technological help from the outside owing to the serious lack of related local knowledge; (3) staff mobility between firms under the same ownership, and learning-by-doing (through the “master-apprentice” training system) and external learning as well, were of great importance to the whole Tonghua pharmaceutical sector; (4) a few formal R&D inputs in terms of number of personnel and expenditure produced very limited outputs of new product varieties, as compared with the following transitional and market-oriented periods. However, from a historical perspective, accumulated technological experience during the first stage provided a platform for the later development of the pharmaceutical industry in Tonghua, and even wider areas in Jilin province, including training a large number of professional managers and pharma entrepreneurs.

8.3 The Early Reform Period

8.3.1 Chinese Nutritional Medicines Based on Ginseng

Entering the 1980s, more and more autonomies were granted to factories due to the introduction of the factory manager responsibility system and the management contract system (see Chapter 3.2.2). The transition to the performance-oriented entity from purely production organization endowed the factories with more impetus of developing new products than before. In addition, due to the improved living standards and the increasing health awareness since the Deng's time, the demand for drugs and invigorants, particularly natural plant-based tonics, climbed sharply and so did the TCM sector in Tonghua. This trend can be perceived from the fact that all of the four newly established enterprises between 1980 and 1985 were specialized in TCM just from their very beginning. In addition, some chemical pharmaceutical plants established in the 1970s successively transformed to the production of traditional Chinese medicine from chemical drugs.

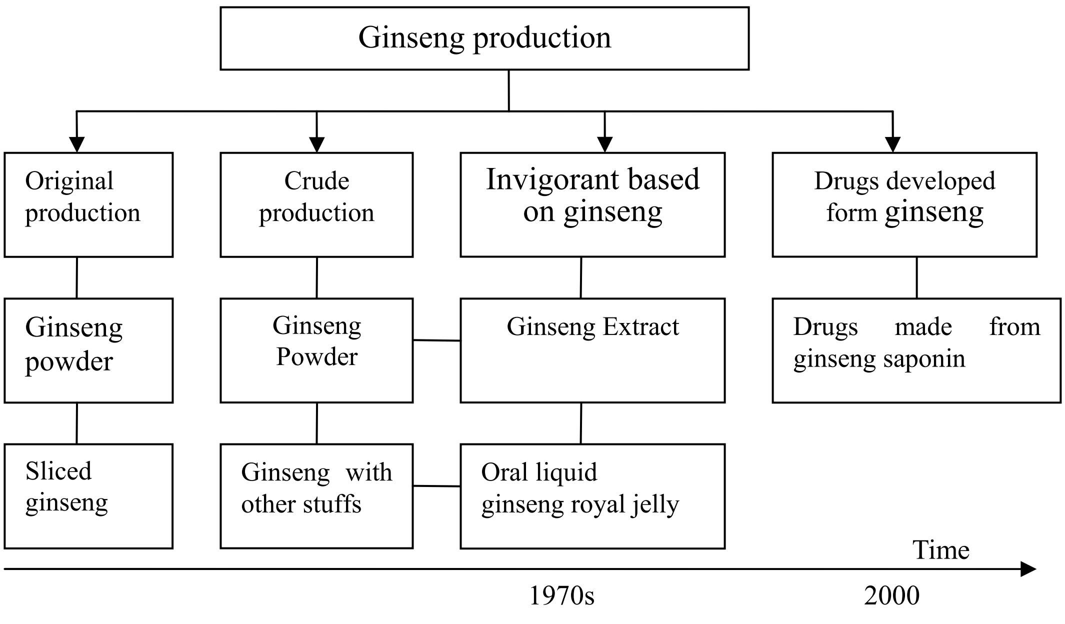

Figure 8.4: Ginseng production Series
Note: Ginseng saponin is the active ingredients extracted from ginseng, and can lower blood sugar, cure diabetes.

There were three main categories of "drugs" during this period: chemicals, Chinese medicine for treating diseases, and invigorants (nutritional Chinese medicine, made from natural herbs and natural ingredients like Ginseng, angelica). Strictly speaking, invigorants are not real drugs for treating diseases but for preventing diseases in advance by enhancing overall energy, maintaining, increasing, or restoring the tone or health of the body or an organ. More interestingly, the economic output of the last two categories of products phenomenally increased while the first one significantly declined. From the viewpoint of economic value, the most profitable products manufactured in Tonghua during the 1980s were the tonic medicines based on precious natural herbs in the Changbai Mountain. More importantly, from a historical viewpoint, entering the sector of tonic medicine opened a window to its locational opportunity for TCM industry since it accumulated a wealth of technological experience and huge financial resources.

Tonghua, as one of the first regions where nutritional Chinese medicines were produced, was the outstanding leader in producing oral liquid made from ginseng, angelica and other precious Chinese medicinal herbs. According to the TCM theory, the proper dosage of ginseng with angelica can improve body circulation, increase blood supply, and help to keep body balance. Ginseng is rich in Northeast China, and almost more than 90% of ginseng used in China comes from the Changbai Mountain (Tonghua city is located in this mountain area). Therefore, it is a long history that Tonghua people makes use of ginseng, together with other Chinese medicinal herbs, to serve for local health care. However, it was only after the 1970s that the ginseng product was expanded to oral liquid and other varieties which are easy to be absorbed (see Figure 8.4). As early as the beginning of 1970s, some of the pharmaceutical factories in Tonghua began to develop new ginseng products.

Weixing Zhao, a senior pharmacist at Tonghua Baishan Pharmaceutical Factory, developed the prescription of Ginseng Royal Jelly Liquid through studying the literature on the Chinese medicine. After a short-term learning from a large state-run enterprise in Chuangchun (Chuangchun Pharmaceutical Factory) in 1972, Weixing Zhao became familiar with production processes. Since then, the new Ginseng Royal Jelly Liquid began to be produced in his factory and put on the market. In the next few years, several technological projects uninterruptedly improved the quality of the royal jelly (for example, the refining process further removed of impurities in 1975). Higher quality and more appreciated taste, in addition, people’s more concerns about health brought by China's economic development and rising education, made the product a good sale. By 1985, the sales of Ginseng Royal Jelly Liquid of Tonghua Baishan Pharmaceutical Factory increased by 10 times as against 1975. It even was in short supply.

Another best-selling product at that time was ginseng extract. For instance, the accumulated output value of ginseng extract and ginseng antler extract in Meihekou Pharmaceutical Factory had reached RMB 11.84 million Yuan by 1978, accounting for 59.4% of the total output value of this plant. This plant got technical support from a wholesale station, Fushun City Medicine Station. In 1976, the output value of Ginseng Royal Jelly and Ginseng Oral Liquid reached RMB 6.453 million Yuan, the profit RMB 359 thousand Yuan, and tax RMB 286 thousand Yuan, occupying an important position in the entire Tonghua medical industry (See Table 8.1).

Table 8.1: Importance of tonic medicine

Unit: Million Yuan

Year	Output Value	Profit	Tax
Nutritional Oral Liquid（1976）	64.53	3.59	2.86
Entire Medical Industry（1977）	1,056.60	8.79	4.30

Source: Cao, 1989.

Thus, after the middle of the 1980s, the increasing entrants intensified competition in the TCM market. The deconcentration of economic administration motivated Tonghua pharmaceutical factories, in particular market-oriented hybrid enterprises, to create new products in order to meet the market demand. It was the fast wave of economic growth in China that stimulated the market of the nutrition products to rapidly expand. Some of the contracted pharmaceutical factories in Tonghua seized this golden market opportunity, making full use of the local ginseng industry-specific advantage accumulated in the planned economy times, and then grew into competitive private enterprises. As I have shown earlier, in fact, there had existed a lot of similar TCM products before these marketable products were developed. For example, the first generation of successful products of Baishan No.5 Pharmaceutical Factory after being contacted by Yikui Li, fresh ginseng royal jelly oral liquid, actually existed in the 1970s. Another good example is the first product with good sales of Zhen Nao Ning, an efficient drug for vascular and nerve headache which also has a long history in Tonghua city.

This contracted company created tremendous profits from these already existing “new” drugs through changing the components, improving the product quality or the process, or promoting marketing innovation. It illuminates that the new firm organization became market-oriented and cared more about market demand. In the planned economy, the main mission of the pharmaceutical manufacturing enterprises was to implement the production plan made by the corresponding level government and then deliver their products to relevant state-owned pharmaceuticals commercial enterprises, without considering production cost and markets. But since the 1980s, the pharmaceutical companies were granted more and more autonomies, including marketing their products and keeping parts of profits. Against this background, the leading pharmaceutical enterprises in Tonghua started to pay more attention to market demand and introduce various marketing models, for example, advertising, recruiting well-trained salesmen and constructing strong marketing networks. The successful story of Baishan No.5 pharmaceutical factory (today's Dongbao Group) is a good example.

Being established in 1985 (see Chapter 7.3.1), Baishan No.5 pharmaceutical factory was the latest one of a total of over two hundred pharmaceutical plants in Jilin province. After 20 years of hard struggle, the factory has grown up into a nation-wide well-known pharmaceutical giant, and is ranked on the list of the top 10 TCM enterprises in China, with a total staff of over 3000 (the salemen is excluded). The commercial success of this enterprise started from its first generation of products. As mentioned many times in this dissertation, the 1980s witnessed the drastical growing demand for invigorant and tonic medicines product. After taking over the small plant, Li Yikui carried out production innovation, namely, improved the production process (to break down the bitter compounds through steaming and drying processes) and added some sweat components (for example, honey) to alleviate the unpleasant bitter taste. Additionally, Li Yikui was the first person in China who advertised for medicines on television. Specifically, he made use of a historical event, a joint mountaineering team consisting of athletes from China, Japan, and Nigeria climbed the Everest in 1986, and the news of the athletes taking "fresh ginseng royal jelly" was broadcasted on CCTV (China's most popular and influential TV station). After that, the first product (fresh ginseng royal jelly) became well-known across the country, and earned a profit of more than 3 million RMB in 1987. The huge profit not only completely changed this factory's financial predicament, but also provided the solid financial foundation for its subsequent development to expand the firm's size.

Furthermore, from the point of view of the local industry, the commercial success of this product of fresh ginseng royal jelly attracted a lot of Tonghua pharmaceutical enterprises to invest in the sector of ginseng-based invigorants, which even caused the war of ginseng-based invigorants. This is of great significance to the following development of Tonghua's pharmaceutical industry. Firstly, the higher profit of ginseng-based invigorants lured both new and established enterprises to enter this sector. Secondly, the increasing entrants led to competition in the market of ginseng-based invigorants, which forced them to develop truly new TCM drugs. Thus it is safe to say that the development of ginseng-based invigorants opened up a window of local opportunity for the TCM industry, at a cheaper cost. Thirdly, the massive investment in this sector resulted in the (re)emergence of TCM industry in Tonghua. Tonghua enjoys the first-mover advantage as the first region specializing in TCM in China.

8.3.2 Innovation based on Existing Traditional Chinese Medicines

After the reform and opening up policy, China's government began to reorient R&D activities from military to civilian products. Starting in 1984, the full funding assignment system was changed and state funding to public research institutions was severely reduced, which threatened the basic survival and research activities of scientists. Public research institutions and universities were encouraged to establish commercial firms or do joint research with industrial enterprises to ease the scarcity of funding (see Chapter 3.2.3). At the same time, market competition in the sector of ginseng-based invigorants in Tonghua became increasingly fierce, and profits remarkably declined. As a result, both contracted pharmaceutical firms which were more market-oriented and large state-owned firms that were previously protected by bureaucrats were forced to search new products. To redevelop the existing TCM drugs was a good choice.

During the early economic reform period the "new" TCM drugs were developed mainly based on already existing varieties. Entering the TCM industry through improving already existing TCM drugs is a rational and habitual response to rapid market change, instability of national institutions, and the absence of effective state-enforced property rights. Thus, Tonghua's pharmaceutical firms in transition searched projects with low-risk, quick and high-return. In addition, due to TCM's long history in this region, the development of "new" TCM drugs based on the already existing TCM drugs was less risky than the development of entirely new drugs.

However, the traditional non-injectable dosage forms of TCM drugs include decoction, powder, bolus, and extract, which are generally inconvenient to be taken and are hardly to be absorbed. The introduction of Western medicine to China has changed the way of how Chinese people take medicines. People became aware that the dosage forms of Western medicine, namely, pills, tablets and capsules, are more convenient to take. Thus, the TCM firms in Tonghua were forced to change the traditional dosage forms of TCM drugs in order to fit the changing practices of taking medicine. However, the transformation of dosage form is so complicated that Tonghua pharmaceutical enterprises at that time hardly did learn this alone, so they started to construct closer and frequent relationships with universities and pharmaceutical research institutes to jointly develop new products, improve the quality of existing medicines, and transform the dosage form. For example, Liuhe Changqing Pharmaceutical Factory began in the 1980s to positively establish ties with universities and made marvelous achievements (See Table 8.2).

Table 8.2: Technological cooperation projects of Changqing Pharmaceutical Factory (1985-1988)

Name	Treatment	Research Institute (Location)	Year
NewTablets Kechuanling	Cough variant asthma	Jilin Institute of Chinese Medicine(in Chuangchun)	1985
Cold medicine series	Anti-cold medicine Infant cold medicines	The China Society of Traditional Chinese Medicine(Beijing)	1985
Aperitive Pills	Defaecation	Changchun college of TCM	1985
Injection Ahylysantinfarctase	Cerebral thrombosis embolism	Jilin Institute of Chinese Medicine(in Chuangchun)	1986
Progesteoni Suppositories	Gynecopathy	Second Clinical School at Bethune Medical University	1986
Rheumatalgia-Reliveing Tablets	Arthritis	Changchun college of TCM	1986
Tongbining Capsules	Pain killer \Anodyne	Jilin Institute of Chinese Medicine(in Chuangchun)	1986

Source: Cao, 1989

The method of redeveloping the already existing TCM is often used in developing "new" TCM drugs. The reason why today's Xiuzheng Group has grown into a high competitive large company in China from a small plant within a short time of ten years can also be ascribed to the successful redevelopment of the existing TCM drugs and other factors (such as constructing the strong market network and brand advantage). The first best-selling product of Xiuzheng Group was a kind of gastrodia pill. As a matter of fact, this medicine is a traditional Chinese herb made from gastrodia, scrophulariaceae and other Chinese medicine materials, mainly for treating epilepsy, headache, hypertension, and neurasthenia (weakness-fatigue) and other convulsions.

When Xiu Laigui took over the small pharmaceutical factory (Tonghua City Pharmaceutical Industry Research Institute) around 1995, a year in which China's pharmaceutical market was in turmoil, fake medicine and inferior medicines were prevalent. The inferior gastrodia pill without enough gastonia could virtually not cure targeted diseases. In order to compete in the established market, Xiu Laigui used enough gastrodia to produce a qualified product of gastonia pill; but even so, he had to sell his pure gastrodia pill at a lower price than that of inferior products at the beginning. This marketing strategy worked very effectively. With the increase in sales volume, the sales price of genuine gastonia pill increased gradually. The product produced a profit as high as 5 million RMB in 200 days, a huge number at that time.

The second, the best product of this company, Sidashu (English name is Vitamin U, Belladonna and Aluminium Capsules), actually was also the result of redeveloping an old traditional Chinese medicine for excessive gastric acid. One year after the first commercial success, Laigui Xiu bought by chance a prescription for the treatment of hypertension from a veteran TCM doctor and then produced this “new” Chinese medicine in the form of capsule. There were in fact a lot of formulas for stomach medicines in TCM pharmacopoeias (books listing drugs and their directions for their uses). What contributed to the commercial success of Xiuzheng Group is that (1) Xiuzheng Group changed traditional dosage into which was easy to take and absorb; (2) it insisted on producing high quality based on genuine materials; (3) it invested much money in advertising and in constructing strong sales networks, and then created a national well-known brand. By 1997, the sales volume of this new redeveloped medicine broke through 200 million RMB, which was a huge number for a single variety in China.

The high profit that Taiheshenggan capsule made stimulated a large group of pharmaceutical enterprises to invest in producing stomach drug, which resulted in a war of stomach drugs in Tonghua. From this lesson, Xiu Laigui became aware that no matter how good the product without its own brand is, it is very easy for other companies to follow and imitate. Since then, Xiuzheng Group began to spend huge money on advertising and building up its own marketing networks throughout China. Xiuzheng Group has taken a long-term advertising-intensive path, and adopts it up to now. The drug advertisement of Xiuzheng Group is broadcasted on the television in prime time every day. Today Xiuzheng Group has already well constructed sales networks covering most parts of the country and the strong and highly efficient marketing networks brought about high profits, which enabled this local giant to put more and more money and other resoures to oragnzation the formal and in-house R&D.

8.4 The Later Period of the Economic Reform

During the later phase of transition, from 1992 to around 2000, there were several notable changes which were different from those in the previous stages and enormously influenced the following development of this local cluster. The first one is the influx of well-educated university graduates to Tonghua pharmaceutical firms, which provided fresh and advanced human resources for Tonghua pharmaceutical enterprises. The second is that a few of Tonghua pharmaceutical enterprises were involved in the bio-pharmaceutical industry.

8.4.1 New Human Resource of University Graduates

In the planned economy period, university graduates were generally assigned to their hometowns by government. This means that almost all university graduates in Tonghua's pharmaceutical industry were local people before the midd-1980s. In the late stage of the planned economy, some university graduates had already come to Tonghua and worked in this emerging industry, among them the founders of the largest local companies (Laigui Xiu graduated from Jilin university and Yikui Li from Beijing). But their number was very limited.

During the initial period of the economic reform and opening up, local schools became a major source of new talented employees. With the rapid development of Tonghua's pharmaceutical industry, local schools, Tonghua City Technical School (a vocational school, established in 1980) and Tonghua Normal College (established in 1958) started to set up relevant courses. There were some differences in the training systems between the two schools. The former mainly trained low-level technical personnel, including pharmaceutical machinery operators and laboratory assistants, while the latter offered courses in pharmaceutical preparations, TCM, biological sciences and marketing. Since most of the students were born in Tonghua, they worked there after graduation. Different from the non-local graduate students who came from other regions afterwards, the local educated employees were deeply embedded in this local society and were strongly loyal to this industrial community; namely, they flowed merely among different pharmaceutical enterprises in Tonghua, rarely moved outside, even in the most difficult stage of state-owned enterprise reform. Their high loyalty to this local sector guaranteed the successful transformation from a poor-perferming state-owned economy to a vigorous private pharmaceutical economy in a certain sense.

With the development of higher education in China, an increasing number of university graduates began to join in the economically growing pharmaceutical corporations in Tonghua, especially in the departments of marketing and R&D laboratories in the middle of the 1990s. This generation of educated staff graduated from universities outside Tonghua, initially from Changchun and recently from faraway regions. It is notable that most of these trained staff did not work in Tonghua, but often did marketing as salesmen of Tonghua's pharmaceutical enterprises all over the country, which I have already discussed in Chapter 5.1.4. They move among different regions and work for different pharmaceutical enterprises (not only for Tonghua pharmaceutical enterprises), which brings regional market information of cross-china to Tonghua.

8.4.2 The Development of Bio-pharmaceutical Products

China's government had decided to significantly develop the biotech industry since 1986. It is estimated that a quarter of the National High-tech Research and Development Plan projects (the 863 plan) was placed in this emerging field by 2000 (for a history of biotechnology policies in China, see Prevezer and Han, 2006). Although the main products of the Tonghua pharmaceutical cluster today are still TCM, four companies in this cluster began to set foot in biotechnology in the 1990s. More interestingly, they entered into this new industry in different ways. It is not safe to say that Tonghua TCM cluster will tranform into a biopharmaceutical cluster in the nearby future.

Yucai Zhang, owner of Tonghua Yujin Pharmaceutical Company, got to know that a research team of Recombinant Staphylokinase for Injection, led by the leading scientist of Shanghai Plant Physiology and Ecology Research Institute of Chinese Academy of Sciences, fell into financial crisis. This project's basic research was initially supported by the National Natural Science Foundation Committee (a national public foundation for basic research) in 1983. After that, the project received financial aid for pre-clinical research from an enterprise group (its name is not accessible) in 1992 and from Chengdu Jinpeng Biotechnology Co., Ltd in 1995. However, Chengdu Jinpeng Biotechnology Co., Ltd could not afford its complete preclinical trial because its cost was too large for a small company. Just then Yucai Zhang participated by investing RBM 3 million Yuan to continue the pre-clinical research. Chinese State Food and Drug Administration (SFDA) approved "Recombinant Staphylokinase for Injection" as the class I drug. Class I drugs in China refer to the new drugs that have not been marketed in the world before. The project created a substantial return for Yujin

Pharmaceutical Company. From this story, we can see that Tonghua Yujin Pharmaceutical Company entered the production of so-called biopharmaceuticals through financial investment, not in-house research.

Table 8.3: Financial sources of “recombinant staphylokinase” project

Unit: thousand RBM

Year	Financial Source	Function	Sum
1983	National Natural Science Foundation Committee	Basic research "staphylokinase" Cloning Research	30
1992	An Enterprise Group	processes experiments on fermentation and separation and purification	200
1995	Chengdu Jinpeng Biotechnology Co., Ltd	pharmacology, toxicology tests	600
1996	Yujin Pharmaceutical Co., Ltd	pre-clinical drug research	30000
1997	Yujin Pharmaceutical Co., Ltd	Production	70000

Source: own elaboration

Maoxiang Group and Dongbao Group adopted different ways to enter the biopharmaceutical sector, by mergering or jointly-creating research-oriented enterprises. Maoxiaong Group merged with ChangSheng Gene Pharmaceutical Co., Ltd (in Changchun) in order to get access to biotechnology. The latter is a gene technology research institute that sprang off from the earliest and largest public research institute in North China. When the new start-up went into financial crisis around 2000, it was merged by Maoxiaong Group and became an affiliated company.

Dongbao Group entered biotechnology by jointly creating a new research institution, Gan & Lee Pharmaceutical Company in Beijing. Gan & Lee Pharmaceutical Ltd. is the only pharmacological enterprise that focuses on biosynthetic human insulin in China since 1994, under the leadership of a returned scientist from America. The commercial marriage of the first-class manufacturer (Li Yikui) and the top-ranking scientist (Dr.Gan) shows again that the strong extended family network will be helpful to commercialize research achievements. Dr.Gan and the founder of Dongbao Group (Li Yikui) were university classmates. Classmateship, some kind of brotherhood, is a very significant social relationship in Chinese culture. Gan & Lee Pharmaceutical Company is one of the sub-companies, and undertakes the mission of research and development of Dongbao Group.

8.5 The Period of Formal R&D

The pharmaceutical industry in Tonghua entered the period of formal R&D after the new Millennium, in the sense that the leading pharmaceutical enterprises predominantly expanded their R&D activities and more and more scientists worked at in-house laboratories. More importantly, through these in-house scientist or the social ties with their academic colleagues, were strengthened. Apart from formal and frequent cooperation, conglomeration and merger of private and small research-intensive enterprises became common forms by which the large pharmaceutical manufacturers made an attempt to construct and improve their capabilities of developing new drugs.

It costed Xiu Zheng Pharmaceutical Group less than 10 years to grow into a relatively large and nationwide famous enterprise. It has become an industry leader in Jilin in terms of output value since 2000. Based on a brand advantage for over-the-counter drugs and networks of marketing and distribution, Xiuzheng Group set up its leading position in the traditional Chinese medicine market. To consolidate its market leadership, Xiuzheng Pharmaceutical Group launched a series of actions to improve the research capability largely through merger and acquisition.

In 1999, Xiuzheng Pharmaceutical Group established an in-house technology center in Changchun High-tech Development Zone, Jilin province, near to the new campus of Jinan University, where the Departments of biology and pharmaceutics are located. This was upgraded to "Jilin Engineering Center of Traditional Chinese Medicine", which is conceived to be a cooperative research centre. It combines several research institutions' expertise in the TCM sector (see Figure 8.5). The center operates on a national scale. Now it employs more than 300 scientists and has two branches in Shenyang and Shanghai. It was equipped with a small-scale production facility which will serve for process innovation, production trials as well as the transformation of the TCM, not basic research as the Western pharmaceutical giants do.

Another function of this technology center is to cooperate with knowledge institutions for multifold innovation. Firstly and more importantly was to develop truly new drugs, for instance, in cooperation with Jilin University to develop thrombolysis; second and most commonly was to create new dosage forms for existing TCM durgs, for example, in cooperation with Changchun College of Traditional Chinese Medicine to create the particle dosage form for Huanhuicao (a Chinese medicine for cough and asthma). The third was to improve the production process, for example, a key production technology of TCM was achieved through collaboration with Tianjin University.

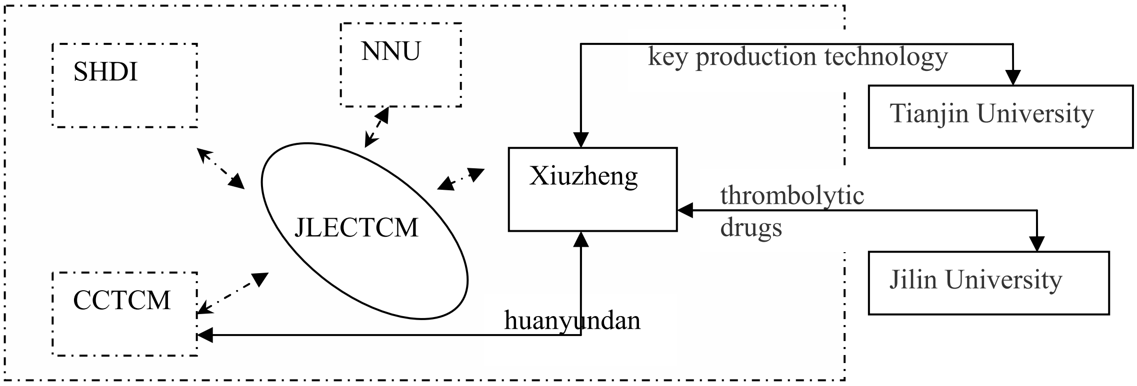

Figure 8.5: The key cooperation network of Xiuzheng Group

Source: the website of Xiuzheng group. www.china-xiuzheng.com

Note: the dashed arrows represent the co-founder of CCTCM (Changchun College of Traditional Chinese Medicine). The solid arrows denoted the current cooperative projects.

NNU: Northeast Normal University; CCTCM: Changchun College of Traditional Chinese Medicine; SHDI: Shanghai drug institute

As I pointed out in Chapter 6.1.3, acquisition is common for the large pharmaceutical manufacturers to get access to firm-specific strategic and competitive assets of the acquired companies such as new product portfolios, brands, research laboratories and technologies. The strategy was adopted as well by the leading Tonghua pharmaceutical companies after 2000. For example, in 2004, Xiuzheng Pharmaceutical Group acquired a biopharmaceutical company, Beijing Xinluowei Pharmaceutical Technology Ltd. which was a leading biopharmaceutical company in China, having a strong biopharmaceutical product portfolio. This acquisition was motivated to gain an entry into the biopharmaceutical market. It was reported that Xiuzheng Pharmaceutical Group would invest 450 million RMB to upgrade this acquired company into China's largest R&D base for the Modernization of Traditional Chinese Medicine in Beijing, jointly with other pharmaceutical manufacturers and research institutes. In addition, Xiuzheng Group introduced Korean ginseng processing technology and cooperated with ginseng processing enterprises in the Republic of Korea in 2005 in order to develop international markets, with a clear aim to make use of the advanced ginseng processing technology and marketing advantages of the Korean business partners.

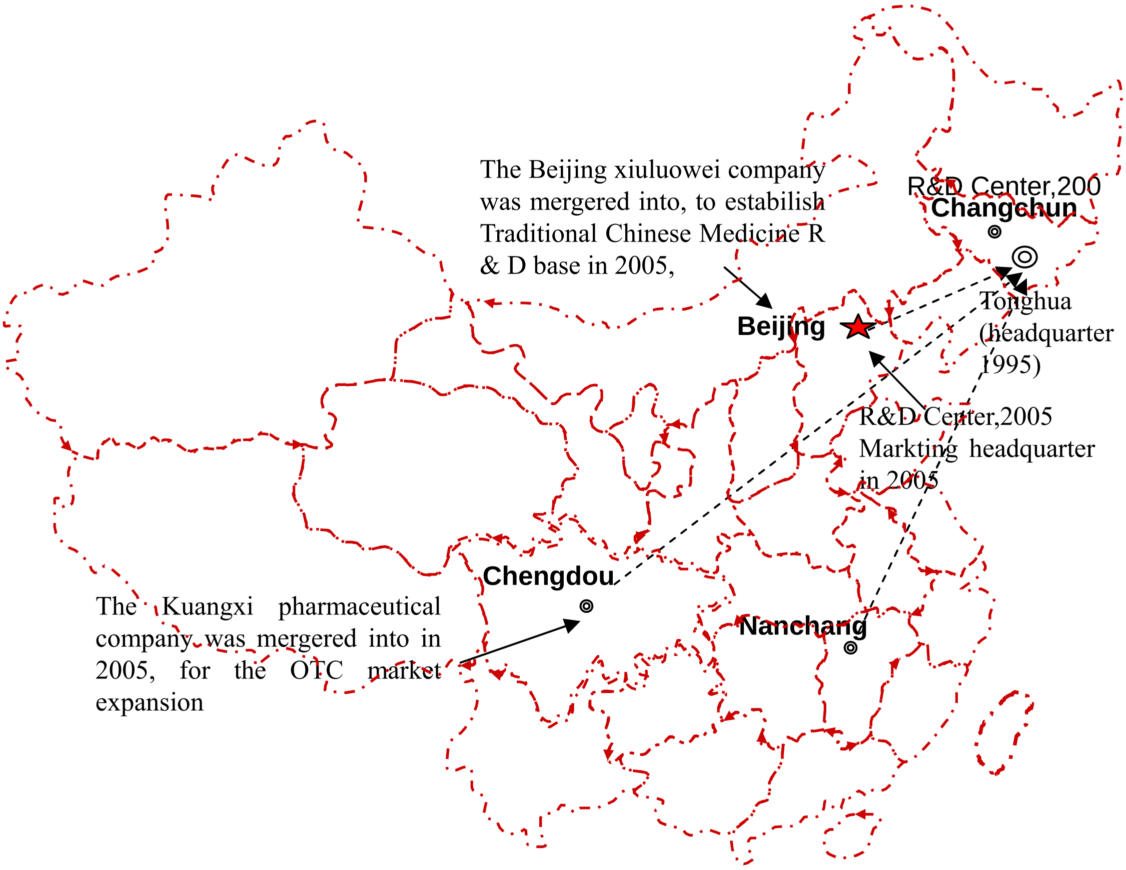

Figure 8.6: R&D and large production bases of Xiuzheng Group

8.6 Conclusions

8.6.1 Tonghua's Pharmaceutical Industry is a Low Technology Sector

Different from the Western pharmaceutical clusters such as Cambridge Biopharmaceutical Cluster in which industrial growth is largely dependent on R&D-based knowledge, the Tonghua pharmaceutical sector is still a low-technology cluster (see Chapter 5.3). Although R&D input data of Tonghua's pharmaceutical industry is not available, the entire R&D input of Tonghua city (see table 8.4) tells us that Tonghua as a whole is not a research-intensive region, even in Jilin province. Now, the total R&D input in Tonghua is still very small, not to mention in the pharmaceutical industry.

Table 8.4: R&D inputs in Tonghua in 2003

	No. Research institute	R&D personnel	R&Dexpenditure (Mil.RMB Yuan)
Tonghua=A	4	4,08	107.83
Jilin=B	107	139.54	12,102.72
A/B*100%	3.74	2.92	0.89

Source: Jilin Province Science and Technology Statistics Yearbook (2003)

8.6.2 Technological Evolution and Firm Organizational Change

It is theoretically argued that new start-ups are a source of path-breaking innovations and opening new submarkets (Klepper, 2001; Boschma and Wenting, 2007). This is also true for the Tonghua case. But we should note that in the case of Tonghua a lot of "new" pharmaceutical enterprises was transformed from the SEOs but entrepreneurial spinoffs mainly occurred around 2000 and hitherto whose number has been very limited. This illustrates that the market mechanism in China is not well developed and still under construction. The variety in technology, especially in the transitional period (from 1985 to 2000) is highly related to the changing institutions and firm organizations. For example, during the early reform, the contracted firms, a market-oriented firm organization, emerged and then created businesses in niches markets (the ginseng-based invigorant in the midd-1980s) to which state-owned enterprises were initially more reluctant to enter. And once a niche market had been opened up, both new startups and established enterprises swarmed into the emerging sector, and the small niche market subsequently became a big industry.

The technological transformation (from the chemicals-dominated industry to the ginseng products and then to TCM drugs) is not based on the dynamics of industrial technology itself, but on organizational innovations (for example, the emergence of contracted enterprises and transformed enterprises) and development of entrepreneurship. Considering that organizational innovation and the emergence of entrepreneurship coevolved with national and local institutions, we can say that the technological evolution is a result of coevolution of firm organization, institution and entrepreneurship. Thus, we can not well explain the evolution of technology in Tonghhua pharmaceutical enterprises without the coevolutionary approach. Now I will discuss this in more detail.

8.6.3 Technological Evolution in Coevolutionary Perspective

The evolution process of the Tonghua pharmaceutical sector went through three main stages technologically: the coexistence of TCM and Western medicine (but chemicals-dominated industry), the ginseng-based invigorants, and TCM drugs. We can find that technology evolved with the changing national and local institutions and changing firm organization, as Figure 8.7 summaries.

During the centrally planned economy period (1953-1978), the local government made more efforts to produce Western medicine, but local technological resources for manufacturing Western medicine were absent since those SOEs had to resort to the large enterprises outside Tonghua. At that time, it was easy for SOEs to get access to production technologies from domestic and local counterparts. The reasons for this are that intellectual property at that time in China was seen as a "free good", and a patent system was absent until 1985. The SOEs which specialized in Western medicine during the planned economy have turned to the emerging sector of ginseng-based invigorants, partly because the local base of the chemical industry-specific knowledge was very week, partly because the rigid bureaucratic management system of state-owned enterprises resulted in a slower response to the changing market. The relatively slow and inflexible response to market consequentially led to relatively poor economic performance of clumsy state-owned enterprises, compared to that of emerging red cap enterprises with with hybrid ownership structures. But the hybrid firms outperformed SOEs because of flexible management and rapid response to the changing market. However, objectively speaking, the commercially unsuccessful chemicals sector has played an important role in transforming traditional dosage forms into the typical westernized dosage forms.

The first generation of TCM factories was the seedbed for the sectors of ginseng based Chinese nutritional medicines and TCM drugs. Tonghua had historically been one of the TCM centres in North China. There were a large number of veteran pharmacists there and they carried the TCM sector- specific tacit knowledge to newly established enterprises after the foundation of PR China. Although some of the first generation TCM factories originated from those organizations that had no techological relation with pharmaceutical manufacturing, they were blessed with the social historical cohesion that can also be found in the Third Italy, and the extended family networks. For example, Meihekou No.1 Pharmaceutical Factory received regular professional guidance mostly from a local state-run pharmaceutical commerce organization, because almost all staff was family members of the employees of this pharmaceutical wholesale station.

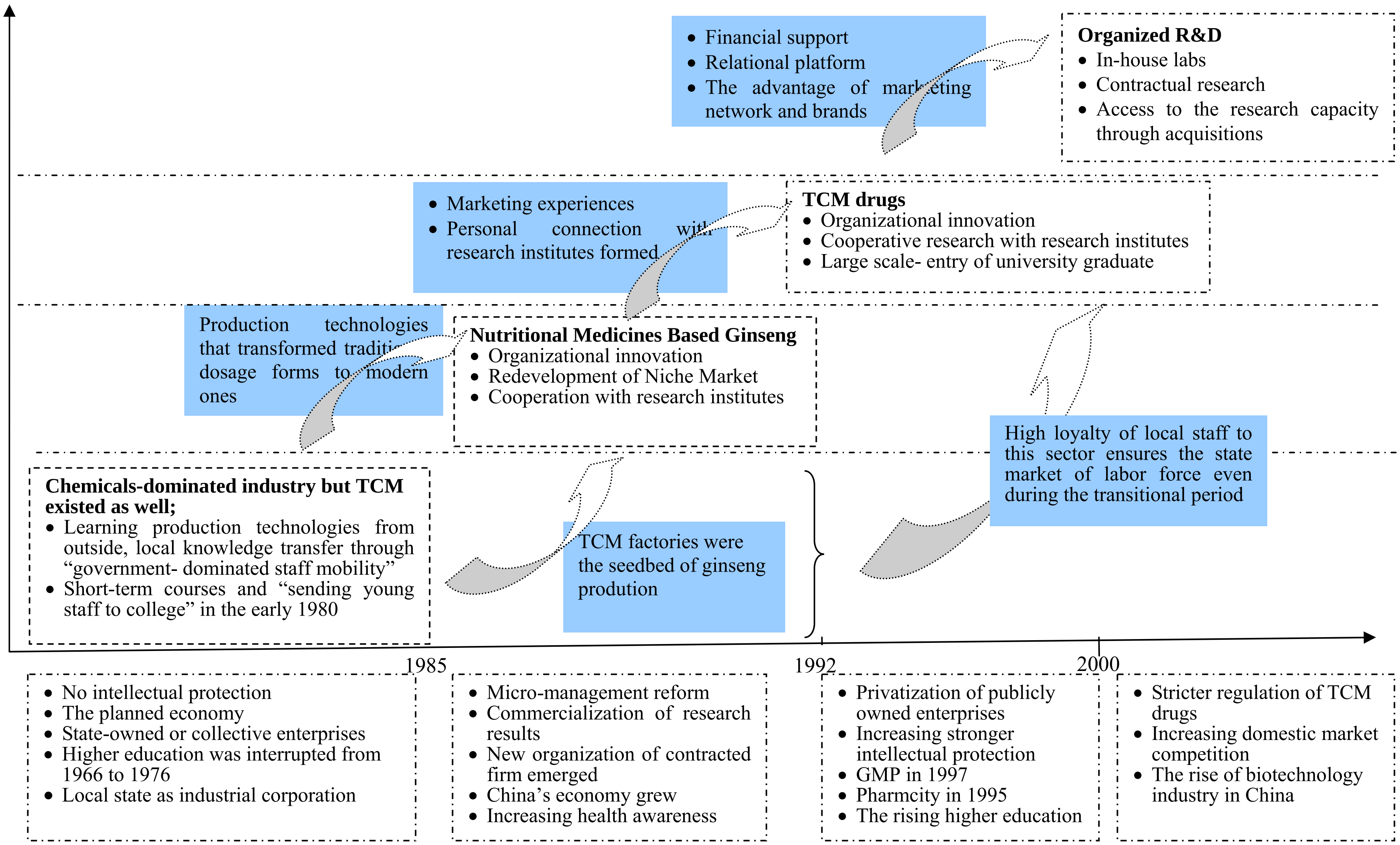

Figure 8.7: Evolution of technology in Tonghua's pharmaceutical industry

With regard to the mechanism of technology diffusion, relatively large local factories played the role of a bridge as they transferred the knowledge that they learned from extra-regional enterprises to intra-regional small or newly established ones. The local government-dominated staff mobility was an important knowledge transfer channel inside Tonghua. Technical and managerial personnel, even normal staff, flowed among state-run enterprises normally under the common jurisdiction. Although such personnel transfer among pharmaceutical plants was not based on employee requests, these non-voluntary transfers undoubtedly were helpful for technological diffusion among SOEs within this cluster.

Entering the 1980s, two new learning mechanisms emerged, namely, short-term courses and "sending young staff to college", which were of great significance to the subsequent industrial development. Firstly, both learning mechanisms trained technical and managerial personnel and thus promoted the management technologies of the whole pharmaceutical sector. Secondly, those who were sent to colleges and then received higher education were promoted to become enterprise cadres. Some of them played a bridge role linking pharmaceutical manufactering to research-intensive institutions and became private pharma-entrepreneurs later on.

Although almost all startups established during the early 1980s began to shift to produce TCM, the market of TCM was still smaller at that time. In addition, the management system of SOEs was rigid. In the mid-1980s a new organizational form emerged, i.e. contracted firms, which is a typical form of hybrid firms in China with relatively higher autonomy compared to the state-owned enterprises due to the introduction of the factory director responsibility system (for the background of this institution, see Chapter 3.2.2; for the empirical evidence, see Chapter 6.2.2). Some contracted firms seized the opportunity of the emerging tonic market and successfully opened up the window of locational opportunity of the ginseng-based tonic market in the mid-1980s (see Chapter 7.3.1). The techniques of producing ginseng-based tonics are less complicated than chemical medicines and are consequently easier to be imitated. In addition, the enterprises that entered early this new sector enjoyed high profits and a favorable market environment with increasing demand. Therefore, more and more new startups and established enterprises, including the previous chemical medicine plants, joined in this emerging sector.

During the period of the enlarged enterprise autonomy (from the mid-1980s to the end of 1980s), the management technologies, even of state-owned enterprises, were significantly promoted, because the operational autonomy was decentralized to factories and even their subunits (see Chapter 6.2.2). At the same time, the production technologies were also improved since Tongue pharmaceutical enterprises at that time increased financial investments into the hardware building, especially introducing mechanized and automated production lines. For example, Jin'an Pharmaceutical Plant, a local large scale pharmaceutical enterprise, imported production equipments twice (a capsule filling machine in 1986 and an automatic double-deck tablet making machine in 1987) from the Federal Republic of Germany.

In traditional ginseng processing, ginseng usually was physically distorted and some active ingredients were partially lost, and its economic and medicinal value was thus reduced. But with the new production processes and techniques, the original shape of ginseng is well maintained and its active ingredients are better kept. The advantages in productivity and quality increased the economic value at least by 30 percent. It is necessary to point out that these advanced equipments could not necessarily ensure sustainable competitiveness of the enterprises, and the material form of technologies plays a positive role only in sound environments of socially shaped soft technologies. This is why the state-owned enterprises with advanced equipments were less competitive than contracted firms which did not have sound production equipments but adopted a more flexible management system. In other words, the soft technologies such as enterprise management are of more importance in the transitional economy than hard technologies like production technology.

As the tonic sector grew radically, revenues and profit margins fell off. Some leading pharmaceutical enterprises in Tonghua began to shift to the TCM drugs that are actually able to treat and cure some diseases. The (re)development of the TCM industry during the ownership transformation was blessed with Tonghua's long history of TCM, especially the long-term relationship of the local enterprises with the research institutes and universities formed in the second half of 1980s. Most of the "new" TCM drugs were not totally new in this sense that they were redeveloped from the old-age varieties through incremental innovation, not radical innovation, for example, the dosage form transformation, the changes in components, and the improvement of the quality. Although the redevelopment of age-old TCM formulas is not as complicated as that of new chemical synthesis of drugs, it is also involved with a great deal of technologies. As a result, Tonghua's pharmaceutical enterprises began to foster cooperative relationships with pharmaceutical research institutes and universities in the early 1980s. In fact, both sides of pharmaceutical enterprises and knowledge institutions benefit a lot from the commerical cooperation. The reduction of R&D funding from the state forced scientists to search an alternative financial resource, and the commercialization of research results was encouraged by the state (see Chapter 8.3.2 and Chapter 3.2.3). For the pharmaceutical enterprises, when the competition of ginseng-based TCM market became increasingly fierce in the late 1980s, pharmaceutical enterprises had to turn to scientific cooperation with universities and other knowledge institutions. Though cooperation during the 1980s was not frequent, it offered the important relational platform for the closer cooperation that enterperise and research community developed afterward. More specifically, the privatized enterprises during the early 1990s made full use of early formed personal connections with pharmaceutical scientists in public universities and research institutes to develop new drugs and improve the quality of existing drugs. That shows that the lasting personal connection contributed to transferring knowledge from research instutitions to the pharmaceutical industry.

Entering the new Millennium, formal and organized R&D emerged in the Tonghua pharmaceutical sector, against the background that the Chinese government enforced stricter regulation on the TCM industry and the increasing market competition compelled enterprises to attach more importance to drug safety and effectiveness and even new drug development. Generally speaking, TCM drugs are relatively safe with low toxicity, but it doesn't mean that TCM drugs have no toxicity at all. In order to ensure the safety of TCM drugs, the Chinese government stated in the end of the 1990s that the safety evaluation of TCM drugs should be performed in accordance with Good Laboratory Practice (GLP) standards.

At the same time, some business groups emerged, such as Xiuzheng, Wantong, Dongbao, mostly through mergers and acquisitions. These groups became so financially powerful to build up formal in-house R&D departments, some of which are not located at Tonghua, but at the capital of Jilin province or Beijing. The R&D alliance strategy between enterprises and specialized R&D institutions became common in the Tonghua pharmaceutical sector. Through the field survey, I found that more new products were developed through contractual research or bought from their allied specialized R&D institutions, while in-house laboratories are engaged with process innovation for the improvement of product quality, rather than new drug development.

In addition, we should note that although a few enterprises in Tonghua were involved in bio-pharmaceutical products, it is doubtful to say that the whole cluster will be transformed into a biotechnological cluster in the next decades. In fact, the rapid entry into the biopharmaceutical field is largely blessed with increased financial strength and social networks these entrepreneurs constructed before. To be specific, the dynamic industrial development since the mid-1980s was based on product extension and market expansion and process innovation, not on R&D-based knowledge, but the high-speed growth layd the solid ground for getting financial means for the mergers and acquisitions of local and non-local enterprises, which not only expanded production capacity but also got access to research capacity. To sum up, the stronger and stronger financial base allowed a few Tonghua's pharmaceutical enterprises to get R&D-based knowledge in other regions, which in turn further increased the competitive and comparative advantage of the cluster.

Chapter 9 The Evolution of Institutions in the Tonghua Pharmaceutical Industry

In the previous three chapters, I have already investigated the evolutionary trajectories of firms, entrepreneurs, and technology, more or less in a separate way. In this chapter, I will turn to the remaining population — "institution", and to examine evolution of institutions in the Tonghua pharmaceutical industry. Finally, I will go back to the main theoretical question, i.e. to develop of a coevolutionary explanation of the Tonghua pharmaceutical sector.

9.1 A Multi-Scalar View on Institution

From the previous chapters, we can see that Tonghua's pharmaceutical industry has developed into a nationally renowned industry and that various actors collaborated in this development process. This leads to important questions: who created or coordinated the collaboration, in what ways, and what was the role of institutions in creating this competitive sector in Tonghua. During this development process, both national and local institutions had an influence on Tonghua's pharmaceutical industry, but to a different degree and in different phases.

In theory, institutions interplay at different scales; and as the Tonghua pharmaceutical enterprises grow, we could image that they will have more and more voices in higher level policy-making. In fact, the pharmaceutical entrepreneurs in Tonghua have already had some voice in policy- making, ont only at the local level but also at provincial one. However, the impact of Tonghua's enterprises on higher-level institution making was very weak before 2000, in particular at the national level. Accordingly, Tonghua's pharmaceutical industry is not a good case for studying the bilateral scalar coevolution of bottom-up and top-down relationships, but only for looking at a one-sided scalar (top-down) relationship.

So I will concentrate on the top-down way of the multi-scalar coevolution, by which higher-level institutions affect the evolution of Tonghua's pharmaceutical industry. I will explain briefly which types of institutions were observed in this dissertation, and why local social capital and social connections should be seen as local informal institutions, before I start to examine their dynamic coevolutionary process.

9.2 A Top-down Approach to Institutional Evolution

As mentioned above in Chapter 1.3.2, following North's definition of an institution, I classify institutions into formal or informal forms. At the same time, I made a difference between local institutions and higher-level institutions. In the case of Tonghua, the city and counties are defined as the local levels, while the province and the state are seen as the higher levels. In the previous chapters, I have largely focused on the national level of institutions concerning changes of firm organization and entrepreneurship, technological innovation and registrations on drug and healthcare system as well and then I have examined the influences of these national institutions on the development of Tonghua's pharmaceutical industry (see Table 9.1).

Table 9.1: Mapping the chapters of national institutions

	National level	Chapter	
		National institution	influences on Tonghua
Formal institutions	Enterprise reform and ownership transformation	Chapter 3.2.2 ;	Chapter 6.2; Chapter 6.3; Chapter 7.1.2,;Chapter 7.3
	Science and technology management system	Chapter 3.2.3;	Chapter 8.3
	Registrations on drug and healthcare system	Chapter 3.2.4	Chapter 6.2.4 Chapter 7.3.3;
Informal institutions	The public's attitude toward private ownership	Chapter 3.2.1	Chapter 6.2.3; Chapter 6.3.3 Chapter 7.3;

In the previous chapters, institutions at the national level were seen as external variables to the explanation of the dynamics of the Tonghua pharmaceutical cluster. In this section, I will turn to the local institutions, including industrial policies, local social capital, and social connections. I view local institutions as endogenous variables. It is very important to note that the nation-level institutions can be changed by the lower-lever actors, for example, when the local enterprises have ample strength, or join with other social spheres and other regions' entrepreneurs. It is not surprising that the formal institutions for market transactions (e.g. commercial law) were weak and no one expects them to mature overnight. Thus the entrepreneurs made use of social networks to supplement the weakness of formal institutions. Hence, among several types of local institutions, I will concentrate on the role of social capital, and its Chinese form, in linking firms to technologies and formal institutions. At the same time, I willl take into account the role of national institutions in creating this local sector. The change in institutions in Tonghua's pharmaceutical sector in the reform period is summarized in Table 9.2.

Table 9.2: The institutional changes in Tonghua's pharmaceutical sector during the reform

Table 9.2continued

Institution	Describing the main contents	The influence on Tonghua	Time
Micro-enterprise management reform	"Factory Directors Responsibility System" granted more autonomy to factories. Factories could produce more than the plan quota and sold the surplus to the market, and the extra profit was partly kept by factories.	The reform allowed substantial scope for bargaining between individual enterprises and their supervisory agencies, which allowed enterprise leaders to establish a close relation with local government officials, which provided the relational platform for the following privatization stage.	in the early 1980s
Business-Government relationship	Contract responsibility system	The "red cap" enterprises emerged, the new firm organization shifted to ginseng-based invigorants, which gradually opened up the window of tcm industry again.	in the late 1980s
Fiscal decentralization	The transfer of expenditure responsibilities and revenue assignments to lower levels of government; "eating from separate kitchens",	Local government agencies created own businesses as industrial corporations to ease fiscal pressure	in the early 1980s
Bank reform	Four specialized banks allowed to compete for deposits and loans	Local governments assisted state-owned or collective enterprises in obtaining loans through local branches of state specialized banks	1984
Regulation on TCM	No patent protection No regulation on new drug test Easy to obtain business license Weak regulation pricing and quality inspection	Shift to ginseng production, and gradually opening up of the window of locational opportunity of tcm industry. Continuing entrances of new tcm enterprises gradually intensified competition which led to decreasing and finally vanished monopoly profits so that firms shifted to tcm drugs in the end of 1980s	in the early 1980s
Local industry policy	Tonghua city formally claimed in 1985 for the first time that the pharmaceutical industry should be developed as the key industry	A hotwave of new startups The first generation of Xiahai cards	in 1985
Social capital	Originated in the planned economy, but was strengthened, As a main way to get necessary resources	It contributed to the emergence of new hybrid firms	1980s
Institution	Describing The Main Contents	The Influence On Tonghua	Time

The objective of economic reform	The "Socialist Market Economy" as a clear objective of the economic reform was formally endorsed by Beijing government	The private economy was accepted by social members A huge increase of approximately 30 new start-ups in one year.	1992
Bank loan	Implementation of a rigid loan policy, State specialized banks were transformed into State owned commercial banks, and rigid loan policy began to be carried out	Minimized the local government's influence on loan from banks Firm loans had to be reimbursed. It was very hard for ill-performing enterprises to get loans from banks, which accelerated bankruptcies of loss-making enterprises	after 1995
Financing	Shanghai Stock Exchange and the Shenzhen Stock Exchange	Dongbao Group became listed companies	1990 1991
regulation on TCM	The preparation method and production process became patentable in 1993 Good manufacturing practice in 1992, And good clinical practice in 1999	All new pharmaceutical enterprises must meet the gmp standards at their start, which raised entry barriers for new entrants, and resulted in the stability of the number of pharmaceutical enterprises during this period.	in the early 1990s
downsize the state sector	The "grasping the large and letting the small go" policy gave local governments authority to restructure the firms, privatizing them, or shutting them down	Local political elite (government officials) and economic elite (the state-owned enterprise leaders) became the largest beneficiaries in privatizing state-owned enterprises	In 1997
national innovation strategy	"to build China as an innovation-oriented country" as a new national strategy	New drug development Consolidated cooperation with universities and research institutes	1999
Local industrial policy	" to build Tonghua as Pharmcity"	Improved infrastructure, new startups Xiahao cadres increased	in 1995
Social capital	Both political elite (government officials) and economic elite made use of relational advantage to "take over" state- owned enterprises, and Xiahai cadres became the bridge between government and private enterprises.	Partially helpful to solve social problems such as underemployment, wage arrears, bankruptcies and lay-offs Helpful for the formation of formal institutions (e.g. Pharmcity strategy and encouraging cadres do business)	In the late 1990s

9.3 Social Capital, Guanxi Network as Local Institutions

The concept of social capital began to be used in the 1960s, mainly in the work of Pierre Bourdieu (his first formulation appeared in Bourdieu, 1980, see Trigilia, 2001), a French sociologist,. In the late 1990s, the term became fashionable in various fields (Narayan and Woolcock, 1999, for a history of this concept, see Trigilia, 2001), including economic geography. However, this concept has been subject to a variety of interpretation (see Huang, 2003). Social capital is defined in some literatures as one of the capital forms, namely economic capital, cultural capital, and social capital (e.g. Robinson and Hanson, 1995; Bourdieu, 1986), being regarded as "*the aggregate of the actual and potential resources that are linked to the possession of a durable network of relationship or mutual acquaintance and recognition*" (Bourdieu, 1986, p: 248). In some other literatures, though, it is used as "*the network of relations which binds individual and collective actors, and which can promote co-operation and trust but can also create obstacles to local development*" (Coleman, 1988, p: 118). Furthermore, another reference is made to the capacity for co-operation, to trust (Portes, 1998; Montgomery, 2000), and therefore to a particular form of local culture (Cox, 1995). The different views of the concept of social capital have a common feature that the social relationships can potentially improve the efficiency of economic activities, but also possibly produce negative effects. In other words, trust and common cognition (e.g. the shared vision) that circulate by means of personal relationships might limit opportunism and facilitate economic co-operation (that might be termed a "collective action") for a collective object, either private or public. But social capital or social networks, due to its function of preventing competition, might lead to collusion between actors and therefore discourage innovation in economic fields. The similar viewpoint was put forward by Granovetter (1985), Coleman (1990), and Portes (1998), and was also proven by economic geographers (e.g. Schamp, 2005; Hassink, 2007), although this concept has not been used in their case or theoretical studies.

My motive here is not to make a systematic and theoretical discussion about social capital, but to examine its Chinese form. Chinese business is famous for its use of social networks in business transactions, it is not surprising that in researching China, social scientists have paid much attention to social *guanxi* or *guanxi* network (e.g. Yang, 1994; Tsang, 1998; Luo, 2000). The practice of Confucian ideology, coupled with common social norms, regulate the way Chinese individuals utilize *guanxi* (Standifird and

Marshall, 2000). *Guanxi* as a type of social capital network is a fundamental web of interpersonal relations permeating Chinese societies, and embedded in every aspect of Chinese social life. Chen and Chen (2004) assert that a close *guanxi* may provide more confidence for *guanxi* partners to utilize it for both expressive (affection and trust) and instrumental (business) purposes. *Guanxi* networks are flexible, efficient, available, and low in financial cost (Standifird and Marshall, 2000).

Powerful social networks matter a great deal in the formation and development of Tonghua's pharmaceutical industry. Just like the Third Italy, the Tonghua pharmaceutical industry is historically a very small community with social cohesion. Before the mid-1990s, most participants were local residents. Those entrepreneurs and government officers who are now active in this sector were local residents, and most of them have lived there for their whole life. They tended to attach much importance to traditional loyalty based on regional origins. Owing to the long-term living together, and close workplace ties, participants are considerably loyal to colleagual networks and extended family and kinship networks.

Networks of blood and kin played a special role in overcoming the absence and lack of supporting conditions, such as financial resources and venture capital during the transitional period. Because of the state monopoly on the financial sector, private start-ups had very limited channels of raising capital. The vast majority of entrepreneurs in the Tonghua pharmaceutical industry raised funds from extended families and kinship networks when they prepared to run their own private entities. At the same time, the extended family networks served to relay important information, such as information about business opportunities. Furthermore, the venture partners during the start-up phase were chosen, firstly, from the extended family and kinship networks, and then from the colleagual networks. Even in today's pharmaceutical business groups in Tonghua, some key positions are still occupied by family members.

Though a colleagual network cannot be equivalent to an extended family network, it is active and useful. Because of weak formal institutions, for example, uncertain property rights, weaker intellectual property protection, strong colleagual networks, colleagual networks became a strategic mechanism to promote access to economic resources, reduce risk or disadvantages by cooperating and exchanging favors. Strong colleagual networks could deal with bureaucratic rigidities, material scarcities and personal political insecurities throughout the Communist period and so entrepreneurs were able to rapidly handle changing markets, transmuting institutions, and personal economic insecurities in the post-Communist period (Wellman et al., 2002). Strong kinship and colleageship-based relational networks also allowed entrepreneurs in the Tonghua pharmaceutical industry to effectively reduce environmental uncertainty (especially in politics), lower transaction costs, and provide useable resources during the transitional period. This is why so many private pharmentrepreneurs in Tonghua are former state enterprise leaders and government officials who had closer colleagual networks with local leaders in various fields of this industrial community, and why the entrepreneurs invested so much in fostering and maintaining various relational networks.

According to the functions of guanxi, we can classify Chinese guanxi forms into three types: The first one is production-related guanxi network (links to suppliers, product users, business partners, universities), the second one is environment-related (links to local political decision-makers); the third one is market-related (general customer relations built through marketing, trademarks, clubs).

9.4 The Evolution of Local Institutions

9.4.1 Institutions Prior to 1978

The local government was the first driving force to the first generation of pharmaceutical enterprises. As illuminated in Chapter 6.2.1, the first generation of pharmaceutical enterprises in Tonghua mainly consisted of small state-owned or collective firms, which means that the Tonghua pharmaceutical industry in the traditional planned regime was monopolized by publicly owned enterprises, and all entry and exit decisions were made by local governments. The first and direct pusher of the emergence and growth of pharmaceutical plants in the early phase was local government, not central government, playing the role of financial investor and the ultimate decision maker concerning important events and the mobility of enterprise cadres. Additionally, local government provided the necessary social services to its employees and their families, including housing, healthcare, child care, and education, to name but a few. In some sense, the creation and development of local publicly owned enterprises were local major political- economic issues (Perotti, et al., 1999), and the management of those enterprises was part of a large governmental system.

The enterprise cadres as representatives of local government managed enterprises in the traditional planned economy. Since economic performance of the enterprises under their leadership was highly associated with their personal promotion, the state-owned enterprise cadres usually sought financial and human resources in virtue of personal relationship *(guanxi)* with local government. This investment from local government fostered the close relation between local government and firms during the early stages of industrial development. This close collaboration between enterprises and local government, which originated in the planned economic period, has laid a relational platform for the formation of local social capital. I will explain this aspect later on.

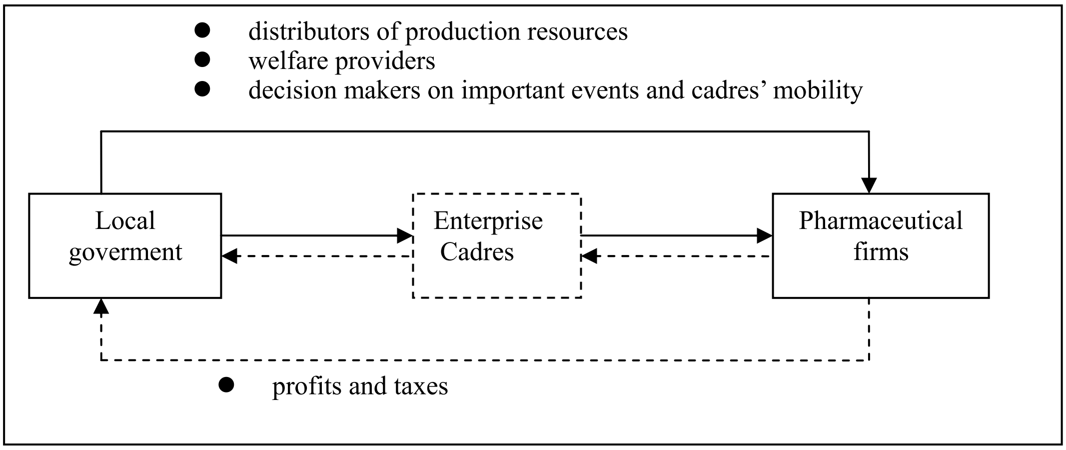

Figure 9.1: Local interaction between government and firms

Note: The solid-line arrow denotes a strong influence, while the dashed arrow represents a weak

Due to being tightly constrained by the rigid planning economic system, the pharmaceutical industry in Tonghua developed relatively slowly before the 1980s, in terms of economic performance (see Figure.9.2). A huge economic success was achieved in the pharmaceutical industry in Tonghua after the micro-management institutional reforms. To be specific, since 1978, especially after the introduction of the contract responsibility system in Tonghua around 1988, Tonghua's pharmaceutical industry had been growing. Industrial output, sales and profits in 1988 reached RMB 544.6 million Yuan, RMB 338.34 million Yuan, RMB 76.43 million Yuan respectively. The industrial output value of the pharmaceutical industry in Tonghua accounted for 33.9% of Tonghua's gross industrial output value. This means that the pharmaceutical industry was a major pillar of the economy in Tonghua city since that time. Among its sub-regions, Tonghua County's pharmaceutical industry was placed in the forefront, with the output value of RMB 113.307 million Yuan in 1988 representing 43% of the county's total industrial output value, RMB 264.144 million Yuan (Cao, 1999, p: 22).

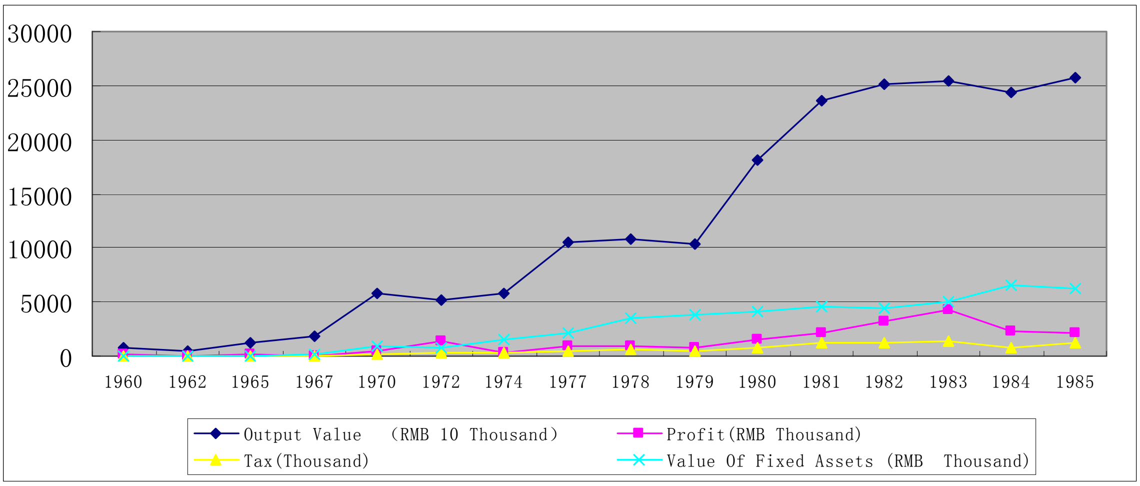

Figure 9.2: The economic performance of Tonghua's pharmaceutical industry (1960-1985)

Source: Cao, 1989

9.4.2 Institutional Change in the Early Reform Period

Entering the 1980s, local governments in China were faced with financial pressure, so local government agencies set up businesses to ease their financial situation. At the same time, the regulation on the enterprise ownership became somewhat relaxed, and a new type of firm organization (contracted firms) emerged. These market-oriented firms had to invest in establishing social capital in order to compete with rivals (e.g. SOEs) for the necessary resources and market. Thus, the relation between firms and government in the early reform period was reinforced, which contributed to the formation of some local policies favorable to this growing industry (e.g. to develop the pharmaceutical industry as the key industry in 1985) and informal institutions. The coupled interaction was increasingly strong partially because the dramatically changing macro-institutional environments (for example, the national fiscal reform, the micro-enterprise management reform and the regulation on TCM market) produced the external driving force of strengthening their links. The closer relation was useful for both parties of local government and firms, which is the internal driving force. In other words, the change of the macro-institutional environment forced governments and firms to work together in order to cope with the new circumstances. Here, I will explain the formation process of local government-business relationship in the early reform period.

Two influential events happened in the early 1980s. The first one was the fiscal decentralization and bank reform, which changed the way of enterprises' financing. The introduction of a new fiscal policy (under the nickname of "eating from separate kitchens", fenzao chifan) altered the traditional central-local fiscal relations and motivate regional governments to develop the regional economy with greater enthusiasm. Under the old fiscal system, "unified revenue and unified expenditure" (tongshou tongzhi), all government revenues and expenditures were under the tight control of the central government (for a detail history of the fiscal decentralization, see Qian, 1999). However, the new fiscal system allowed the central-local sharing out of revenues to be fixed for several years in advance and earmarked the profits of local enterprises as local revenues (Shirk, 1993; Hubbard, 1995). Hence, fiscal decentralization granted sub-national governments more authorities and incentives to promote the local economy because regional government can retain part of the revenues they produced. In addition to the financing of enterprises, since 1984, the State Council allowed four specialized banks[50] to compete for deposits and loans in previously monopolized markets, so enterprises were allowed to open accounts in more than one bank. The economic performance of the branches of specialized banks was highly associated with the local economy in which they operated. So, the specialized banks were energetic to replace the government and provided loans to SOEs. At the same time, the local government executed more or less influence over banks' credit decisions.

The second influential event was that the scope of the administrative jurisdiction of the Tonghua prefecture was reduced in 1985, since Hunjiang City was separated out. The rest of the former Tonghua prefecture comprises today's Tonghua city (see Figure 5.1). The reduction of jurisdiction scope implies a significant reduction in local government revenues. Accordingly, the Tonghua government had to find other methods of gaining public economic income. The rapid growth in the TCM industry made it become a first choice. After the policy reforms and opening up in 1978, in particular after the implementation of the "micro-enterprise management reform" around 1984 in Tonghua (see Chapter 3), the pharmaceutical industry in Tonghua had developed rapidly in terms of new firm number and economic performance (see Figure.9.2 and Figure 6.1). By the end of 1985, the number of pharmaceutical factories reached 18, employing 6,590 persons, with a total output value of 149.93 million Yuan, and profits of 19.02 million Yuan. In addition, the market of ginseng-based tonics boomed across China during the early 1980s. It is also worth of being noted that, in the 1980s, the Chinese

[50] In China, the People's Bank of China (PBOC) served both as the central bank. There are four specialized banks: the Agricultural Bank of China (ABC) for the rural sector; the Industrial and Commercial Bank of China (ICBC) for the industrial sector, the People's Construction Bank of China (PCBC) for long-term investment, and the Bank of China (BOC) for foreign exchange business.

central government began to implement weaker regulations on TCM which made it easier to obtain a business license. To a large extent, Tonghua's success in pharmaceutical industry, especially in ginseng-based tonics, also attributed to the unique opportunities created by China's weak regulation on the pharmaceutical market (beside the above mentioned license, pricing and quality inspection). A large number of TCM enterprises was established and then reaped monopoly profits. It is estimated that for these early entrants, the average rate of net profit on capital was 70 percent and the total rate of profit and tax per unit of capital was 40 percent. Continuing entry of new TCM enterprises gradually intensified competition which decreased profits. However, the huge profits in the early 1980s and early 1990s greatly contributed to the takeoff of TCM sector. Faced with a huge market and high returns, in addition to the increased fiscal pressure owing to the fiscal deconcentration, Tonghua city formally claimed in 1985 that the pharmaceutical industry should be developed as the key industry. This industrial strategy was very early, compared to other TCM regions. The firm's organizational forms and the factory management system changed in the early 1980s, which was highly connected with institutional changes on the national level. The changes of national institutions created an institutional space for the Tonghua government to open up the window of the ginseng-based TCM sector. In fact, the national institutional adjustments gave other TCM regions (at least in North-eastern China) an equal opportunity to revitalize the TCM sector, but merely a few regions including Tonghua city developed into the nation-wide famous TCM industry bases. The reason for this lays in local factors, in particular, in the continued local institutional innovation. The activation of local entrepreneurship, the construction of local industry-specific social capital, and sustained innovation of local industry policy together contributed to the industrial success of the early phase, which allowed Tonghua city to gain a first-mover advantage.

The "Factory Directors Responsibility System" allowed substantial scope for bargaining between individual enterprises and their supervisory agencies, in the setting of output and quality targets (Hubbard, 1995). But it is noteworthy to say that the enterprise leaders (factory directors) at that time bargained with local governments or supervisory agencies, not directly for themselves, but for the sake of the factories they were working in. In the following reform phase of privatization, entrepreneurs of contracted enterprises also bargained with the governments, but for their own benefits, which I will explain later on. I would like to say here that the early bargain and long-term colleagueship with local governments made the enterprise leaders establish a close relation with local government officials, which provided the relational platform of their smooth taking over of those enterprises in the privatization stage.

I focus on the early reform stage here. The “Contract Responsibility System” in the late 1980s not only increased factory director’s (or manager’s) autonomy over production and staffing, but also motivated staff by linking their income to negotiated performance targets (Byrd, 1991, p: 10-11). In short, the fiscal decentralization and reduced administrative jurisdiction placed much fiscal pressure on local governments and the local state thus had to create new rural enterprises or improve the firm’s economic performance. These were mainly needed to provide revenues for local public goods, such as schools, health care, utilities, price subsidies, urban development, etc. At the same time, the newly established enterprises could increase income and offered job opportunities for the families, relatives and local people (Byrd, 1990, p: 199). The introduction of the “Factory Directors Responsibility System” made factories reinforce communication and contacts with local government for enterprise’s interests, such as tax reduction. Here I will examine in detail why and how local government and pharmaceutical firms began to consolidate the long-lasting alliance between business and government, which nourished the growth of this local sector.

This positive mutual interaction between individual enterprises and the local state has been favorable for both sides. On the one hand, the local state assisted to firm development not only through being involved with the creation of new firms, the management and disposal of firm assets, but also through gathering information, making connections with potential customers, pulling in production subcontracts and using its connections to acquire loans from national banks, and so on (Walder, 2003), as what some scholar termed “local state corporatism” (Lin, 1995; Oi, 1992) or “industrial firms”(Walder, 1995, 1998). The firm growth and industrial development should bring the above mentioned benefits to local governments (increased fiscal revenues and employ opportunities). On the other hand, because of the lack of universally applicable rules for allocating economic resources in China’ transition to a market economy, enterprises had to place a great deal of time and energy to bargain with local governments (Tidrick and Chen 1987, p: 198-9), mostly for gaining more resources and reductions of taxes. Nee (1992, p: 3) defined local corporatism as a “*loosely coupled coalition between local government, financial institutions, and firms (collective and state owned) aimed at promoting market-oriented growth*.” The business-government alliance was a locally efficient solution to the problems of partial reform and weak market institutions, although it might have exacerbated overall inefficient resource allocation. In sum, the decentralization of enterprise management and fiscal authority forced individual enterprises and local government to go together and started the tradition of bargaining between both sides (Hubbard, 1995, p: 342).

The “red cap” enterprises which emerged during the late 1980s and the early 1990s consolidated this government-enterprise coalition. The “red cap” enterprises can be viewed as “safety nets”. They did business according to the market mechanisms, namely, they raised founding capital, and then sought raw materials, and most importantly, reacted not to the government’s order, but to the rise and fall of demand and prices in the market. They had to response to the changing environments in the transitional context, especially the moving national-scale institutions where the support of a well-specified structure of property rights and effective autonomy were absent. Therefore, they turned to personal ties (for example kinship, colleagueship and friendship) with local government officials rather than making legal contracts in order to ensure that the parties would fulfill the terms of transactions (Yang and Li, 2008), and avoid political or life risks. In addition, because the contract was mainly based on negotiations between contractors and supervisory agencies, the “red cap” entrepreneurs relied more on personal connection with government officials. At the same time, the economic improvement of loss-making enterprises could be helpful for supervisory agencies.

The high profit in the TCM sector lured a number of entrants into the pharmaceutical industry. During the period of 1988 to 1992, the government agencies at the levels of counties, cities and districts established a great deal of pharmaceutical plants through joint and independent investment. This kind of semi-official enterprises became the bridge linking various government agencies to local pharmaceutical industry, and these agencies supported the development of this growing sector. A clear evidence is that due to direct interventions by government, a large quantity of loans from banks flowed into pharmaceutical enterprises, being used to start new enterprises and to expand the size of the old ones. Although most of these companies went bankrupt or were privatized in the following years, they were helpful to form the business-government collaboration in Tonghua’s pharmaceutical industry.

9.4.3 Institutional Change in the Late Reform Period

The reform before the 1990s was “groping for stones to cross the river” (in Chinese, mozhe shit guohe), while the overall goal of the economic reform became clear step be step after Deng’s southern trip in the spring of 1992 (for this history, see Qian, 1999). “The Establishment of a Socialist Market Economic Structure” was finally adopted by the Third Plenum of the Fourteenth Party Congress in November 1993. The clear objective of the economic reform and formal endorsement of private economy greatly pushed the Tonghua pharmaceutical industry, and the number of pharmaceutical enterprises in Tonghua leaped from 27 in 1991 to 56 in 1992, with an increase of approximately 30 new start-ups in one year. The market–oriented economy and the business-friendly supporting institutions had been built up since 1994. Besides the unemployment insurance system for laid off workers, the capital-market oriented financial system was constructed. To be specific, the public fiscal system was moved to revenue transfers based on a fixed formula rather than bargaining, the Shanghai Stock Exchange and the Shenzhen Stock Exchange were established successively in 1990 and 1991, and the public issue of “stock subscription cards” was a symbol of China's joint-stock reform, after which the stock market grew up at an unprecedented speed.

As regards regulation on the pharmaceutical market, the Chinese government relaxed the administrative regulation on pharmaceuticals production before the 1990s, when a large number of pharmaceutical plants were run without production licenses, and a mass of fake and shoddy drugs flooded into the market. The number of cases about fake and shoddy medicines increased continually, from 17,000 in 1992, 24,500 in 1993, to 41,700 in 1994. In order to cope with the deteriorating pharmaceutical market, many attempts have been made since 1992, including the revised patent law in 1993. The revised patent law expanded the scope of protection, and biomedical products and the preparation method and production process became patentable.The standards of Good Manufacturing Practice (GMP) were introduced in 1992, and of Good Clinical Practice (GCP) in 1999 (see Chapter 3.2.4). According to the GMP policy, all new pharmaceutical enterprises must meet the GMP standards just at their start, which undoubtedly raised entry barriers and resulted in the stability of the number of pharmaceutical enterprises during this period.

The national institutional environment was characterized by weak capital structures, ambiguous property rights, and high institutional uncertainty as well as imperfect market information during this period. At the same time, local governments and firms further consolidated the long-lasting mutual coalition. Firstly and the most importantly, these "red cap" entrepreneurs increased their responsiveness and flexibility and seized the market opportunities of strong demand for the tonics during the period between 1980 and the 1990s, and the hybrid firms could not only provide economic benefits (e.g. taxes), but also nonfinancial needs for the state, maintaining full employment, and funding housing and social services for their employees. As a result, the creation of hybrid firms was encouraged by local governments. Secondly, the fiscal pressures on all levels of sub-national governments caused competition among regions across China. The faster the local industries grew, the faster local revenues would grow. As the regulation on bank loan relaxed in the early 1990s, especially from 1992 to 1995, government officials pursued too much their "political achievements" and encouraged the firms to borrow a lot from banks. However, centralization of the operation of the central bank and the specialized bank reform minimized local government's influence on bank loaning after 1995, meanwhile firm loans had to be reimbursed. Due to a substantive debt burden brought about by irrational investment, together with uncompetitive products and increasingly fierce market competition, a large number of SMEs came into financial crisis. Local officials had to search new methods to revitalize those poor-performing SMEs. Just at that time, the Beijing government encouraged the ill-managed SMEs to be privatized. Local party-state cadres and enterprise cadres took advantage of their closer relationship with local states to "take over" the poorly managed SMEs.

Moreover, although the economic performance of SOEs had been improved more or less during the enterprise management reform, state-owned pharmaceutical factories in Tonghua as a whole were less competitive, as compared to their non state-owned pharmaceutical competitors (e.g. contracted firms or newly established private enterprises). A great number of small-sized SOEs suffered from losses and came to the verge of collapse entering the 1990s. Furthermore, these small-sized state-owned pharmaceutical enterprises in Tonghua could not get special protection from the central government, because they were actually on a list of "letting the small go". As the economic reform processed, underemployment, wage arrears, bankruptcies and lay-offs in this local sector were becoming more common. Most workers in the SOEs were employed on contract terms and hence no longer entitled to the "iron rice bowl" protection during the experimental initiation of shareholding enterprises. As a result, employment and social stability became the primary task for local governments. Under such circumstances, Tonghua's government responsed to the Beijing government's policy of privatizing SMEs and then encouraged private entrepreneurs, most of whom were the owners of contracted firms, to "take over" these enterprises, in order to provide more job opportunities for local residents.

In addition, this region has suffered a considerable decline in most traditional industries, such as textiles, chemicals, machinery, and metallurgical industry, in terms of employment and economic output entering the early 1990s. It was high time for Tonghua to make a new strategic plan for the future economic and societal development. In the year of 1995, the local government proposed the grand and historic strategy of "To Construct the Pharmaceutical Industry City" (Pharmcity), which undoubtedly promoted the development of the pharmaceutical industry in Tonghua. This influential strategy could be regarded as a result of the long-lasting "government and pharmaceutical enterprises cooperation" during the new period. Benefiting from the ideological liberation and lured by expected high returns from this golden industry, some of the new small and medium-sized pharmaceutical companies were set up, meanwhile some Tongua pharmaceutical enterprises (especially 'rep cap' ones) started to restore economic vitality and gradually grew up. By 1994, the number of enterprises reached 47. The Tonghua pharmaceutical industry as a whole showed a stable growth trend. A group of economic and political elites (enterprise cadres and government cadres) also joined into the sunrise industry as private owners or senior professional managers in Tonghua city. They played an important role in forming local formal institutions such as the Pharmcity strategy and informal industry-specific institutions such as social networks (see Chapter 9.5).

As a matter of fact, besides the pharmaceutical industry, some other newly developed industries grew significantly at that time as well, for example, the food and wine industries. But no industry had more party-state cadres than the pharmaceutical sector. Due to the day-to-day interaction between entrepreneurs, in addition to the rapid development of the pharmaceutical industry in terms of firm number and economic output, Tonghua city government attached more importance to the pharmaceutical industry, and formally made a great decision to build Tonghua into "the city of pharmaceutical industry" (Pharmcity) in 1995. This was the first slogan of building a Pharmcity in China. Similar strategic initiatives to establish (bio)pharmaceutical bases were launched by other regions in China after 2000. Given increased competition among regional governments on economic revenues, the Tongua government increased investment in physical and skill infrastructures like transport, general educational institutions, technical and managerial training centers. These all together have greatly helped the industry to grow. To sum up, the strategy of building Pharmcity was the result of the longstanding interaction between local government and pharmaceutical enterprises, and this in turn consolidated the mutual coalition between both parties. A similar collaboration can be seen in other cases, for example, the BioCity of Turku, Turku, Finland (Höyssä et al., 2004). This shows that sound longstanding business-government relations will be helpful for the gowth of industries, at least in the early phase of the industry life cycle.

After the privatization stage, the Beijing government launched a new national strategy, "to build China as an innovation-driven nation". A major element of its strategy is the building of an enterprise-based innovation system. China improved the enforcement of intellectual property rights protection to increase the propensity of firms to innovate. At the same time, Tonghua's government changed significantly the role in promoting this emerging industrial cluster, from previous industrial investors in the planning economy and the coordinator of the privatization of state-owned enterprises in the transitional period, to the planner of industrial development and facilitator of innovation. Apart from the conventional measures that are often-seen in promoting an industrial cluster (for example, encouraging cooperation and dialogue between local actors including enterprises and local universities, between enterprises), the Tonghua government often invited a number of non-local university professors to Tonghua to offer professional training to SMEs both in technology and management. The attemps made by local government maintained to some extent the competitive advantage of Tonghua's pharmaceutical industry.

9.5 The Role of Xiahai Cadres After 1995

The Xiahai cadres were a very special group of political elites who previously worked in local government agencies, and afterward in the pharmaceutical industry as employees not private owners. Here we should note that Xiahai Cadres are different from government officals entrepreneurs I described in Chapter 7.2.3 and Chapter 7.3. These ex-government officals replaced the role of previous enterprise cadres who could move amongst spheres of government, state owned enterprise in the command economy (see Chapter 7.1.3) and then became a new "bridge" in the market-oriented economy linking the local state to private pharmaceutical enterprises in Tonghua. This bridge contributed a lot to the formation of local institutions favorable to this sector. Thus, I will try to discuss how far and in what way this special group of former government offficals promoted Tonghua's pharmaceutical sector.

9.5.1 Xiahai Cadres in the Tonghua Pharmaceutical Cluster

The relatively successful transformation from a poor SOEs-dominated pharmaceutical economy to a highly competitive private one benefited a lot from and at the same time also strengthened the local mutual government-enterprise coalition. It is a commonly accepted viewpoint that the local government was the dominant actor who controlled to a great degree the process and ways of ownership reforms because of the absence of the universally applicable practices for privatizing SOEs in China. Without the local longstanding and sound collaboration between enterprises and government, Tonghua city would not have today's social stability, not to mention the outstanding economic performance of its pharmaceutical sector. It was the business-government collusion that contributed to the local government's taking timely and appropriate actions in the restructuring of state-owned enterprise and transforming into the private pharmaceutical economy. It was the Xiahai cadres that became a new "bridge" linking local governments and private firms and maintained and enforced the business-government partnership in the Tonghua pharmaceutical community.

Xiahai is a metaphor of jumping into the (commercial) sea[51] and means the phenomenon of people giving up their "iron rice bowl" jobs to start their own businesses or going to do business. Thus, Xiahai cadres refer to a special group of government cadres who quitted admirable jobs and "jumped into the commercial sea" (Xiahai). In the strict sense, Xiahai cadres consist of two spheres, one is the group of cadre entrepreneurs who have worked in government but now have their own pharmaceutical entities, and the other is the group of professional managers who were alsogovernment officials in the past but are now working in this growing cluster as senior managers, not as founders or owner. According to incomplete statistics from a relevant government agency in Tonghua city (the Organization Department of the CCP of Tonghua City Committee that is in charge of party-state cadres), a total of 141 officials signed their government jobs off and went into business (Table 9.3). The statistics also show that 80 percent of these former officials joined in local private

[51] In Chinese language, the commercial market was compared to the vast sea in which one had to swim or sink.

pharmaceutical firms. Although accurate data are not available, we have reason to believe that this number of Xiahai cadres is constantly expanding as this cluster develops. Now, a great deal of former local government officials, from the former mayor to general government employees, is presently engaged in pharmaceutical enterprises in Tonghua city.

9.5.2 The Reasons of Government Officials Going into Business

The early 1990s witnessed the mushrooming of administrative talent moving in Tonghua, which resulted partly from the Southern Cruise of Deng Xiaoping in 1992, which brought forth the famous declaration that “Development is the cardinal principle” (fazhan jiushi yingdaoli). Since then, China’s economic reform speeded up the ownership transformation. Sagacious government officials became aware of the coming of the golden era of China's unprecedented rapid economic development, and some far-sighted officials in Tonghua left the government and swarmed into the private economy by setting up their own business or working in private enterprises as senior managers (see Chapter 7.3).

Tonghua has encountered a rapid growth in the pharmaceutical industry after the historic strategy of building Pharmcity in 1995, bringing economic and social prosperity. From 1996 to 2000, the number of newly founded pharmaceutical companies jumped from 45 to 64. These new businesses required more human resources, in particular senior managerial personnel, and therefore provided large space for government officials to seek the second career success different from that in their previous political life. Consequently, most of the cadres going into business flooded into the high-return pharmaceutical industry. With the increase of the number of new start-ups and the expansion of existing enterprises, competition grew brutally and in turn required more administrative talents to join in the sector.

Probably the human resources market was underdeveloped, Tonghua’s pharmaceutical companies usually sought for senior employees with strong capability of coordination and management through personal relationships. Government officials are a group of social elites who have a higher level of education than local residents. Since the entrepreneurs and government officials have lived in the same place for a long time, a “small industrial community” full of trust was formed, and local entrepreneurs and party-state cadres have an in-depth understanding of each other. Therefore, pharmaceutical companies were more willing to hire those trustworthy government officials. The pharmaceutical industry in this mountainous area acquired a nationwide reputation as one of the top pharmaceutical industry bases, which attracted a great deal of local government cadres to this sunrise industry.

There are basically three subgroups of party-state cadres who are working in the pharmaceutical industry. Firstly, some party-state cadres realized that it is difficult to get further promotion in their political career (due to the age limit for a corresponding level position in China), and then went into “the commercial sea”. The proportion for this subgroup is only about 10% of the total. Secondly, the former officials who had not yet reached full retirement age (60 for men and 55 for women) retired in advance in the case of already having served for the government for 30 years. For example, Shudong Liu retired at his age of 54 in 1997, and then worked in Wantong Group as a senior manager, in charge of production site construction and logistics. This group accounts for 24 percent of the total of the Xiahai cadres. Finally, some officials were assigned by the local state to assist private enterprises as advanced managers. This subgroup accounts for 64% of the total. However, my field survey shows that most Xiahai officials and cadres are employed by private enterprises, while a small number of them are self-employed, namely, they established usually small-scale but independent private businesses, especially after the compulsive enforcement of GMP policy. This perhaps reflects that after the GMP policy, the pharmaceutical market was strictly regulated, market competition therefore became intensified and the entry barrier was increased within this local sector.

Table 9.3: Former government officials in business by July, 2003

Industrial field	Pharmaceutical industry	Others	
	About 80%	20%	
Age	<35	35-55	≥56
	9 (6.4%)	119 (84.4%)	13 (9.2%)
Level of social duties in local government	High	Middle	Low
	3 (16.3%)	44 (31.2%)	74 (52.5%)
Form of moving	Voluntary resign	Retirement in advance	After off-the-job
	16 (11.3)	34 (24.1)	91 (64.6)

Source: the Organization Department of the CCP of Tonghua City Committee

Note: One year later, by 2004, the number of Government Officials in business areas in Tonghua city increased to 195, with an increase of 8 at the divisional level and 66 at the sectional level.

9.5.3 The Effect of Government Officials Going into Business

Although this phenomenon of government cadres' going to business was not unique to Tonghua and can also be observed in other places in China, the phenomenal quantity and density of Xiahai cadres were rarely seen in other pharmaceutical regions across China. In the transitional China, this phenomenon of a large number of government cadres' Xiahai only happened in China's coastal regions, the most active entrepreneurial areas in China. This seems to mean that the place hosting a great deal of former government cadres can be considered as an entrepreneurial area.

Xiahai was epoch-making and had a far-reaching effect on the development of this pharmaceutical cluster. First of all, cadres' going into business broke the traditional official-oriented values (guanbenwei) to some extent, which is helpful to nurture and cultivate an entrepreneurial culture that promotes social atmosphere friendly to private economy. Xiahai played an essential role in breaking the traditional Confucian thinking of official-cored values and in encourageing people to pursue material wealth. A remarkable evidence is that there were 13,596 party-state cadres in Tonghua at the start of the nineth five-year plan (1996-2000), while this number was reduced to 11,075 by 2003, with a decrease of 18.54%. Some of these former officials engaged in the local pharmaceutical sector.

Secondly, the former party-state cadres joining the pharmaceutical industry upgraded the management capability of the overall industry. For example, under the lead of Liu Licheng since 2001 (the former leader of the Tonghua City Planning Commission), Tonghua Golden-horse Company grew up from a heavily loss-making enterprise to a local highly competitive one.

Thirdly, these former government officials brought personal relationships accumulated over the years in the bureaucratic system of government to their present work units, which solved difficult problems the enterprises were faced with. It is very normal that those who were previously government officials are more likely to get access to bank loans and to secure an adequate production site, taxes, and fees than those without state employment backgrounds.

Lastly, because this group of former government officials in Tonghua's pharmaceutical industry has had a strong and lasting colleagueship with the current local policy-makers, they had an unignorable impact on the formulation of local development policies. In fact, when the current government officials make some policies, they tend to consult these former government officials in the Tonghua pharmaceutical industry about how to further promote this sector.

Chapter 10 Conclusions

In the previous four chapters (Chapter 6, 7, 8 and 9) I have examined the evolution of firm organization, entrepreneurship, technology and institution during the emergence of the Tonghua pharmaceutical industry in the context of Chinese transition. These observations demonstrate that we have difficulties in identifying the nature of the emergence of industrial clusters in transitional countries. Institutional fuzziness and diverse trajectories in Tonghua's pharmaceutical industry during China's transition limit the applicability of the existing theoretical and conceptual arguments in literatures on industrial clustering that are largely based on the reality of Western countries. What seems to be clear, however, is that those existing theoretical arguments do not fit China's reality. Subsequently, I try to go back to the theoretical issues listed in Chapter 1.2 and to draw a conclusion on the co-evolution of firm, technology and institution on the level of an industrial cluster.

10.1 The Evolution of Tonghua's Pharmaceutical Industry in Comparative Perspective

From the observations I described in the previous four chapters, we can find that there are some differences in the formation mechanisms of industrial clustering between transitional countries of the former communist economy and mature capitalist countries such as North America and Western Europe. For the formation or emergence of industrial clusters in North America and Western Europe, a new technological breakthrough is mostly held responsible for the rise of 'new growth' regions, just as Detroit (the standardized car in the early 1900s), Santa Clara County/Silicon Valley (the semiconductors in the mid-1950s), Boston/Route 128 (the minicomputer in the early 1980s) etc. In studying these Western industrial clusters, some factors associated with knowledge production and distribution and proliferation would be at the centre, for example, closer proximity to knowledge institutions, the presence of cutting-edge technology, and the mechanism of spin-off and so on. At the same time, geographical proximity enables potential favorable innovation, but not in the deterministic sense (for this point, see Boschma, 2006). Social factors and local institutions that nurture local friendly entrepreneurship and interaction between related actors were also emphasized, such as the local synergy or collective action between firms and the resulting collective efficiency, 'club' culture, etc.

It is also notable that the arguments based on the experience of industrial clusters in Western Europe and North America in which the technological life cycle has more importance cannot offer sound explanations for the formation of industrial clusters in transitional nations from a centrally planned system to a market system. In these transitional nations such as Eastern Europe and the former Soviet Union, and China, huge fundamental institutional changes have a more powerful impact on the nation-scale and local industrial evolution. This transition to a fundamentally different economic system gave rise to various changes, including the ownership, the redistribution of economic power between the different levels of governments, the entrepreneurship cultivation and the construction of market-supporting institutions. Of course, there is also a big difference inside transitional countries which I will explain in Chapter 10.2. Although China is also facing huge challenges, China has made great economic achievements in the short time span of 30 years after the implementation of the economic reform in 1978 (see Chapter 1.1). In the last three decades China has undergone a comprehensive political and economic transition from a socialist centrally planned to a market economy. Fundamental changes in the institutions and the economic structure have gradually created the pre-conditions for sustainable economic growth.

The successful transformation of Tonghua's pharmaceutical industry is reflected in China's gradual integration into a market economy. The evolution of Tonghua's pharmaceutical industry has some remarkable features, as compared to its Western counterparts. The main feature is that Tonghua's pharmaceutical industry cluster is currently at an early, still immature stage, with a low level of R&D-based technology. The low capability of developing new drugs is connected to the past "production-oriented" not "R&D oriented" S&T policy. On the contrary, the worldwide top (bio) pharmaceutical industries clusters are based on cutting-edge technology and knowledge which has been accumulated over a long time, and they always dominate the market in the global patented drugs. In the case of the TCM industry, China faces big challenges particularly from Japan and Korea. Accordingly, as far as the formation mechanism is concerned, the Tonghua pharmaceutical cluster is different to a large extent from its foreign counterparts. In Western countries in which the environments of national fundamental institutions (e.g property rights and intellectual property) are well developed, technology is a first and major driving force of the development of an industrial cluster, but institutional innovation is of much more importance for China.

However, for the Tonghua pharmaceutical sector, the impetus is complicated and at least the following factors should be included. Firstly, institutional changes, including the ownership reform of SOEs, and fiscal decentralization, the financial institution reform (for example, bank loan policy adjustment and the formation of stock exchange), and local formal and informal institutions (for example, the Pharmcity strategy in 1995, the formation and consolidation of a local collaboration between government and firms); Secondly, technological advances (for a summary of the technological evolution in this local sector, see Chapter 8.6 and Figure 6.5), from imitation-based learning (in production technology) to new drug development, which was accompanied with the change in the science and technology management system and involvement of higher education institutions that provided well educated employees and did cooperative research with the industrial enterpries; Thirdly, the formation of local entrepreneurship (for a summary of the technological evolution in Tonghua case, see Chapter 7.4 and Table 7.3), which can not only be attributed to changes in nation-scale institutions (e.g, the private economy was accepted by China's society, and the ownership reform), but also to changes in local social culture and social capital.

From the above analysis, the most important factor that influences the evolution of an endogenous industrial cluster in transitional countries such as the Tonghua pharmaceutical industry is not technological change, at least not the most imporantly, but changes in fundamental national institutions such as the property rights system, and the resulting changes in informal institutions on the national level, for example, s social acceptance of of private private enterprises. Tonghua's success in the pharmaceutical industry can be ascribed to the formation of local private entrepreneur-friendly institutions and cooperation between local government and pharmaceutical firms, both of which originated in the planned economy. The construction of these favorable factors is a time-consuming social process that required intensive participation of various social actors. From this aspect, we cannot easily understand the formation and evolution of a (endogenous) industrial cluster in transitional countries without a systematic social perspective. This means that when we study an industrial cluster in countries in transition from a former socialist towards a freer market economy (Eastern Europe and Central Asia), we should take seriously the changes in basic national institutions and the resulting changes in social ideology and attitude to private economy, rather than only technology. Of course, we have good reason to believe that when the national institutions will be well-established and transparent and property rights and intellectual property rights can be well protected, technology will become an increasingly important factor in economic and social development. In fact, the economy of transitional countries, including China, has begun to rely more on technology rather than on the breakthrough of fundamental institutions. In the case of Tonghua or China's TCM industry, I can imagine that how far Tonghua's pharmaceutical industry, like all TCM industrial clusters in China, will progress in future, will largely depend on its technological capability (and international market access; perhaps Africa and Asian countries could be the targeted regions of outward investment and marketing for China's TCM enterprises). Considering that Tonghua city itselfy is not a knowledge-intensive area, the further advance of its technological capability will perhaps be mainly based on "buy-in", contract research, and mergers and acquisition as well, just as Tonghua's pharmaceutical giants have recently acquired new drug development technologies (see Chapter 8.5).

10.2 Path Creation Based on Initial Conditions

After having compared the driving forces of Tonghua's pharmaceutical industry and its counterparts in Western countries in Chapter 10.1, I will tackle one of my theoretical questions, how far path dependence matters in creating new paths, based on the empirical evidence of Tonghua's pharmaceutical industry. This question is related to a long-lasting and still ongoing debate: is it necessary or contingent for an industry to emerge in some region? The focuses of this debate are on constancy and change in creating new paths, and the force of social structure and initiatives of human agency therein.

The difference inside transitional countries could be ascribed to the variance in their initial condition that originated at least in the planned economy. As the Tonghua case shows, the early conditions of this local sector have greatly influenced it's subsequent trajectory. Here I will briefly summarize by what ways the early macro and local conditions previous to 1985 affected the evolution of this local sector (see Table 10.1).

Table 10.1: The initial conditions and variety of Tonghua's pharmaceutical industry

	Initial Conditions Prior To 1985	Implication	Variety
Firm	• SOES enterprises dominated industry; • all local enterprises were governed by local government • half of firms was collective in the form of ownership	• the lower the government to which the enterprises were affiliated, the easier and earlier they were privatized • loss-making collective SOEs became the first generation of privatized enterprises (contracted firms) • the early relaxed regulation on ownership resulted in the organizational innovation and technological transformation which allowed Tonghua to have the first-mover advantage.	• the hybrid firms in the mid-1980s • private firms in 1990s • business groups after 2000
"Enterprise-Government" Relation	• factory directors as the representative of owners • local state as industrial corporate and welfare providers • personnel arrangements and production were governed by local government	• local government was directly involved in privatization • enterprise cadre and government officials had considerable power and privileges in transforming public enterprises to private assets • mutual coalition between local government and firms	• government role changed from direct investor or owners to facilitator • enterprise Cadre and govern officials became private entrepreneurs
Technology	• a long history of tcm • existence of Western medicine • a great number of local skilled workers	• the accumulated production technologies contributed to the shift into traditional dosage forms of Chinese medicine to the modern dosage forms of Western drugs in the post-socialist planned economy • some redeveloped ginseng products and TCM drugs were virtually based on the existing products • high loyalty of local workers allowed technologies to remain in Tonghua	• chemical factories established in the planned economy fell off • ginseng-based invigorants in the mid-1980s • TCM drug after 1990 • formal organized R&D after 2000

As regards the firm structure, the Tonghua pharmaceutical sector was dominated by small- and medium-sized enterprises (SMEs) before 1985, about half of which was collective in their form of ownership. Not all of the pharmaceutical enterprises in Tonghua before 1985 were governed by China's central government but some by local governments (see Chapter 6.1.3). As I pointed out in Chapter 6.1.3, the lower the government to which the enterprises were affiliated, the easier and earlier they were privatized. The relaxed regulation on ownership resulted in organizational innovation (for example, the hybrid were tolerated by local government) and finding a niche market (ginseng-based invigorants) which opened up the window of opportunity of the TCM sector in Tonghua.

During the planned economy, local governments were responsible for local pharmaceutical factories as representatives of owners and regulators of the local economy, allocating inputs and outputs, providing welfare such as housing, healthcare for employees (see Chapter 6.3.1), issuing business licenses, coordinating development, resolving business disputes, and engaging in profit-tax policies (Qian, 2000). Particularly after the fiscal decentralization, local firms became a main source of local public fiscal revenues (see Chapter 6.3.2). There were 18 pharmaceutical enterprises in Tonghua by 1985, all of which were under the supervision of the county or city-level governments. This leads to a close relationship between enterprises and local government during the initial stage. Hence, I would like to argue that local "enterprise-government" collaboration contributed a lot to the formation of the pharmaceutical industry in Tonghua, and has its origins in the planned economic period, and was consolidated in the process of building the Pharmcity which was launched in 1995 (see Chapter 7.3.2). This implies that the early "enterprise-government" relations played the role of a platform for the formation of social capital in the post-planned economy (see Chapter 9.4)

In addition, the successful development of the Tonghua pharmaceutical industry, in particular, the entry into the ginseng tonic-based sector and the renewal of the old sector of TCM, is blessed with technologies which were accumulated before 1985. On the one hand, though the chemical factories established in the planned economy fell off and shifted to product TCM products, the production technologies they had accumulated contributed to the shift of traditional dosage forms in Chinese medicine to the modern dosage forms of Western drugs in the post-socialist planned economy (See Chapter 8.2 and Chapter 8.6); on the other hand, some redeveloped ginseng products and TCM drugs were virtually based on previously existing products.

Accordingly, it is safe to say that the rise of this local industry did not start from scratch, but is deeply rooted in local history. In other words, the emergence of so- called new industries is not an entirely accidental outcome because it is often triggered by existing practices and structures that provide challenges or opportunities, which is consistent with Boschma's findings of a center of the British automobile industry, i.e. Coventry, Birmingham (Boschma, 2007). Different from the creation form of new industries (that could be termed "old industries give birth to new industries"; for example, the rise of the automobile industy in Coventry could be attributed to a long history of related industries like coach and cycle-making before, Boschma and Wenting, 2007), the Tonghua case is about the re-creation of industries, namely, about how to reutilize pre-existing resources of industries or so-called historical legacy of industries in re-creating or redeveloping existing industries. This aspect is equally important for understanding the regional or local dynamics of new industries.

However, a new industry does not automatically present itself in a region, as the rise of the Tonghua TCM cluster shows. A more interesting question arises here. In reality, many regions share some common initial conditions in the early development stage, but some of them finally outperform so far others. Even many regions in Changbai Mountain area, besides Tonghua, had similar starting conditions before the mid-1980s, in terms of a number of state-owned or collective TCM enterprises and a closer "business-government" relation. But why only Tonghua's TCM sector grew up into the highest competitive industry, not others? Hence path creation is more important than initial conditions.

It is these changes in multiple paths that drove transition forward and that ultimately determined the nature of the new system during the transitional period. The changes in Tonghua's pharmaceutical sector can be summarized as follows (see Table 10.2): (1) altered organizational dynamics, including the emergence of new organizational forms, for example, the emergence of contracted firms, private enterprises, and the resulting formation of private entrepreneurship; (2) dramatic changes in technologies, for example, ginseng-based products and redevelopment of TCM drugs; and (3) the formation of formal and informal institutions, for example, the initiative of Pharmcity launched in 1995, the going to business of government cadres which was encouraged by local government, and local social capital which coordinated interactions among firms, government, and knowledge-intensive organizations such as universities and research institutes. If these innovative actions would not have been carried out Tonghua would not have grown up as the first-class TCM industrial region in China. Accordingly, today's success in the pharmaceutical economy is the result of the purposeful, deliberate and strategic human action (e.g. Schumpeterian innovation) on the base of existing resources or old paths. Clearly, institutional innovation and the activation of local entrepreneurship are fundamental to the transition process, and as a result, they have been central to research on market transition.

Hence, it is safe to state that the emergence of the Tonghua pharmaceutical cluster cannot be completely attributed to initial conditions, which theoretically follows the traditional theory of David-Arthur's path dependence, but can be considered as an artificial result of creating new paths based on old paths. As pointed out above, this debate on change and nonchange of the dynamics of an industrial cluster is associated to necessity and contingency in the formation of a particular industrial cluster, in particular, to constancy and change in creating new paths, and the force of social structure and initiatives of human agency. For this question, the concept of the *Window of Locational Opportunity* (WLO) could be especially noteworthy. This approach was firstly introduced by the Californian School of Economic Geography in the late 1980s (Scott and Storper, 1987; Storper and Walker, 1989, p: 75), and refined later by Ron Boschma and his colleagues (e.g.Boschma, 1997; Boschma and van der Knaap, 1999; Boschma and Lambooy, 1999, for a review on WLO, see Boschma, 2007). The WLO-concept questions the widely accepted assumption that new industries start from scratch and then claims that the rise of new industries in space, though highly unpredictable, is not an entirely accidental outcome because it is often triggered by existing practices and structures that provide challenges or opportunities (Boschma, 1996, p: 12). More specifically, new industries have the capability to produce space for their own growth and development in places through creating new institutional structures. Once the new industry emerges somewhere, new supportive institutions come into being and, in turn, contribute to the increasing returns at that particular locality. The formation of new industries, on the one hand, is embedded in old socio-economic systems, and makes use of the existing generic resources, and, on the other hand, creates and develops specific and new resources to match the needs of the new industry (Boschma, 2007, p:45).

Boschma and his colleagues find that some regions have a higher probability to develop new industries, when they diversify into new but related directions and build on generic resources present in the region (Boschma, 2007). This denotes that old industries can give birth to new industries because new industries could be created by entrepreneurs of related or supporting industries, so "*regions with generic resources like related industries may be favourable places on which the growth dynamics of a new industry can take off.*" (Boschma and Wenting 2007, p: 49). Different from Boschma's study (2007), my case study on Tonghua is how to reinvigorate old industries in the transitional contexts, but the mechanism of reinvigorating old industries is similar to creating the new industries based old related industries. The Tonghua TCM sector, on the one hand, made full use of the existing systems of institution and technology, on the other hand, created new institutional and technological systems. For example, the redcap enterprises appeared in the old ownership form of SOEs, but operated according to the laws of market economy. At the same time, the Tonghua pharmaceutical enterprises utilized well the material resouces including production sites and equipments and immaterial assets like technology accumulated before, and also continuously found new niche markets and developed new economic structures and local institutions. From this aspect, we must move away from a theory in which the emergence of an industrial cluster is seen as an automatic outcome of the existing path(s) at work, and move to one in which the formation of regional competiveness is a product of conscious collective actions.

Arguably, it is somewhat doubtful whether it will make sense to derive general theoretical and policy implications for regional development from the case study of the Tonghua pharmaceutical industry, because Tonghua is a very special case in some aspects. Because of the context of China's transition in which the institutions at the national level have much more influence on the evolution and development of local industries than in mature market economies, some finding are necessarily not universal, and can not be applicable to other contexts. Moreover, in a strict sense, no historical stories of economic success in one place could exactly recur in other places. As a result, the Western world cannot dirctly learn from the Tonghua case. However, this does not mean that it is impossible to get general theoretical and policy implications which will provide constructive lessons for other regions to cultivate local industries or maintain regional competitiveness. In fact, the "historical" perspective on path dependency will be useful in the Western world and everywhere else, because the historical heritage should or could be successfully used in the Western world as well when it comes to policy advice. Accordingly, policy-makers not only in the existing socialist countries such as Vietnam and North Korea, but also in Western developed countries and the former socialist countries can indirectly learn from the successful transformation of Tonghua's pharmaceutical sector.

In fact, even Western developed countries in which the basic social institutions were well formed are faced with many challenges as well, for example, the revitalization of old industrial regions and industrial restructuring. The regional industrial economy cannot only be pushed by creating new industries, but also by upgrading existing industries. Creating new industries from old industries would be the first choice to promote the regional economy, as the case of Coventry's automobile industry shows in which the automobile industry originated from coach and cycle-making industry in the same place (Boschma and Wenting, 2007), while the Tonghua case illuminates how to develop regional economy by upgrading existing industries. In recreating or redeveloping existing industries, regional policymakers need to develop a historical awareness in designing regional innovation policy. Specifically, because the creation of new 'pathways' for economic development depends considerably from a region's previous economic structures and historical heritages, local development agencies should be actively aware of local existing strengths embedded in the local tangible assets (e.g, specialized infrastructure, machinery and equipments) and intangible assets (specialized labor pool, and technology), rather than creating things entirely new from scratch.

10.3 Summary of the Coevolutionary Process in Tonghua's Pharmaceutical Sector

In Chapter 10.2, I discussed the constancy and change of the paths in the emergence of the Tonghua pharmaceutical sector, which can partially give an answer to the question "why an industry does necessarily emerge in some region, not others". But there is still another unanswered question, namely, how did multiple paths work together and create a highly competitive industrial cluster. The main task of this section is to tackle this question, the main theoretical issue of my dissertation.

As I have already stated, a co-evolutionary approach is useful for the understanding of the complex reality of the economy (see Chapter 2.2.4). But almost all the existing literature on industrial evolution from a coevolutionary lens is at the national level, not at the regional or local level, except for a paper of Lee and Saxenian (2008). Coevolution takes place at multiple levels, however (Lewin and Volberda, 1999; Volberda and Lewin, 2003; McKelvey, 1997, p: 360). "Multiple-level" for economic geographers or regional economists could mean multiple geographical scales. Lee and Saxenian (2008), as almost geographers, consider the firm as the micro-level, the region (especially agglomerations, or industrial cluster) as the meso-level, and nation and globe as the macro-level. I see a competitive industrial cluster as a coevolutionary hotspot (see Chapter 2.4.4) in which the interaction of multiple populations produce positive effects. Since an industry consists of firms and an industry is subject to institutions, and technology, I placed institutions and technology into the spotlight in this coevolutionary framework for an understanding of the rise and leadership of industrial clusters. Here I try to summarize the coevolutionary process in Tonghua's pharmaceutical sector (see Table 10.2), based on the collected observations.

Table 10.2: The coevolutionary process in Tonghua pharmaceutical industry

	Firm organization	Technology	Institutions, local/national
Before 1978	SOEs Collective	Chemicals-oriented industry But TCM existed as well Imitation, slight improvement of production technologies	"Self-sufficiency" policy No links to R&D Forced to labor mobility Interrupted higher education
1978-1985	New established enterprises: collective	More on TCM Imitation	Fiscal and administrative decentralization to lower government and firms Micro-management reform
1885-1991	Contracted firms	Ginseing-based invigorants	Encouraged commercialization of research results Higher education: firstly, local courses provided; then non-local university graduate.
1992-2000	Private firms	The redevelopment of TCM existing New drugs through cooperation with research institutes	Informal institutions (guanxi) began to be gradually formed Pharmcity in 1995 Large-scale privatization of SOEs Stricter regulation of TCM drugs
After 2000	Business Group; Alliance	New drug development Biological medicines Organizational R&D	Formal R&D departments Local action and non-local collaboration Contract research, through acquisitions

In the Maoist period, Tonghua's pharmaceutical industry was characterized by the local government's direct and intensive intervention, and relative small production units, as compared to the large-sized state-owned enterprises in metropolises. Although there were some TCM enterprises, the local state committed himself largely to the development of the chemical industry, as a response to the self-sufficiency policy of the Beijing central government. An evidence is that the local relatively large state-owned enterprises were primarily engaged in chemical pharmaceuticals. Meanwhile, there were no linkages between Tonghua's pharmaceutical firms and the technological community at that time. The reason for this is that the R&D administrative system in China was like what Lieberthal (1992) described as 'fragmented authoritarianism", in which the manufacturing industry was seriously separated from knowledge production institutions. In the fragmented authoritarianism, public research institutes and universities were entirely dependent on the state in terms of financial sources and other inputs (for a detailed background of China's science and technology system, see Chapter 3.2.3), while the main task of pharmaceutical firms in Tonghua was just to produce according to the government's orders. Thus what the pharmaceutical factories in Tonghua searched for a technological improvement during the Maoist period was production technology, not the technology of developing new drugs. Further, the production technology was diffused through local government-dominated labor mobility among Tonghua's pharmaceutical factories (see Chapter 8.2). Imitation of new products was dominant because the intellectual property protection system did not exist before the mid-1980s.

Due to the introduction of the micro-enterprise management reform, Tonghua's pharmaceutical enterprises were transformed from a production orientation rather than customer-centric approach. More importantly, a new firm organization, contracted firms, emerged. They were more market-oriented and had more flexibility in product development. In order to survive, the established firms and contracted firms shifted to develop ginseng-based invigorants. High profits and enormous market opportunity attracted already established and new firms to this huge niche market, which gradually opened up the window of opportunity of the TCM industry. As more and more firms flooded into the sector of ginseng-based invigorants, the products became more and more homogeneous and quality had failed to keep pace with customer expectations, which lead to an intensified market competition. So some enterprises shifted to producing TCM drugs.

At the same time, the science and technology system changed as well, the old system of guaranteed annual appropriations from the state (which we might term “vertical channels”) was changed into a mutli-channel funding system, in which technical knowledge was considered more as a commodity and the flow of funds through “horizontal” channels was encouraged, especially between research institutes and manufacturing enterprises and between research institutes and local governments. The public research institutes began to compete for financial resources from manufacturing enterprsies by doing contract research and selling their research results. Hence, the first wave of cooperation between the enterprises and universities or/and pharmaceutical research institutes appeared in the second half of the 1980s, with the main purpose of improving the quality of existing medicines and (re)developing the ginseng-based TCM.

From the above summary, we can find the changes of nation-scale institutions including the micro-management reform, the reform of the science and technology system, and fiscal and administrative decentralization to lower government and firms, and created a new potential opportunity for some areas to (re)develop new industries in the early 1980s. However, only a few areas could capure the potential development opportunity and then turn this possibility into reality, namely, a few of the TCM regions grew into higly competitive industrial clusters. The reason might lie in the local factors, i.e. local historic assets and deliberate joint efforts of various local actors. It was the new firm organization (contracted firms) that successfully opened up the window of ginseng-based TCM sector by making good use of the historically accumulated knowledge. Tonghua is the first place of producing ginseng-based tonics in large-scale, which let Tonghua have the first-mover advantage. The continuous innovation in technology and institution in the subsequent stages created and maintained the competitive advantages.

During the privatisation period from 1992 to the end of the 1990s, most of the local pharmaceutical enterprises simply imitated some leading firms’ products, and sought low-risk and fast-return, without focusing on technological improvements. This is well consistent with some scholars’ statistical findings (for example Guthrie, 1997). There are some reasons that can account for this “interrupted” mutual coalition between pharmaceutical enterprises and knowledge institutions, especially at the early privatisation period. Firstly, although intellectual property rights were issued, the firms viewed product innovation as a high-risk and a low-profit strategy as well, because the judicial enforcement of intellectual property rights protection was weak and social members did not accept intellectual property as private property, and thus product innovations were discouraged. Secondly, also related to the external environments, the newly emerging “red cap” enterprises and entrepreneurs preferred short-term and high-profit projects rather than long-term new product development, due to the chaotic system of intellectual property rights. Last but not least, newly established or restructured enterprises and even SOEs did not have sufficient funds to engage in the (re)development of new drugs during the early transitional period. These newly established or restructured enterprises were relatively small and young and therefore had to seek fast-return. Meanwhile, the SOEs were suffering from poor economic performance brought about by the rigid management system, inflexible managing operation mechanism and laggardly response to the changing market, as well as competition from restructured or red-cap enterprises.

But more interesting, the local public trainning system began to respond to the dynamic growth in the Tonghua pharmaceutical sector. As I described in Chapter 8.2.2, local advanced schools (a university and a vocational training school) started to offer full-time training courses in pharmaceutical technology, and marketing and enterprise management, and provided a large number of talented people for this rising cluster since the midd-1990s. Moreover, some local university professors in related fields did part-time jobs in or contract research with Tonghua’s pharmaceutical enterprises.

After Deng Xiaoping's southern tour speech in 1992, the whole Chinese society accepted the private economy and created the private business-friendly environment, and after a short time, the Beijing central government began to encourage small-scale state-owned enterprises to be privatized. In Tonghua, the local government launched the initiative of Pharmcity in 1995, and then stimulated the government cadres to do business. We can see that the number of new startups sharply increased, on the one hand, and the existing state-owned pharmaceutical enterprises went into financial crisis, on the other hand. Some ill-operated enterprises were merged or acquired by private pharmaceutical giants, almostly in Tonghua.

Since the TCM market became increasingly competitive and the awareness of intellectual property rights protection enhanced, in addition to the wide acceptance of the private economy by the whole society and the growing financial strength of enterprises, the pharmaceutical enterprises in Tonghua began to build formal in-house laboratories, and rebuild relationships with knowledge institutions inside and beyond Jilin province after 2000. At the same time, acquisition is an often-seen way to get access to firm-specific strategic and competitive assets of the acquired companies such as new product portfolios, brands, research laboratories, and technologies (see Chapter 8.5). Some mechanisms for linking firms, the technological community and government that Murmann (2003) observed in the case of the German synthetic dye industry (1857-1914), including the exchange of personnel, and the formation of a sustaining commercial relation, joint lobbying, could be observed in the present Tonghua pharmaceutical sector as well.

Although similar channels emerged in different places, the degree and the way by which these channels operated were different. Similar to knowledge industrial clusters both in the Western countries and in China, the leading scientists in the field of medicine and pharmaceuticals in Jilin province undertook or participated in some joint research projects with Tonghua's pharmaceutical enterprises, the leading professionals trained excellent students, many of whom work today as scientists in in-house R&D departments of Tonghua's pharmaceutical enterprises. But according to my field survey, there is no top scientist who resigned university and did a full time job in an enterprise. Thus, the access to top scientists of Tonghua's pharmaceutical entrepreneurs is mainly established through their former students who work in their own companies or by other personal relations (in Chinese, *guanxi*).

A more important cooperation between these two social spheres, together with governments, is to jointly lobby higher-level governments for favorable environments, including indirect benefits (encouraging the development of TCM industry) or direct advantages (e.g. tax treatment and financial support for R&D). The collective lobbying does not only bring about economic or financial benefits but, more far-reaching, improves the reputation of Tonghua as the promising Pharmcity in China, and, in turn, helps to coordinate the various actors, not only local, to jointly push forward Tonghua's pharmaceutical industry.

After 2000, the local government changed its function from the previous role of industrial investors to the planner of industrial development and the facilitator of innovation. Besides lobbying higher levels of government for preferential policies, the local government played a role as coordinator in creating interaction between knowledge institutions and the pharmaceutical sector, in particular with small and middle sized enterprises (SMEs), to make up for a lack of local knowledge. For example, local government regularly invited university professors to Tonghua to offer various courses on technology and management.

There are two meaningful points to be emphasized. The first one is that coevolution is not a fixed process, i.e. the intensity and effect of co-evolution is an important parameter for coevolution. The strong coevolution could lead to a strong dependence on each other, and could cause negative effects, as Grabher shows in the case of the Ruhr area (1993). But very weak coevolution implies that coevolutionary entities have very few interactions or have a one-way causal influence, in which it is very hard to produce positive innovation effects. As illuminated earlier, the Tonghua TCM industrial cluster went through an increasingly reinforcing interaction of firms and technology, firms and local institutions. I argue that the process of the emergence and growth of an industrial cluster is in essence a dynamic process of interactions between firms, technology and institution, from weak to strong co-evolution, just as the Tonghua case shows. The second is that coevolution is not a self-actualizing process, but one that is derived from collaborative adaptation among numerous interconnected and interdependent populations (of firms, institution, and technology), which is harmonized by human actors with innovative awareness (e.g. entrepreneurs and innovative governments).

This leads to another question about coordination mechanisms, i.e., by whom and by what ways the changing firms, technology and institution are coordinated. In general, radical changes in national (or global) industrial environments (for example, the technology revolution in early industrialized countries such as Western European, and radical institutional changes in the Eastern European countries, the former Soviet Union, China. and today’s Vietnam) could create new development opportunities. However, whether one region can grasp these opportunities partially lies not only in its own existing capabilities, but also in learning capabilities and coordination capabilities. Coordination capability refers to the capability to coordinate various local and non-local development agencies. It works largely on the basis of communication, consensus building and collaboration among various actors (or interest groups). The coordination is both horizontal and vertical. When new industrial opportunities are available, the earlier the interest groups can take collective actions, the higher the possibility to gain a first mover advantage. Taking collective action can be often seen as a response to increasing market competition, namely, more and more regions enter into the niche market. The way of coordination mechanisms which direct all collaborative efforts toward the realization of these opportunities is definitely industry-specific, space and time-specific. However, just as the Tonghua case shows, the role of the deliberate strategic innovation of entrepreneurs and government is indispensable in creating new paths. In addition, the dense and well developed social networks, e.g., a close government-enterprise relationship, mutual trust of the industrial community members and loyalty to the target industry play a primary role in leveraging resources within the industrial system.

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Appendix

Appendix 1: Formal Provincial Government Agency and University Interviews

No:	Names of institutions	Interviewee's description	Codes
1.	Development Research Centre of Jinlin Provincial Government	Senior Analyst, Industrial and regional Development	G1
2.	The Jilin Province Development and Reform Commission of Jinlin Provincial Government	Vice Director, Department of Planning	G2
3.	Jilin Provincial Science & Technology Department	Vice Director, TCM office	G3
4.	Jilin Food and Drug Administration	Vice Director, Department of Drug Registration	G4
5.	Jilin Academy of Social Sciences	Advanced researcher, Institute of Soft Science	G5
		Advanced research, Institute of Rural Development	
		Advanced research, Institute of TCM Industry Development	
6.	Jilin university	Professor, School of Life Sciences	U1
		Professor, Business School	
		Professor, Center for Northeast Asian Studies	
7.	Northeast Normal University	Professor, School of Life Sciences	U2
		Professor, Urban and Environmental	
		Professor, Business School	
8.	Administrative Office of Pharmaceutical Industry, Tonghua City	General Director	G6
9.	Department of Science Technology Tonghua City	Vice General Director	G7
10.	Department of Science Technology Erdaojiang District	Director	G8
11.	the Organization Department, the CCP Tonghua City Committee	Director, Executive Officer	G9
12.	Tonghua Normal University	Professor, Pharmaceutical School	U3
		Associate Professor, department of geography	

Note: G= Government agency; U= university

Appendix 2: Formal Local Companies Interviews in Tonghua

No:	Names of institutions	Chinese Names of interviewed institutions	Interviewee's description	Interviewed firms' description
1.	Xiuzheng	修正	Vice Director, The Office of Product Planning	L
2.	Xinghua	兴华	General Manager	
3.	Weijing	卫京	Manager, Human Resources	
4.	Changcheng	长城	Manager, Marketing	
5.	Fangda	方大	Staff, The Office of General Manager	L
6.	Wangtong	万通	Staff, The R&D Team	L
7.	Maoxiang	茂祥	Head of The R&D Team	L
8.	Tengda	腾达	General Manager	
9.	Shenghe	盛和	Manager, Marketing	
10.	Limin	利民	Vice General Manager	
11.	Feiyang	飞扬	Manager, Human Resources	
12.	Jiuming	久铭	Vice General Manager	
13.	Jinma	金马	Manager, Marketing	
14.	Shenyuan	神源	Manager, Marketing	
15.	Zhenlin	振霖	Founder	
16.	Dongbao	东宝	Staff, The Office of the Chairman	L
17.	Hongbao	鸿宝	General Manager	
18.	Huaxia	华夏	Vice General Manager	
19.	Zhenguo	振国	Staff, The Office Of the Chairman	L
20.	Hongtaomao	鸿淘茂	Vice General Manager	
21.	Yisheng	颐生	Vice Manager	
22.	Huachen	华辰	Manager, Marketing	
23.	Linhai	林海	Founder	
24.	Jurentang	巨人堂	Manager, Marketing	
25.	Mintai	民泰	Vice Manager	
26.	Yujin	玉金	Manager, Marketing	
27.	Huinan Changlong	辉南长龙	Vice Manager, Product Developement	
28.	Tianyu	天宇	Vice General Manager	
29.	Huifa	辉发	Vice Manager, Product Developement	
30.	Shenhui	沈辉	Vice General Manager	
31.	Hongjiu	宏久	Vice Manager	
32.	Meihekou Nuoshi	梅河口诺氏	Vice General Manager	
33.	Yongyuan	涌源	General Manager	
34.	Hongxing	宏兴	Staff, The Office Of the Chairman	
35.	Boxiang	博祥	Vice General Manager	

Note: "L" (large) represent that the corresponding enterprise is on the list of the top 10 pharmaceutical enterprise in Tonghua by 2004 sale.

Appendix 3: Formal Non-local Companies Interviews in Changchun

No:	Names of institutions	Interviewee's description	Interviewed firms' description
1	Changchun ChangSheng Gene Pharmaceutical Co., Ltd	Vice General Manager, R&D	Merged into a Tonghua pharmaceutical company (Maoxiang)
2	Jilin Wangtong Pharmaceutical Co., Ltd	Staff, The Office of the General Manager	Merged into a Tonghua pharmaceutical company (Wangtong)
3	Chuangchun Dongbao Pharmaceutical Co., Ltd	Manager, Human Resources	Merged into a Tonghua pharmaceutical company (Dongbao)
4	Natural pharmatech (JiLin China) Co., Ltd	Vice General Manager, R&D	its Founder and the chairman comes from Tonghua
5	Jilin Bencaotang Pharmaceutical Co., Ltd	Manager, R&D	its Founder and the chairman comes from Tonghua

Appendix 4: Interview Designs

Note: Questions were planned and interviews were conducted in Chinese, and translated in English in this dissertation.

Fieldwork in Tonghua's pharmaceutical cluster

The semi-structured interviews were conducted for gathering information of the formation of the Tonghua pharmaceutical cluster. The questions were planned to cover the issues of the influence of the central and local policies on the growth of the firms in this local sector in different periods, the relationship between the cluster growth and the technological accumulation, and the key events which happened in the process of the firms development including technical innovation, firm organization, market and management innovations.

The sample questions below are presented for the government agencies and firm managers respectively. These questions are given in generalized form, but were changed slightly according to different interviewees.

Sample questions for the government agencies

1. Changes in regulations on pharmaceutical industry

- Have there been any adjustments of national regulation on the medical industry since 1980s? What kind of adjustments?
- Did the implementation of GMP policy in 1997 influence the pharmaceutical sector a lot? How?

2. Plans and strategies of pharmaceutical industry and their influences

- In Jilin province or the Changbaishan Mountain Area, what policies related to pharmaceutical industry have been conducted since the 1950s?
- Have Jilin got any favourable industrial policies from the 'Northeast revitalization strategy' conducted by the state in 2002? Did these policies facilitate the development of the pharmaceutical sector? Can you describe the role of these policies in promoting the status of pharmaceutical sector in detail? What are obstacles to further development?
- How to lobby the central government for favourable industrial policies?
- Which pharmaceutical enterprises in Jilin did get the important central investment, for example the Bond Project? What projects?
- Are there any firms in Tonghua that participate in the national research projects? How did the provincial government agency promote pharmaceutical enterprises in Jilin?
- Have these firms improved their technological abilities and economic performance, such as developing patents and new products, promoting output values.

3. Pharmaceutical innovation

- What are the characteristics of the pharmaceutical innovation? What type of innovation is most important for the pharmaceutical industry? Technological innovation, institutional innovation, or the managing and organizational innovation? Examples?
- What are the driving factors of innovations? How did the demand and market factors influence the innovations in pharmaceutical sector? Examples?

4. Local industry-support measures and other China's TCM regions.

- What industry-support measurements have been conducted by local authority? And what influences have they brought to the performances of local firms and the development of the pharmaceutical sector?
- What are the situations of other TCM regions in China? What advantages and disadvantages does Tonghua have compared with them? What corresponding measures have the local government conducted?

Sample questions for the firm managers

1. The organization of firms

- How did the ownership of the firm evolve? What was the ownership of this firm at the beginning? When did it transfer into a private one?
- Is this firm a spin-off? If yes, from which parent company? Do you know other spinoffs?
- Does the founder have any experiences in the medicinal field? What did he/she do before starting this business? What were the main financial sources of the startup?

2. Production and technology

- Have there been, during the last years, any more or less important changes of the product that the firm sells on the market?
- How many patents or brands/labels have the firm applied for and got? What have the consequences been of the innovations that have been made?
- How many technicians in the company? What are their experiences of receiving education and undertaking research programs in national and local levels? From whom did these firms learn new production technologies? how to learn the technologies concerning the development of new drugs
- How much money is given to R&D in average year? What is the proportion of it to the sales revenue?
- Where is the core technology of your firm from? Internal research and development? Or getting from outside? If both, what is the proportion between them?
- Will you transfer technologies to other organizations? In which forms? License? Technology shares? Or others?

3. Financial situation

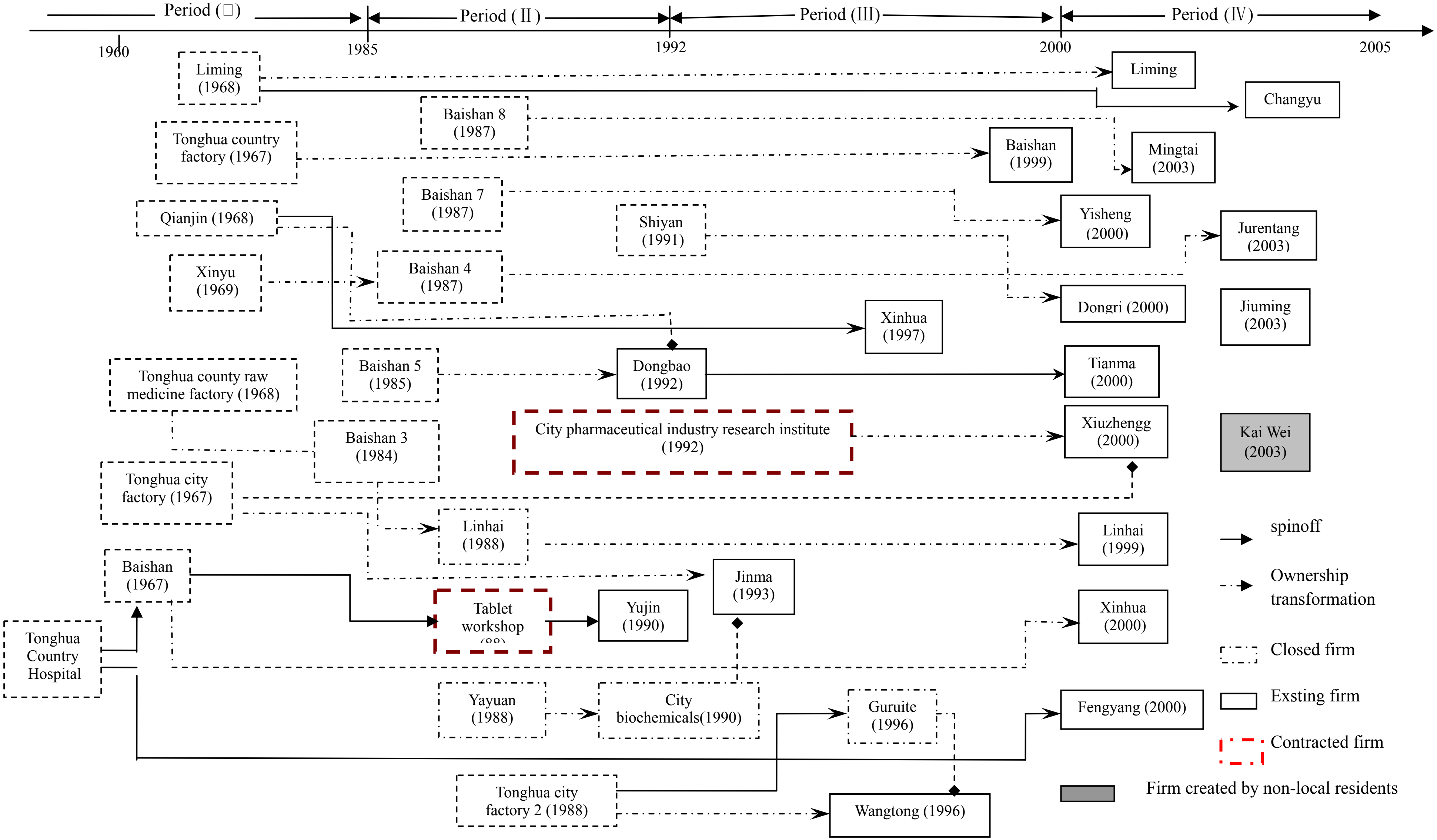
- Where did you get external financial support when you started this firm? By what channels and how large of the proportion of the total startup capital?
- Has this company invested to some projects? Are these projects local or outside Tonghua? Can you give me some reasons for investing in other areas?
- Did the turnover, capital investments and other internal and external factors have influence on the development of the firm and the competitive environment?
- Did you receive any direct financial support from the government? For example, capital, land, and so on?

4. Information about other local firms

- What kind of relationships between firms producing similar products? Are there inter-firm competition for talents and market shares?

- Do you participate in any industry associations or similar organizations? Do you often exchange information with other firms?

Appendix 5: Genealogy of Selected Pharmaceutical Enterprises in Tonghua



Appendix 6：University and Public Pharmaceutical Research Institutions in Jilin

Institution	Founding Year	Location	Relative sub-departments and their information
Jilin University	1946	Changchun	School of Pharmaceutical sciences was founded in 1998, currently with 113 professionals. 7 key laboratories at the above-provincial level;
			School of Life Sciences founded in 1960, have 70 staffs
Northeast Normal University	1946	Changchun	The Department of Biology was founded in 1948, Currently; the School of Life Sciences has a faculty of 102 members.
Jilin Institute of Chemical Technology	1958	Changchun	Pharmaceutical Engineering began to enrol in 2000, preparation in 2005
Changchun Normal College	1958	Changchun	Life Science Institute was formally established in 2005, integrating the different teaching units, with a total staff of 39 people in 4 sections like molecular biology teaching and research
Changchun College of Medicine	1936	Changchun	Pharmacy department has 24 teachers
Jilin Agricultural University(1948)	1948	Jilin	Chinese herbal medicine plant
Jilin Medicine Colleg	1952	Jilin	In this college about a total of 150 staffs relative directly or indirectly to pharmaceutical science
Tonghua Normal College	1958	Tonghua	Department of Pharmaceutical and Food Science has about 30 staffs
Yanbian University	1949	Yanji	Department of Pharmaceutical sciences was traced to 1976 and established Yanbian medicine research centre, with current staffs of 41
			Department of Chinese Medicine was founded in 2005, with a total staff of 23
Jilin Normal University	1958	Siping	School of Life Sciences founded in 1983，40 full-time professionals

Appendix 7: List of the pharmaceutical factories established before 1985 in Tonghua

Name	Foundation year	Original ownership	Parent institutions	Current	Industrial field
City Pharmaceutical Factory	1958	State-owned	traditional Chinese medicine stores	Acquired by Xiuzheng Group	TCM
Liuhe County Chuangqing Pharmaceutical Factory	1966	Collective	a garrison (2682 army)	Privatized, Changqing Pharmaceutical Co., Ltd	TCM
Tonghua County Pharmaceutical Factory	1967	State-owned	Tonghua county hospital	Privatized, Tonghua Baishan Pharmaceutical Co., Ltd	WM
City Qianjin Pharmaceutical Factory	1968	Collective	pharmaceutical workshop and Tonghua City Comprehensive Chemical Plant	Privatized, Xinghua Pharmaceutical Co., Ltd	WM
Meihekou No.1 Pharmaceutical Factory	1969	State-owned	a TCM store in Shancheng Town	Acquired by Fangda Group	TCM
Meihekou Sanhong Pharmaceutical Factory	1968	Collective	Third branch of Logistics deparment of Shenyang Military Command	Acquired by Jilin Pharmaceutical Group	WM
Liming Pharmaceutical Factory	1968	Collective	PLA 206 Hospital	Privatized, Liming Pharmaceutical Co., Ltd	WM
Xinyu Pharmaceutical Factory	1969	Collective	a garrison (2682 army)	Acquired by Dongbao Group	WM
Tonghua County Raw Medicine Factory	1969	State-owned	Tonghua county medical bureau	Privatized, Jinhui Pharmaceutical Co., Ltd	WM before 1973 TM,after1973

Continued to Appendix 7

Name	Foundation year	Original ownership	Parent institutions	Current	Industrial field

Longgangshan Pharmaceutical Factory	1968	State-owned	a garrison (93038army)	Privatized, Zhongchen Pharmaceutical Co., Ltd.	WM
Baishan No.2 Pharmaceutical Factory	1970	State-owned	Tonghua City health school	Acquired by Dongbao Group	WM
Jian County Pharmaceutical Factory	1972	State-owned	Jian County Light Industry Bureau	Privatized, Ji'an Group	WM
Meihekou Pharmaceutical Factory	1971	Collective	Meihekou Medicine Station	Acquired by Maoxiang Group	TCM
Huinan County Ginseng & Deer Pharmaceutical Factory	1982	State-owned	deer raising factory	Privatized, Tiantai	TCM
Liuhe County Chinese Medicine Factory	1980	State-owned	Liuhe County Agricultural Bureau	Privatized	TCM
Changcheng Pharmaceutical Factory	1984	State-owned	local garrison	Privatized, Changcheng Pharmaceutical Co., Ltd.	TCM
Baishan No.5 Pharmaceutical Factory	1985	Collective	Tonghua County Light Industry Bureau	Developed into Dongbao Group	TCM
Meihekou Shanbao Pharmaceutical Factory	1985	Collective	Third branch of Logistics deparment of Shenyang Military Command	Closed	TCM

Note: the firm name changed in the planned economy ① County Baishan Pharmaceutical Factory, ② Baishan No.4 Pharmaceutical Factory,③ Baishan No.3 Pharmaceutical Factory;
TCM= traditional Chinese medicine
WM=Western medicine