Cluster-Based Regional Innovation System: Theoretical Extension and Case Study of Shaoxing

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Abstract—Innovation is not an isolated activity for enterprises. On the contrary, a mass of information exchange with the external world is required. That’s why enterprise and the environment it involved should be considered as a system. Due to inherent characters, industrial cluster creates good conditions for innovation and can be a special innovation system.

In China, most industrial clusters lie in the middle section of the value chain, while sections of high margin are in the hands of others, i.e., R&D and marketing. Therefore, improving the industrial added value has been put on the agenda.

Based on the case of a Chinese city, Shaoxing, this paper discusses its textile industrial cluster, which has become one of the key driving forces supporting the rising economy. Our study shows that building the regional innovation system based on industrial clusters in Shaoxing is a great choice to improve innovation competitiveness. As the industry is one pillar of China’s economy, it’s important to study this trend for further growth of the industry.

I. INTRODUCTION

Shaoxing, China Textile Production Base, boasts one of the largest marketplaces in China. China Textile City in Keqiao is now Asia’s largest textile trading place, with its trade volume accounting 1/3 of the nation’s aggregate.

Textile industry is the pillar industry of Shaoxing County’s economy. In 2002, the output value of the textile industry amounted to 53.1 billion RMB, accounting for 75% of the county’s economic aggregate. After 20 years’ reform and opening-up, Shaoxing, now has basically formed a complete industrial chain composed of textile raw materials, spinning, weaving, dyeing, textile and garment industry. Around the main value chain, Shaoxing has developed textile machinery, dyes auxiliaries, textile technical services and other supporting industries. These actors and interactions between them constitute a complete collaboration supporting system for the development of textile industry. The area composed of these actors naturally is formed a considerable size and characteristics of local textile industry cluster.

Of course, there is more than one textile cluster in China, for instance, women’s wear in Hangzhou, men’s wear in Wenzhou, socks in Ningbo (plus Shaoxing, all in Zhejiang Province). According to China National Textile Industry Council (CNTIC), there are now 19 such township industrial clusters of textiles, which altogether have a total output of RMB238 billion (nearly US$30 billion), accounting for about one quarter of the total textile output of the country. About 1.81 million workers are employed in these clusters [1].

Industrial cluster of textile in Shaoxing is not in high-tech sectors related to R&D core; however, it is represented by various local networks of small firms with a local base and strong export orientation.

According to Belussi, in fashion-led or engineering-based industry-characterized by the presence of practical knowledge-the development of a competitive regional system is the result of a pre-existing industrial cluster [2]. Based on the textile industrial cluster, Shaoxing developed its regional innovation system after several decades’ effort.

The paper proceeds as follows: Section 2 focuses on the theoretical and empirical background and introduces the research industrial districts. Section 3 analyses the industrial cluster based RIS in Shaoxing, while Section 4 proposes some concluding remarks and hints for further research.

II. LITERATURE REVIEW

A. Regional Innovation System

In the 1990s, the concept of regional innovation systems (RIS) has become increasingly popular among economic geographers, regional studies scholars, and regional development policy makers [3, 4, 5-10]. The popularity of this concept reflects the importance attached to the role of learning and social milieu in social development and economic growth. The approach is popular in part because it provides a narrative on the intangible dimension of local economic development and the processes of knowledge circulation and learning at the more manageable regional scale. Another, more simple rationale for the widespread adoption of this approach may be that, from a policy perspective, it is easier to manage economic policy at a regional rather than a global scale.

The concept of regional innovation systems has no generally accepted definitions, although it is typically understood to be a set of interacting private and public interests, formal institutions, and other organizations that function according to organizational and institutional arrangements and relationships conducive to the generation, use, and dissemination of knowledge [11]. The basic argument is that such a set of actors produces pervasive and systemic effects that encourage firms within the region to develop specific forms of capital that are derived from social relations, norms, values, and interactions within the community in order to reinforce regional innovative capability and competitiveness [12].

The notion of RIS lies on the crossroads of two main bodies of literature (Fig.1): evolutionary theories of economic and technical change, which conceptualize innovation as the result of complex, non-linear social processes, stimulated and nurtured by Several actors and factors within and outside the external world is required. That’s why enterprise and the environment it involved should be considered as a system. Due to inherent characters, industrial cluster creates good conditions for innovation and can be a special innovation system.
firm [13]. In contrast to neoclassical theory, which posits the firm as a homogenous, atomistic unit of rational utility maximization, in evolutionary economics the firm is differentiated, making use of heterogeneous inputs, and learns through the double feedback loop of assessing its own experience and the experience of peers. The process of innovation becomes systematic as it develops within clusters of inter-firm relationships. Another one is theories of regionalization and clustering, which emphasize that economic growth and innovation do not take place in abstract spaces, but are locally rooted, thanks to the advantages of spatial proximity, social embeddedness, interaction with local institutions, and knowledge spillovers [14-19].

B. Relationship between RIS and Clusters

As regards the evolution of RISs, recent analyses have elucidated the complex relationship that exists between the building of a coherent innovation system and the evolution of innovative local clusters. The underlying hypothesis is that in fashion-led or engineering-based industry -characterized by the presence of practical knowledge-the development of a competitive regional system is the result of a pre-existing industrial cluster [2], while in science-based industry-where the role of scientific/analytical knowledge [20] is extremely important-the presence of leading research institutions (and research funds) represents the sine-qua-non precondition [21].

Innovation occurs more easily in situations of geographic concentration and proximity, which means regional clusters play a crucial role in such processes. A regional cluster is defined as a “group of firms in the same industry, or in closely related industries that are in close geographical proximity to each other is meant to include geographically concentrated industries included so-called ‘industrial districts’” [22]. Clusters can include governmental and educational institutions and support services, with cluster boundaries defined by linkages and complementarities across institutions and industries [23]. Clusters have in common specialization, proximity, and cooperation that lead to spillovers and synergies within a regional innovation system. Innovation activities benefit from a concentration of economic activities by similar and related firms in a cluster, which facilitate knowledge spillovers and stimulate various forms of adaptation, learning, and innovation [24, 25]. As Malmberg and Maskell [26] pointed out, “In such environment, chances are greater that an individual firm will get in touch with actors that have developed or been early adapters of new technology. The flow of industry-related information and knowledge is generally more abundant, to the advantage of all firms involved”. According to these authors, the general argument is that a local industrial structure with many firms competing in the same industry or collaborating across related industries tends to trigger processes that create not only general dynamism and flexibility but also learning and innovation.

C. A model of network for cluster-based Regional Innovation System

Actors involved in cluster-based regional innovation system can be generalized to five main bodies: enterprises, R&D institutions, educational organizations, intermediary and government. Innovation is the outcome of actors’ connection and interaction with each other, and innovation performance depends largely on the openness of enterprises with suppliers, sub-contractors, and service firms.

As for the enterprises embedded in the network, crossing the boundaries and cooperating with external actors (R&D institutions and educational organizations) is an opportunity to multiply the learning occasions, mostly in knowledge intensive sectors [27]. These industries have witnessed the wide spread diffusion of distributed forms of innovation driven by the necessity to integrate specialized and complementary knowledge [28]. Recent studies on modularity and system integration [29, 30] have pointed out that increasing modularization of complex products has favored firms’ R&D disintegration and knowledge specialization although raising the need and complexity of inter-organizational coordination.

External sources which are rooted in the capability to enrich the firm knowledge with a network of interactions including external partners (suppliers, customers, research and market institutes) can make the knowledge flow easier, as well as facilitate the diffusion of new technology (Fig.2 The model of network for cluster-based Regional Innovation System).
III. CASE OF SHAOXING

A. Overview of Shaoxing

Shaoxing is located in central-northern part of Zhejiang, and between Hangzhou and Ningbo. Shaoxing occupies an area of 8,256 square kilometers and has a population of 4,340,000. Shaoxing is one of National Famous Historic and Cultural Cities of the first group, and Shaoxing County was a center of politics, culture and economy in southern China from the Qin and Han dynasties up to the Ming and Qing dynasties. Shaoxing breeds outstanding people over centuries, like Premier Zhou Enlai, great writer Lu Xun, etc. Because of its long history and profound culture, Shaoxing develops its own commercial culture of dedication and continuous improvement. The economic dynamism in the region has continuously produced highly profitable entrepreneurial firms especially in manufacture industry, with 297 firms' sales revenue exceeding 100 million, 33 firms exceeding 1 billion and 1 firm exceeding 10 billion in 2008.

Shaoxing is a place full of vitality in economic development. Shaoxing generated a gross product of $16.5 billion in 2003, an increase of 15% over the previous year. Shaoxing economic aggregate was the 29th among national big and intermediary-sized and gross financial income reached $1.63 billion, rose by 26.3%. The total amount of social consumable retail reached $4.4 billion, increased by 12.6%, with $1013.8 per person.

There are four main features leading Shaoxing's economy:

The first superiority is private economy. Private economy accounts for about 95% of Shaoxing's economy.

The second is manufacturing industry, which accounts for 60% of Shaoxing's economy, developing pretty well. Particularly, the light textile industry accounts for more than half industrial aggregate. In 2003, textile enterprises reached the sales income of $13.8 billion, with $0.68 billion profit, which occupied 7% and 12% of the national textile industry respectively.

The third is trading markets facilitate the boom of economy. There are 357 commodity trading markets in the whole city, and trading value hit $12.1 billion in 2003, including 13 markets' annual sales exceeding $151.9 million per trading market. China Textile Market is the nationwide biggest textile products market with annual trading value of $3.73 billion.

The fourth is the prosperity of industrial clusters. Shaoxing has formed 35 clusters of certain sectors, such as textile, printing and dyeing industries of Shaoxing County; socks, shirt, pearl, hardware industries of Zhuji City; umbrella, chemical, mechanical and electrical industries of Shangyu City; necktie industry of Shengzhou City; medicine and axletree industries of Xinchang County and furniture industry of Yuecheng District.

Shaoxing has been developing education for a long time. After the founding of New China, particularly since economy reform and opening door policy, education and research in Shaoxing has a great improvement. Now there are 5 colleges and universities, 36 secondary vocational schools and 41 high schools in Shaoxing, and 1.5 million college and university graduates can be provided to the society each year. Shaoxing has mature infrastructure with fitting natural and humanistic environment, and built Shaoxing Economic Development Zone, Paojiang New Park, Shaoxing Ecological Park, Shaoxing County Binhai Industrial Zone, Hangzhou Bay Fine Chemical Zone in Shangyu, Xinchang Hi-Tech Industrial Park, etc.

B. Cluster-based Regional Innovation System in Shaoxing

Textile industry is the pillar industry of Shaoxing. Shaoxing, now has basically formed a complete industrial chain composed of textile raw materials, spinning, weaving, dyeing, textile and garment industry. Around the main chain, Shaoxing has developed textile machinery, dyes auxiliaries, textile technical services and other supporting industries, the whole value chain in textiles (Fig.3 Value Chain in Textiles) has developed maturely in Shaoxing.
Based on the model proposed in the second section, we describe the picture of Shaoxing’s RIS from four perspectives: enterprises, universities and R&D institutions, government, and intermediary.

**Enterprises**

Enterprises in cluster are the main actor creating value and driving force for the boom of region. For the past few years, Shaoxing textile industry has been developing rapidly, and made remarkable achievements. According to statistics, in 2007 there are totally 2405 enterprises in Shaoxing textile industrial cluster, including 684 enterprises above designated size, which account for 61% of the total enterprises above designated size in the county. The cluster employs 150,000 persons, occupying 48% of the county’s total employees. In 2007, the cluster’s gross industrial output reached $144.9 billion, with $11.5 billion of tax amount.

With the support of industrial cluster, Shaoxing has become the most important textile manufacturing base in China, with 15% of the national total chemical fabrics, and about a fifth of the national total shuttleless looms.

There are many large-scaled manufacturing enterprises in Shaoxing textile industrial cluster, such as Zhejiang Yuandong Chemical Fiber Group, Busen Group Co., LTD., whose products are not only sold in China, but also exported to Asian countries, Europe and America, sharing a good reputation of trademarks. What’s more, lots of small firms can also find their space in cluster, which boost the innovation in region to a great extent. These enterprises with innovation capabilities are spread over the whole value chain of textile industry, from chemical fiber, weaving, printing, to dyeing and garment, as well as textile services, textile machinery and other relevant industries. Thanks to the value chain, the enterprises with various types and scale are linked together and pave the way to develop regional innovation system.

**Universities and R&D Institutions**

The actor engaged in the research activities of textile industrial cluster is mainly the R&D department in large-scaled enterprises, Such as Yuhua Textile Institute attached to Zhejiang Yuhua Holding Group Co. Ltd., the subsidiaries of Hengmei Group Co. Ltd. Shaoxing Light Textile Technology Center. Moreover, most collaboration research institutions are universities and research institutes out of the cluster through university-industry cooperation projects, talent communication, joint research center, and technical achievements trading to access knowledge and innovation from the outside.

For instance, Tianma Group Co. Ltd. cooperated with Zhejiang University exploiting computer automatically pulp controlling system, filling a technical gap in China. Jingong Science & Technology Co., Ltd. has solid “university-industry” collaboration with domestic famous universities, like Tongji University, Donghua University and Zhejiang University, as well as research institutions like Beijing Machine Tool Institute, and sets up Huaneng Electromechanical Institute of Beijing Institute of Technology. Up to 2003, the number of various technology development centers has reached 131 in Shaoxing County including 91 research centers in enterprises. Enterprices, universities, research labs through university-industry cooperation combine the nodes in the whole technology innovation networks together, integrating the national technology into cluster-based RIS of Shaoxing.

In the closed regional innovation system, small firms, which clearly are not able to afford large investments in R&D,
are at a disadvantage. These types of firms cannot be innovative only counting on internal knowledge, but they have to build fruitful relationships with other organizations, in a network perspective. Firm size in the emergent open regional innovation system is no more an obstacle or unique driver to increase innovative productivity [33]. Relational and coordination capabilities of firms and research labs allow the establishment of a positive spiral of learning at the boundaries [34], which appear to be the crucial variable to look at when determining the degree of innovativeness [35, 36, 37, 38].

Crossing the boundaries of the firm and cooperating with external actors (research labs or institutions) is an opportunity to multiply the learning occasions (Baba et al., 2009). The textile industry have witnessed the wide spread diffusion of distributed forms of innovation driven by the necessity to integrate specialised and complementary knowledge.

In the regional innovation system, the cooperation between universities, research labs or institutions and SME is mainly based at exchange of material resources, human resources and technical resources. Universities and research labs or institutions provide human resources and technical resources. Universities and research labs or institutions enable enterprises to purchase the most advanced technology and new products. At the same time, according to the rise of labor cost in China, the profit of enterprises is declining constantly.

Government

Government plays a positive thrusting and guiding role in the formation and development of regional innovation system. Because of political system, government in China has more power, through its guiding, motivation, protection and coordination government can greatly affect enterprises' innovation process.

To construct a favorable market environment, government makes relevant laws, regulations, policies and standards. These not only protect the enterprises from unfair competitions, but also encourage enterprises’ innovation. For example, aiming at the challenges of fast changing both at home and abroad the textile industry faced, government organized series of activities to improve products’ quality, expand market volume and increase the enterprises’ efficiency.

Meanwhile, to promoting the construction of regional innovation system, local government signs long-term cooperative agreement with external universities and research labs to help SME in RIS multiply the learning occasions and distribute to innovation.

Government sets up innovation funds and reward to encourage innovation activities. Every year, local government specifically allocates $22.8 to $30.4 million to support the implementation of Textile Fabrics Innovation Project. Start-up companies can benefit from this capital supporting and survive its hard beginning. It is conducive to the fostering of innovation culture.

What’s more, government builds public infrastructure, including education, information, and transport infrastructure. Shaoxing County’s public finance invested $182.3 million in the constructing of research building and facilities for "Zhejiang Modern Textile Technology and Equipment Innovation Service Platform". Furthermore, local government supported Zhejiang China Light Textile Industrial City Group Co. Ltd. to vigorously promote the construction of professional electronic service platform for market, and provided the information service over 6000 booths, the sum of trading through the service platform amounted to $455.7 million, can save more than $303,808.2 for one booth annually.

Intermediary

Intermediary in cluster-based RIS mainly refers to the services units of technology convert, finance, logistics and so on. Business incubate refers to Productivity Promotion Center, and Innovation Park. Industry associations, lawyers’ and accountants’ office, logistics center and education training center, etc., these intermediaries become auxiliary system for cluster-based RIS, supplying knowledge, information and talents, and play a coordination role. For example, in order to solve the problem of SME’s design capabilities, there are several technology intermediary agencies specialized in fabrics analysis, design, plate-making services, forming the bridge of SME and research labs.

C. Existing problems in RIS of Shaoxing

Most enterprises in Shaoxing RIS pursue "cost leadership" strategy, and dare not invest in long-term innovation projects. Lacking the input of technology innovation, enterprises with low innovation competencies cannot learn and absorb high-class R&D knowledge. This makes enterprises’ profit remain the same or even declined while export sales rise. At the same time, according to the rise of labor cost in China, the original competencies of textile industry is losing constantly.

The primary learning mechanism of enterprises in RIS is imitation, and improvement of products’ quality mainly depends on the update of fixed assets, with low R&D expenditure. Enterprises do not turn into the investment subject of technology innovation, and this causes low innovation competencies. RIS’s innovation capabilities are relatively weak. Besides, although enterprises establish internal research and development institutions, the scale is small, and the quality of staff is not high, these lead to the weak R&D ability.

Although in recent years the number of patents granted by Shaoxing is raising sharply, inventive patents account for few of them, the proportion of inventive patents is low (Fig.4 Patent situation in Shaoxing).
The other problem is that the collective efficiency of Shaoxing textile industry is still low. Within a cluster, competitions far outweigh the cooperation between enterprises. This greatly affects the competitiveness of Shaoxing RIS.

IV CONCLUSION

On the basis of previous studies, this paper has a review on theories of regional innovation system, and discusses the relationship between RIS and regional cluster. A model of network is proposed to analyze the cluster-based RIS of Shaoxing. The empirical factors taken into account include the role of enterprises, the role of local government, the development of supporting intermediary, and the research labs. During the past three decades in the process of development, the cluster has grown rapidly. Many of the enterprises in Shaoxing RIS export fabrics to the international market. While most of the enterprises started as a family business, now many of them are managed professionally and cooperate with famous universities in China. Many of them have well-established systems and met with international compliance standards and requirements, like ISO900 certifications. But there also some problems in Shaoxing RIS, the main two are enterprises’ weak R&D capabilities and low collective efficiency of cluster.

REFERENCES


Data Source: Shaoxing Statistical Yearbook

Fig.4 Patent situation in Shaoxing²