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The Knowldege Learning Network and the Geographical Embeddedness: a Case Study of Shanghai Zhangjiang High Technology Park in China

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Abstract

Zhangjiang high-technology park is one of the most important clusters of integrated circuits (IC) in China, which represent about 20.8% of Chinese IC sales revenue, and its output value has grown by an average of 17.2% between 2006 and 2010. As the IC industry in China has a special manufacturing called vertical disintegration, there are many studies report that can help the dynamization of the learning effect between the actors of a region.

This study adopts the concept of Malmberg and Maskell (2002), which means to analyze the structure of learning networks through the horizontal and vertical dimenstions, and then to study the relationship between the knowledge network of ICs companies and its embeddedness within an area. We collected data from 127 ICs companies located in the Zhangjiang high-technology park and we also did 21 interviews with the ICs company managers.

The results show that the links between the actors of the cluster are weak, about half the companies establish cooperative relations with actors outside the park, there are low activity of R & D partnership between different actors in the region. This weakness could harm innovation, thus would slow the development of the cluster.

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Keyword: Knowldege learning network, geographical embeddedness, Shanghai Zhangjiang High Technology Park, vertical disintegration.

1. Introduction

Before China's economic reform, most industrial installations are approved by the government based on the needs of national defense and regional balance. During this period, the needs are not the decisive criteria for the establishment of a factory. Thus, there is no external economy which is mentioned by Marshell in 1890. With China's economic transition, the market mechanism was introduced into the Chinese market, restrictions on capital and labor costs reduce, which help the industrial areas develop and promote the region. Indeed, firms consider their costs, achieved benefits and other factors, in order to face a drastic competition, therefore, the emergence of agglomeration geography can attract economic activities and further develop the industry (He, 2010).

The concept of agglomeration refers to a concentration of industrial activities in a specific geographical area, which means to attract economic activities and to concentrate them into one place. The advantages of science parks come from the concept of agglomeration. In recent years, in order to reduce the instability of the production process, the industries changed their way of production from vertical integration to vertical disintergration because it no longer is the best way to fabricate products. The manufacture of vertical disintegration can connect different companies and form company networks; it can also respond to the uncertainty of the market demand (Wang, 2009). The integrated circuit (IC) industry is one type of vertical disintergration, it can be divided into upstream and downstream as IC design, IC manufacturing, IC packaging and IC testing, each sector must cooperate with others to accomplish the production, therefore, this kind of production systme maximize the effectiveness of agglomeration economies.

Many researches indicate that the production system of vertical disintegration has an flexibility to adjust and react to the market changes; it would not be confined by the rigid organization and management and like the production system of vertical integration may have, because it have enough reaction to absorb innovative ideas, new products and new technologies (Hsu, 2000) , also, this kind of production system can

help technique learning among the companies (Hsu, 2000; Tseng, 2009), when problems occurr, companies within the cluster may communicate with each other and solve problems collectively. As a result, these contacts provide advantages for competitiveness (Saxenian and Hsu, 2001; 915-916). Also, the cooperation of the companies can foster the development of industrial clusters, through the organization of regional networks, new technologies information flows, knowledge pass and interactions which focus on making innovations; companies can achieve the effectiveness of innovation (Saxenian, 1994; Fritsch and Kauffeld-Monz, 2010).

Since 1990, the industrial clusters research focus mainly on transaction costs, flexible specialization, but in recent years, the theme of research turns to knowledge innovation and collective learning. Researchers think that knowledge and learning are important assets to advance region developments (Malmberg and Maskell, 2006), such as the european association GREMI (Group de Recherche Européen sur les Milieux Innovateurs) indicates that the innovative milieux occur in a special environment, because it needs the interaction of both innovation and knowledge to form a network system to improve its advantages of competitiveness (Aydalot, 1986).

The IC industry's division of labor in China is different from that of in the United States and Japan, the Zhangjiang high-technology park is one of the most important clusters of ICs in China, which represent about 20.8% of sales revenue, whose industrial output value of the IC has grown by an average of 17.2% between 2006 and 2010. As the science park in China appeared much later than the U.S., Europe, Japan, and Taiwan, it would be interesting to ask the following questions. What is the form of knowledge networks in Zhangjiang high-technology park? What are the relations of cooperation between actors in Zhangjiang high-technology park? How to diffuse an innovative knowledge through a vertical disintegration system in Zhangjiang high-technology park? What is the source of innvoative knowledge of ICs companies? Do these innovative knowledge networks embed or disembed in Zhangjiang high-technology park?

This study includes several different sections. First of all, to understand the relations among the manufacture of vertical disintegration and the geographic embeddedness, then explore the reason why companies tend to congregate in Zhangjiang high-technology park. Second, to understand the concept of knowledge learning networks, then try to apply the theory into structure of this study. Third, introduce the Zhangjiang high-technology park and the source of innvoative knowledge of ICs companies. Last but not least, the conclusion and several advices from this research.

2. Knowledge learning networks and geographical embeddedness

Early in 1776, Adam Smith has explored into the relation of region and industrial activities in his book “The Wealth of Nations”. He mentions that region is an important factor to promote economic development because when different countries and regions have absolute divergence in productivity, each country would choose to specialize in producing certain goods which have absolute advantages. Therefore, the industrial agglomeration occurs in certain countries or regions (He, 2010).

Then, Marshall indicates that the phenomenon of certain industries aggregated in some geographical areas is the result of the attraction of abundant natural resources (such as mineral resources), knowledge and employees (Marshall, 1920). This type of area is named “industrial district”. In addition, Porter named this type of geographical concentration "industrial cluster", which he defined as a group of organizations in a geographical area, which presents similarities and complementarity of companies because they are all connected to each other. The competitive advantage is therefore the dynamic interactions of a region (Porter, 2000). Becattini (1990), Begnasco and Triglia (1993), in the research on third Italy clustering, found that the advantage of cluster comes from the competition and cooperation between small and medium enterprises which have same cultural and historical backgrounds (Becattini, 1990). In other words, the emergence of industrial cluster is originated for the purpose of competing and collaborating with other industries within the region, a cluster of

related industries can cooperate with each other in certain phases during the producing process. For example, they can share specific facilities, informations and technical personals. In this kind of business network, trust plays the most important role and has the biggest effect among other factors, and we can consider that the industrial cluster is the maximum result of trust which means that industrial cluster not only includes the trade bond between industries but also non trade interdependency. A good relation of trust and cooperation could reduce business risks and transaction costs (Granovetter, 1985), which helps entrepreneurs to establish social networks and obtain knowledge within the industry (Wang et al, 2001). Also, the geographic proximity of the cluster can increase the knowledge spillover which can help innovate the companies (He, 2010).

The production system of vertical disintegration provides manufacturers the opportunity to learn technologies (Hsu, 2000), Tallman et al (2004) analyzed the knowledge in the clusters from the point of view of flow and stock and they found that with the interaction of the companies, the companies can receive the innovative idea and the knowledge easily, therefore the collective learning behaviors within the industrial clusters can form an ability of absorbing and taking in certain knowledge. In other words, by absorbing, learning, distinguishing outer information and applying certain abilities, a knowledge learning system forms.

However, the interactions between companies and the processes of absorbing innovative knowledge are not limited in geographical agglomeration. Maillat (2006) thinks that there are no specific boundaries in regional learning networks, and the composition point is the cooperation between firms, and interactive learning relationships. Porter (2003) also mentions that economic geography possesses dual characteristics, which means that regional fixity and global mobility, what means if there is only knowlege network within the region and at the mean time lacks global connection, there is a possibility of lock-in effect. Therefore, foreign firms and cross-border technology knowledge could bring the innovative knowlege from outside of the clusters and foster the development of the clusters (Saxenian and Hsu, 2001).

Besides, Malmberg and Maskell (2002) mention that the interaction of knowledge within a cluster should have networks called "international and local network", knowledge interactions within a science park should be opened to allow connection between different companies in the world, and the creation of local networks should make companies to interact with each other and facilitate the dissemination of knowledge. In other words, local links and global ties should be both dynamic to support the networks of knowledge in order to expand since the development of external and internal links are the keys to innovative knowledge. Malmberg and Maskell therefore indicate that through the horizontal and vertical dimensions, they think that the companies in the horizontal dimension would have the same markets and sell similar products even they have no contact, they can still enhance their competitiveness through the act observation and comparison. On the other hand, companies in vertical dimensions are different types of industries; they can induce creativity under the relation of mutual cooperation and exchange with other companies.

Different clusters have difference types of knowledge networks, and different social systems will also affect knowledge networks, in order to understand the knowledge networks of the IC industrial cluster of Zhangjiang high-technology park, this study adopts the concept of Malmberg and Maskell (2002), which means to analyze the structure of learning networks through the horizontal and vertical dimenstions, and then to study the relationship between the knowledge network of ICs companies and its embeddedness or disembeddendness within an area.

3. The IC industry in Zhangjiang high-technology park

The IC industry in China has a system of manufacturing called vertical disintegration, this kind of production has a great relevance with the chinese government policies. To review the context of Chinese industry of IC industry, in 1978, there are only small number of manufactures during the Chinese opening up

policy. In 1993, Chinese government has implemented the plan "908" over a period of five years, the goal was not only to build a factory producing 6-inch silicon but also to foster 19 companies IC design. And then, the government continues its momentum and implements a similar plan: the plan "909", which the government invested 1.4 billion dollars to build manufacturing plants and 8-inch silicon invested in the development of 7 IC design companies. In 2000, the Chinese government launched the "No. 18" and in 2011 launched the "No. 4" in which the government will allocate allowances to the software industry and IC industry.

A series of government support plans focus on IC design and IC manufacturing which makes the IC industry in China move to the pattern of specialization (MIC, 2009). Under such circumstances, we can find that the development of IC packaging and IC testing is weak compared to other levels of production systems in the IC industry in China. Besides, it is worth mentioning that, compared to Taiwan's IC design industry, the industry's overall production value is about $ 14 billion in 2010, with the growth rate of 40%; however, the overall output of mainland China's IC design industry is $ 5.7 billion, with the growth rate of 140 %. In addition, the output proportion of Chinese IC design industry in Greater China in 2006 is still less than 20%; yet, it reached 28.8% in 2010. On the other hand, the proportion of Taiwan's IC design industry in 2006 is over 80% but in 2010 the number slipped to 70%, which shows that the IC design industry in China have made a progress and improved their capability in designing (Ye, 2011).

To compare the four development zones in Shanghai city, which are Shanghai Zhangjiang, Lujiazui, Jinqiao development zone and Waigaoqiao development zone. Among these zones, Lujiazui is classified as finance and trade zone while Waigaoqiao belongs to free trade zone, therefore these two zones are different from Zhangjiang high-technology park.

Before 1999, the profit before tax of Jinqiao development zone is 16.3% of Shanghai, and Zhangjiang high-technology park is 0.4%, which means Zhangjiang

high-technology park is far behind the Jinqiao development zone, and even less than 14% (Shanghai Pudong bureau of statistics, 2011). However, the Chinese government still decided to invest a large amount of money in Zhangjiang because 80% of the industries in Zhangjiang belong to High technology industry[1] but in Jinqiao, it is less than 50%. The project "Focus on Zhangjiang" launched in 1999, the government then decided to help developing IC manufacturing and IC design industries. Inspecting the investment of IC industry, one can find that the Chinese government has invested 68.5% of its investment in Shanghai compared to the amount in Jinqiao which has only 2.1%. According to the development report of Shanghai IC industry, Zhangjiang high-technology park is the most concentrated and has the most complete industrial chain in China (Shanghai IC industry association, 2011).

Table 1: The comparison between Zhangjiang high-technology park and Jinqiao development zone

Area	Number of IC companies	Total investment	
		Amount (hundred million U.S. dollars)	proportion of Shanghai
Zhangjiang	146	1,527,944.86	68.5%
Jinqiao	16	46,606.15	2.1%

Zhangjiang high-technology park is founded in 1992. By now, there are 121 IC companies including 89 IC design companies, which accounted for 73.6% of the total IC companies in the park. And there are 5 IC manufacturing companies and 8 IC packaging and testing companies, which represent for 4% of the total number of IC industry. Therefore, there is a high propotion of IC design companies in the park and most of all are small and medium entreprises.

[1]According to Torch high technology industry development center, Hi-tech industry including biological medicine, new materials, environmental protection, aerospace, marine engineering, nuclear and other industries. http://www.chinatorch.gov.cn/default.aspx

Table 2: The number of IC companies in Zhangjiang high-technology park

Specialized of companies	Number of enterprises	Percentage	Industry revenue (Billion Renminbi)	Growth rate
IC Design	89	87.2%	66.1	56.0%
IC Manufacturing	5	4%	96.2	40.2%
IC Packaging and IC testing	8	7%	115.7	37.7%

In the level of R&D performance, there are 2171 patent applications, 809 patent authorizations in 2010. From 1985 to 2010, six of ten largest patent companies in Shanghai are located in Zhangjiang high-technology park. It shows that the number of IC patents in Shanghai accounted the main propotion in Zhangjiang high-technology park.

The IC companies located in Zhangjiang high-technology park have outstanding reputations and ranked high not only in China but also around the globe. For IC manufacturing, the company SMIC ranked as the fourth and Hua Hong NEC electronics ranked as the eleventh in the world. For IC design companies, Spreadtrum Communications ranked as the second in China, and IC packaging and IC testing company ASE ranked as the first in the world. And although Zhangjiang high-technology park appeared much later than the science park located in U.S., Europe, Japan, and Taiwan but it has been growing rapidly, and has a complete industrial chain in the cluster.

4. The research methods: interviews and secondary data analysis

We collected data from 127 IC companies located in the Zhangjiang high-technology park; these companies come from the list of members of the Shanghai IC industry association which was made in 2011 with a total number of 397 manufacturers after deducting 270 companies that are not located in Shanghai Zhangjiang high-technology park. And we also interviewed with 21 IC company

managers. With the help of Shanghai Zhangjiang incubator center, we collected secondary data and completed this field study.

The depth interviews in this study include several parts. The first part is the company's basic information which focuses on understanding the size and the specialized field of the company. The second part investigates the reason why the companies choose to locate in Shanghai Zhangjiang high-technology park. This part aims to understand the relation between the technical learning network and company's geographic agglomeration. The problem of this part includes whether IC companies could get benefits in Shanghai Zhangjiang high-technology park, whether the cluster helps the company to innovate and whether there is any pipeline to promote linkages between firms within the cluster. The third part is to understand the innovative sources of knowledge and the current status of R & D cooperation. This part also includes current status of R & D cooperation within and outside the park, R & D cooperation between upstream and downstream industries or between public / private research institutions, universities. Above all is set for the purpose to understand the embeddedness and disembeddedness for the IC companies within a cluster. The fourth part is about the basic information of the respondents including career experiences, seniority etc.

In order to make a complete analysis and description for the learning network and the geographical embeddedness in Shanghai Zhangjiang high-technology park, we use secondary data to complement the interviews of the the respondents. These data come from the website of 127 IC companies, governmental industrial development reports, industrial development reports of semiconductor industry of China association, reports of China electronic information industry development research institute, iSuppli semiconductor market research reports, IC Insights, semiconductor market research reports, and the Shanghai economic and information technology commission etc.

5. The learning network and the geographic embeddedness of

Shanghai Zhangjiang high-technology park

The flow of new technology and R&D knowledge is the way to develop competitive advantage of a cluster (Saxenian and Hsu, 2001). After having interviewed 21 participants and inspected data collected from 127 IC companies located in the Zhangjiang high-technology park, this study adopts the concept of Malmberg and Maskell (2002), analyzes the structure of learning networks through the point of view of horizontal and vertical dimensions and studies the relationship between the knowledge network of IC companies also its embeddedness within an area. The findings are as followed:

(1). From the aspect of the vertical dimensions: firms of production networks contact and cooperate with each other closely.

(i). Learning networks from cooperation with clients within the same geographical agglomeration

For companies in the production system, the cooperation between upstream and downstream industries not only have transaction cost concerns but also have to increase possibility of the interactive process of technology exchange (Patchell, 1993). In order to manufacture IC chips, it is necessary to seek other manufactures to cooperate with. In this way, companies can make contact with different technologies, products and customers in the markets. Therefore, they would have several potential opportunities to receive new and innovative knowledge.

Our knowledge of innovation often comes from customers and there could be situations when we are not able to manufacture the expected merchandises. However, we will contact and make discussions with our customers for several times. And then we will have better ideas about the making the products, afterwards, we will be able to gradually finish making the products. In the process of exchanging opinions and ideas with our clients we can improve our

abilities and make progress with them. (according to the interview A01-01-58)

For IC design companies, by taking purchase orders from different kinds of techical demands, companies can improve their technique during the process of manufacturing. Yet, on the other side, IC manufacture companies will also be demanded by IC design companies to raise the level of the IC layout. As a result, the contact among the companies upstream and downstream formed a learning network. Compared to the vertically integrated system, the production of vertical disintergration offers an opportunity to improve the technique (Hsu, 2000).

Our customers are mainly from large companies such as SMIC, GSM. Furthermore, our companies always cooperate with manufactures which have high reputation because through cooperating with them we can know our weaknesses and then we can improve our techniques. Also, the learning effect will be much better if we cooperate with some outstanding companies. (according to the interview A04-28-42).

The difference between the production of vertical intergration and the production of vertical disintegration is that the latter is an open system, which can absorb the knowledge from different customers. Besides the relations of customers, the strategic alliance between the companies can help to form a learning network between the production network manufactures in the same geographical area. And since 2005, some strategic alliance also has started to appear in Zhangjiang high-technology park. For example, AVS (Audio Video coding Standard) alliance, which launched jointly by Spreadtrum, Shanghai Hua Hong, Elcoteq century enterprise, and China's IOT (Internet of Things) industry alliance, which established by Shanghai Mobile, Huawei, Huahong 22 enterprise in Zhangjiang high-technology park are all belong to this kind of alliance. The objective of the alliance is to discuss product standards and to share technical information.

(ii). Cross-border learning network

Aside from the fact that relationships between clients of the same geographical agglomeration would form learning networks, because of the improvement of cost of transportation and communication, which reduces the limit of distance and obtain the highest profit, the cooperation between different regions could form cooperation systems through continuous contacts. As a result, there will be knowledge spillovers, which may help to form formal learning networks.

There are two forms of cross-border learning network. One is to cooperate with well-known companies to increase the possibility of technological learning. We can see examples like IC design companies located in Zhangjiang high-technology park Spreadtrum Communications cooperating with ZTE Corporation, which located in Shenzhen, and also the example of IC manufacture SMIC, which located in Zhangjiang high-technology park, cooperating with Cadence located in Peking for the R&D research projet of 65 nm low power solution project.

> *We would manage to cooperate with some well-know companies because they have higher quality. And by cooperating with them we can learn techniques from them and make progress. Furthermore, big companies may introduce customers to us. This partnership is not only seen in Zhangjiang but also in other geographic areas. The business that we are looking for is to elevate our reputation and innovative techniques by collaborating with our clients. (according to the interview A02-09-10).*

Aside from official contract of partnership, there are also informal cross-border learning networks, in that case, China semiconductor industry association and Shanghai IC industry association play important roles in this network. For promoting the cooperation between industries, these two associations organise annual seminar, trend conferences to help boosting cross-border exchanges between vertical disintergration companies.

There are several seminars held each year, and this kind of seminars not only takes place in Zhangjiang but also in some other places in China. This kind of seminars is organized by the industry association to help us to communicate with other companies; therefore we can get some useful industry information and secrets in the seminars. (according to the interview A02-09-10).

(2). From the aspect of horizontal dimensions: the learning network in the same type of industry

(i). Learning networks forms because of the relationships in the same geographical agglomeration.

From horizontal dimensions, companies provide the same product or services would compete with each other; however, that does not equal to the end of their cooperation. In Zhangjiang high-technology park, we can notice that the learning network could come from the relations between industry investments and mergers. For example, the merging plan between Hua Hong Semiconductor and GSMC, both companies are located in Zhangjiang high-technology park, and the case of IC design house Spreadtrum Communications purchasing mobilepeak holdings. There are many large IC design companies increase their range of product, enhance the relationship of cooperation between firms, and recruit design talent through investing or merging small and medium enterprises (Chen, 2008). This kind of action is usually used for network technogical learning in order to develop specific chips (Tseng, 2009).

In addition, the innovation and incubation center of Zhangjiang high-technology park plays agent between companies with the purpose to help increasing the interactions and cooperation between companies in the park and then develop learning networks.

The objective of the incubator center of Zhangjiang is to nurture new companies which are less than three years. We often hold parties for promoting interation of

companies. There are some newly established companies being acquired because of their unique technologies, and with our help, they can contact companies which interested in them. (according to the interview A03-12-47)

While for IC design companies, on the basis of mutual trust, they often outsource one part of the productions in order to reduce costs and shorten the time of the products being launched into the market. Therefore, the relationships of companies will change from competition into cooperation, or they will even establish strategic alliance. Such instances can be found in the cases of Brit Semiconductor and VeriSilicon establish design services alliances for sharing its information with others.

Outsourcing is very prosperous in Zhangjiang high-technology park, which is the so called solutions provider. This kind of companies provide design services to other companies through the partnership, in this relation, The company may be able to get a lot of experience and report, it will learn a lot (according to the interview A18-29-35).

(ii). Cross-border learning network

From the aspect of horizontal dimension, the cross-border learning network often occurs in the inter-industry R & D cooperation relations. And since the industries are quite competitive, it shows that the cooperative relations are endorsed by official contracts. And in Zhangjiang high-technology parknology Park, we also notice that IC design companies which located in different clusters signed formal contracts and built R&D relationships together. Take the company Leadcore technology for example, the company signed a contract with Vimicro to develop multimedia standards for 3G mobile phone and find its related solutions. There is also another example of Spreadtrum Communications cooperating with ZTE to develop a R&D program, which has formed a learning network.

When we signed the formal contrat with China Telecom we advised China

Telecom to join in with the Taiwanese company Metanoia Communication and the German company Latiq. We think this kind of cooperation can help us to do IC designs together. And although our business is in a competitive situation but it doesn't matter because it's a new industry, the cooperation between companies can help to expand the market. After the industry becomes mature, our competitive relationship is to see whose product is good and the customer service is well, this kind of relation is not contradictory for our company (according to the interview A05-17-45).

Another R&D program designed by the companies is to seek top technologies, and since the companies aim to get better techniques, they don't consider geographical distances as limitations and regard the distances as the elements which can help the development of the industries and thus forming another cross-border learning network.

The reason why we set up our company in Zhangjiang high-technology park is because there are more complete industrial chains in China, also, the facilities and the employees there are better. Moreover, there are more clients. Despite of these advantages, we still have to contact with the companies in Shenzhen because Shenzhen's technology is relatively new so it is not necessarily to limite our partnership in Zhangjiang(according to the interview A08-17-38).

Also, there are established through personal relationships. This kind of relation could be official and non-offical, and this kind of relation will be not limited by geographical distance so the relationship can last longer. Jinn-Yuh Hsu mentions in his research that the knowledge embodied the engineers or scientists would spillover to different companies (Hsu, 2000). This kind of knowledge spillover may not only occur in a cluster but also outside of it.

Our company will find some outsourcings for R&D; these outsourcing relationships come from informal relationship. However, this kind of relationship

is under table because the people who did this outsourcing work have their own jobs. The only difference is that these jobs are not contradicted to our industry. It is because they are interested in IC designing so we keep this relationship of R&D with him (according to the interview A11-06-38).

The main purpose of this personal relationship of cross-border learning network is to get some specific R & D techniques. The companies belong to the same type of industry but since they are located in different regions which may reduce the contradiction of competitiveness. And with the help of personal relationships, which may auxiliary the diffusion of technical knowledge.

(3). The cooperation between the company and acadamy, public and private R & D institutions

Besides the learning network of vertical and horizontal dimensions, learning network outside of the production system can also be observed. In Zhangjiang high-technology park, there are several research programs developed by companies and universities. For example, the company Huahong electronic cooperates with Shanghai Fudan University for developing a research program; also, the Teradyne Technology has developed a joint project with Shanghai Jiaotong University for establishing a semiconductor laboratory.

Our company has cooperated with Fudan, Jiaotong University. This kind of cooperation is mainly established for the purpose of doing some researches collaboratively. And thanks to this partnership, we would have the opportunity to employ many students from Shanghai Jiaotong University in our company (according to the interview A05-14-18).

6. Industrial Cluster and Knowledge Network Research and Development

Many studies suggest that innovative milieux come from collective learning because the interaction, coordination and cooperation of various actors in the cluster can bring up learning relation. Actors in the cluster can learn to absorb, identify and use the knowledge in the cluster. These are all capabilities which will be developed in the cluster, in the meanwhile, reducing the uncertainty in the R&D process to decrease the cost of the depletion (Maillat et al, 1991; Camagni, 2006). Geographic proximity is beneficial to face-to-face communication and to facilitate the exchange of information and knowledge spillover. Simultaneously, knowledge and creation are strongly influenced by local resources, institutions, social and cultural factors (Maskell and Malmberg, 2002). Therefore, industrial cluster is more effective to the formation of learning networks. However, the innovation of the firms not only comes from the industry cluster but also from the cross-cluster and the global links. Owen-Smith & Powell (2004) research found that although the geographic proximity helps to generate knowledge spillovers; however, new knowledge is still established through the link generated by different scales of strategic alliance partners.

In order to understand the R&D network and the connection of the cluster, we collected data from 127 IC companies located in Zhangjiang high-technology park and we also use secondary date for completing the following information.

Table 3: The R&D network and the connection of the cluster in Zhangjiang high-technology park

	R & D relationship within the Zhangjiang high-technology park	R & D relationship outside the Zhangjiang high-technology park
The number of R&D relationship	17 (7.5%)	52 (40.9%)
Research institutes / Universities	10 (52%)	14 (26.9%)
Companies within the production system	8 (48%)	38 (73.1%)

	The same type of industry	2 (25%)	16 (42.1%)
	Different type of industry	6 (75%)	22 (57.9%)

The table above shows the R&D relationship of the IC companies within and outside of the Zhangjiang high-technology park. The date collection also includes the depth interviews, and the announcement of the companies. The results of the calculation contain not only formal R & D partnership (including two companies jointly released a new technology and the solution). The results also show that there are several cooperative R & D programs outside the park, with 40.9% of the companies in the park signing a partnership contract for R & D with companies located outside of the park. Among them, there are 73.1% of the companies build relationship with the companies within the production system, 57.9% of the companies have relationship with the companies in the system of vertical intergration, and 42.1% have relationship with the firms in the system of horizontal integration. However, only 7.5% of the companies have signed a partnership internal Zhangjiang high-technology park. Therefore, we can see low activity in R & D between different actors in the park.

According to the above table, we can observe several phenomena in Zhangjiang high-technology park.

(1). The links of R&D activities in the park are weak.

Regarding the numbers of IC patents, Zhangjiang high-technology park accounted for the main proportion in the IC industry in Shanghai; however, most of the companies choose to cooperate with the companies outside the park or they would choose to do researches on their own.

The flow and the exchange of knowledge within a cluster should also include international and local networks. Indeed, knowledge interactions within a science park

should be opened to allow interaction between different companies around the world. And the creation of local networks should make companies to interact with each other and facilitate the dissemination of knowledge. In other words, local links and global ties should be both dynamic to support the network of knowledge to expand, because the development of external and internal links are the keys to innovative knowledge. (Wang, 2009).

In Zhangjiang high-technology park, most companies depend on independent R&D. The knowledge sources come from the learning network which formed by horizontal and vertical relationship of companies, according to a companies located in Zhangjiang high-technology park, the weakness link of R&D in the cluster is unfavorable for the development of industrial cluster.

> *There are still big differences between Zhangjiang high-technology park and Hsinchu science park because even there are several universities and research centers nearby Zhangjiang, the two institutions are like two layers of skin which do not fit in with each other (according to the interview A06-07-40).*

Porter mentioned that the advantages of the competitiveness of an industrial cluster come from producing factors like raw materials, strategies, competitiveness, requirements, and related supporting industries. Carrie (2000) adopted the concept of Porter to explore into the strategy of the cluster development of Arizona State. He mentioned that the government should concentrate on creating the human resources, capital, quality of life, technology, tax and management etc. Industry cluster development still needs the government to support them with great effort.

Although there are research institutions (Shanghai IC R&D center), universities (Tongji University, Fudan University and Jiaotong University) and technology transfer offices in the Zhangjiang high-technology park, there is no organisation served as a bridge to help to transfer the technology like the industrial technology research institutions of Taiwan does, therefore we can see that the links between them

and the IC companies are weak. As a result, about half the companies establish cooperative relations with actors outside of the park.

> *At first, the responsibility of Taiwan's industrial technology research institution is to do the technology transfer but now it starts to develop the R&D techniques. And it also begins to connect universities, companies and institutions. Now, it is very influential to the development in Hsinchu science park (according to the interview A06-10-22)*.

Shanghai IC R & D Center is established according to the policy "Software services and IC industry development policy", which is set up by the Shanghai municipal government in 2002. The objective of this center is to help transferring the technology, R&D and personnel training. And it belongs to a nonprofit public R & D institution. However, regarding the patent applications of IC in Zhangjiang high-technology park, the key technique and information of the patent belongs to the companies like SMIC, Shanghai Hua Hong and Shanghai Microelectronics which accounts for the number of patents in Shanghai about 30%, 14.8% and 5.5% distinctively. Acoording to the interview, Shanghai IC R & D center's exchanging effects are not specific and clear, Zhangjiang high-technology park is still lack of formal R & D activities in the Park.

(2). The companies within the park frequently cooperate R & D with the companies outside the park

According to Zhangjiang high-technology park industry's development report, from 2006 to 2009, the amount of domestic capital is approximately 74.78 hundred million dollars, and the foreign capital amounted to about 38.56 hundred million dollars. This shows that foreign capital accounted for 51% of the total amount of the investment in the Zhangjiang high-technology park. And it may perhaps explain why 40.9% of the companies in the park signed a contract in R & D with companies located in the exterior of the park.

Castells (2000) mentioned that most multinational enterprises are the owners of some top techniques around the globe; and the constructions of these top techniques are made to surround the enterprises. And the aspects outside of these techniques should be supported by a complex, continuously changing cross-border network. Under the development of globalization, the formal and informal relationships can generate synergy effects, which may help to connect local links and global ties. (Amin, 2002). In other words, the information and communication technology developed under the evolution of innovative knowledge may help to reduce knowledge acquisition, transfer and communication cost; however, it still cannot replace the knowledge spillover effects completely. The geographic proximity helps to build a connection a network through formal and informal relationship, which can help the industrial clusters to develop more sustainable.

> *Our company has teams both in the United States and Spain, and we have many experiences for transnational management. Every year, we would send some of the local's engineer to go out training and go out abroad to learn techniques. But even so, we still prefer the face to face communication. For example, this afternoon, SMIC have a problem about IP Licence with our company. At that time, we can immediately stand out to discuss the problem in person with them and work together to solve the problem (according to the interview A18-09-50).*

Collective learning and local knowledge network can help to form and develop an industrial cluster (Keeble and Wilkinson, 2000). By cooperating with the enterprises outside of the cluster, the companies can get the innovative knowledge and techniques. And by cooperating with the enterprises within the cluster, the companies can facilitate the dissemination of the knowledge in the cluster and help to foster the development of the cluster. However, local links and global ties should be both dynamic to support the knowledge network. And if there is only the local links in the cluster it may cause the lock-in effect, which may stop the development of the cluster. The development of external and internal links is the key to innovative knowledge

(Bathelt, Malmberg and Maskell, 2004).

After interviewing with the managers of the companies which are located in Zhangjiang high-technology park, we can know the reason that why most of the companies chose to locate in Zhangjiang high-technology park. It is because of the complete industrial chain which made it to make this choice. Another reason is that this cluster is close by universities of Fudan and Jiaotong so the companies can find the engineers easily. Hsu (2000) indicates that the vertical disintergrated production system can help the industries to concentrate, the employees have the knowledge embodied and can use the cluster to diffuse the techinques in the science park. This kind of flow on one hand solves the bottleneck, on the other hand integrates the firms of upstream and downstream. But this kind of work-flow may cause the situation of the knowledge being lock into specific technique (Hsu, 2000).

The advantage of Hsinchu science park is not only the internal flow of knowledge but also the openess of connection with the global tie (Saxenian and Hsu, 1999). For example, there are strong interactions between the engneers in Hsinchu science park and the talent in Silicon valley. Looking back at Zhangjiang high-technology park, the system production of vertical disintergration can help the knowledge spillover but the weakness of innovative milieux will keep the effectiveness of the innovation down. On the other hand, if the innovativeness should be generated through the non official relationships in the cluster, it will rouse a question that whether this kind of technique proliferation should be classified as a technique plagiary or derivation.

To avoid the decline of the industrial cluster, the key is to keep the interactions between organization of the network, new technique and the flow of the information within the cluster and the innovative performance of the companies having the demand to interact with the actors outside the cluster. (Saxenian, 1994; Fritsch and Kauffeld-Monz, 2010). In short, the key to sustain the development of the industrial clusters is to absorb the external knowledge and innovative technologies. The

advantages of Hsinchu science park pose on the link with Silicon valley, and the effectiveness of Taiwan's industrial technology research institute (ITRI) R & D and technology transfer. Since 1970, ITRI transfered the technique of IC and the management from RCA, and then establish private companies, including TSMC, UMC, and Taiwan Mask. Therefore, there are strong connections between ITRI and the IC companies (Hsu, 1997).

However, the source of the techniques of Zhangjiang high-technology park comes from the Japanese companies; the cooperation is under the encouragement of "Software industry and IC industry development policy". In this transfer, the governement give companies special discounts on tax and fund but there is no help on R&D and technique transfer (Huang, 2008). Therefore, there are differences between the Chinese governement and Taiwanese governement to promote the industrial cluster.

7. Conculsion

In the mass production industry, knowledge innovation is considered to be a linear model, which is like a production line, the innovative ideas come from the laboratory, and the laboratory would give ideas to the design departement, after designing the blueprint, the ideas are then given to the manufacturing sector, and then it become products and would be sold to the market. However, this concept misses other possibilities to innovate and the innovation may come from a mechanism of feedback interaction (Wang, 2009). In recent years, there are more and more researches of regional industral emphasizing on the concept for learning regions (Cooke, 2001, Asheim 2002). These researches indicate that learning is an interactive process; only by effctive interacting that can make the tacit of knowledge be rapid delived and diffused.

The IC industry in China adopted the manufacture of vertical disintegration, which means that the upstream and downstream manufacturers should cooperate

closely to complete IC chips. In this kind of manufacture system, the localization economy and the knowledge spillover are produced easily. The research findings are as follows.

(1). Clustering, cross-border technological learning network

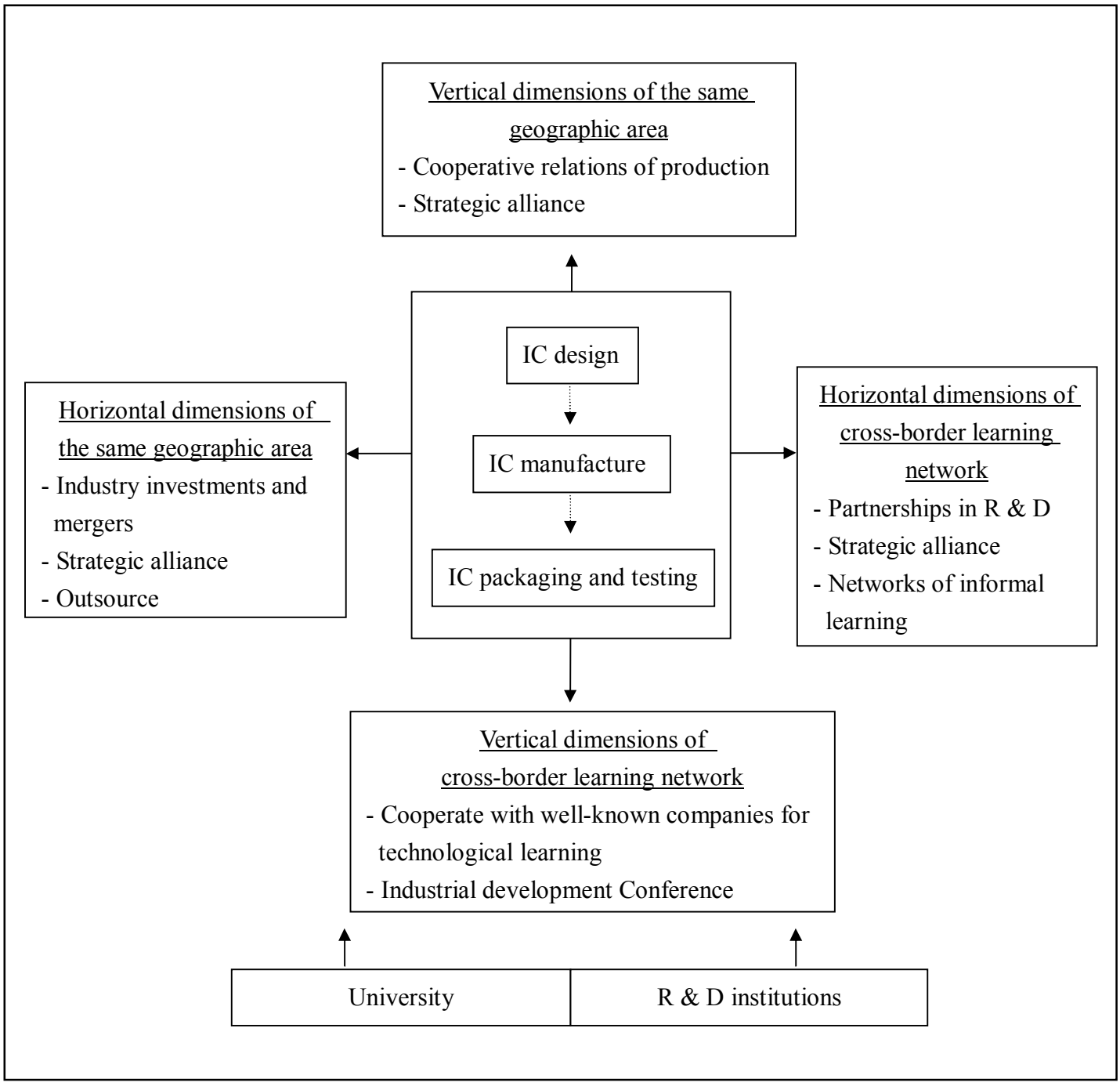
The learning network of Zhangjiang high-technology park is formed by the manufactures of vertical disintegration and the relations of cooperation and competition between the same kind of companies, this cooperation including company and acadamy, public and private R & D institutions. The manufacturers of vertical disintegration of IC industry increase the interactions of upstream and downstream companies; therefore, the companies can improve their techniques by communicating and cooperating with each other and can further form a dynamic learning cycle. Besides, the companies could exchange their knowledge by discussing the product standards, and developing the technical information.

The vertical learning networks from upstream and downstream not only occur in the same geographic area, to get higher techniques, the IC companies often build cooperative relationships with well-known companies in order to get the technological learning, and ignore geographical restrictions. In addition, there are seminars organized every year by the China semiconductor industry association and Shanghai IC industry association in different regions to promote the cross-sector interactions between the companies.

On the other hand, the horizontal learning network could occur within the cluster and outside the cluster. The same type of companies could build a network to interact with each other by the relationship of strategic alliances, partnerships in R & D etc. Also, besides formal relationship, informal relationship can promote the discussion and the exchange of the knowledge; this relationship could happen both inside and outside of the park. The learning networks outside of the production system could be observe in the cooperation between industry and university program or public /

private research institutions in R & D cooperation etc, these relationships will help reduce the R & D costs, but also to promote mobility between universities and enterprises.

Graph 1: The vertical and horizontal learning network within and outside the Zhangjiang high-technology park



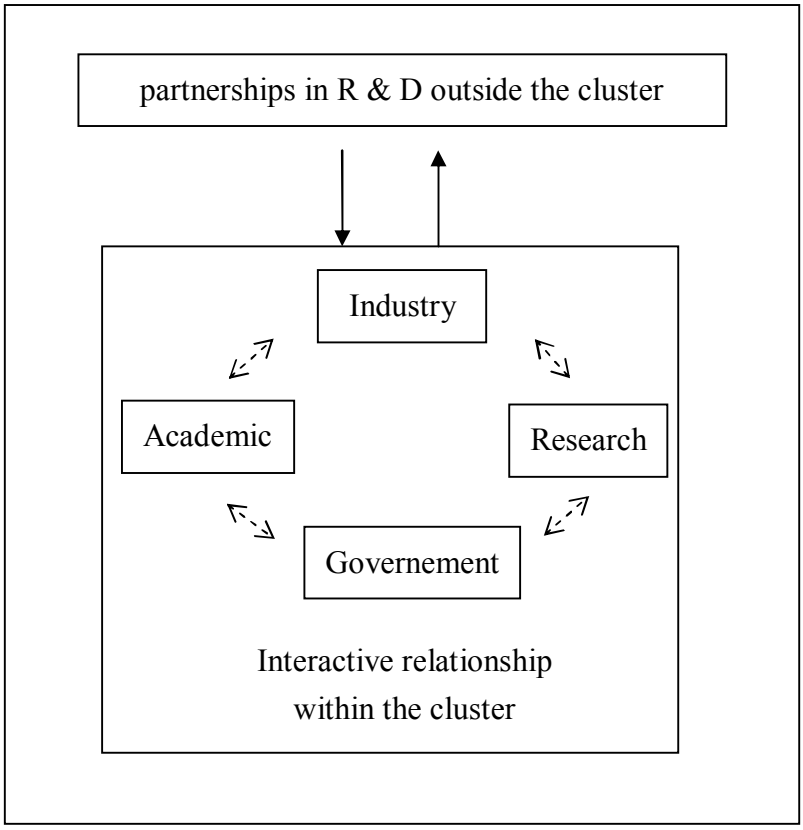
(2). The global R&D cooperation network

There are many researches mentionned the key of the development lies to the interactions between globalization, industrial region and the system of the industry. The manufacturers of vertical disintegration of IC industry can form a cooperative learning network easily. The companies can get the innovative knowledge from different clusters, and then diffuse the knowledge through knowledge spillover to the members of the clusters. This kind of external and internal links are the keys to get the innovative knowledge, just like the graph 2 shows.

This study collected data from 127 IC companies which are located in the Zhangjiang high-technology park. The results show that there are several phenomena cooperative R & D outside the park, 40.9% of companies in the park have signed a contract concerning R & D with companies located in the exterior of the park. Although the manufacturers of vertical disintegration can have the effet of knowledge spillover; however, the developpment of industrial cluster should combine the knowledge of different clusters and then transmitted within the clusters. Through research results, we can see that the links of R&D between companies and other members in the clusters are weak in Zhangjiang high-technology park. And it lacks the formal R&D cooperation within the cluster, so that it is worth exploring whether the development would face cluster lock-in or not.

World's number four IC design companies MediaTek's Chairman Tsai Ming-Kai rose "one generation of Muhammad theory." This means that for IC design companies, it’s easy to beat other competitors by using new chips and new products but it may also cause the companies to forget to innovate and then fall into the old products, old customers, and catch up by other competitor, enjoy only the glory for a moment. In other words, the innovation is the key for the companies to keep their advantages, the companies could get the innovation by interacting with the institution, universities, information and new techniques.

Graph 2: External and internal links are the keys to innovative knowledge



(3). Cross-border learning network and local interaction

As mentioned above, Zhangjiang high-technology park has a weak connection in formal R&D activities; most of the companies choose to cooperate with the enterprises outside the park on the R&D section or they choose to do R&D independently. This is not good for the development of industrial clusters. Shanghai IC R & D Center is established by the Shanghai municipal government in 2002. The objective of this center is to help the transfer of technology, R&D, personnel training. It is a nonprofit public R & D institution. However, its role to drive the exchange knowledge is weak; therefore, it lacks formal R & D activities in the park.

The ideal development of the cluster should have a network called "international and local network". Indeed, knowledge interactions within a science park should be opened to allow connections between different companies in the world, and the

creation of local networks should make companies to interact with each other and facilitate the dissemination of knowledge. However, Zhangjiang high-technology park lack the dynamique interaction within the cluster, and the companies prefer to cooperate with the enterprises outside of the region, which form a cross-border interaction. And according to the statistical report of Zhangjiang high-technology park, the park has an average growing of 17.2%; it would be interesting to know what the future of the park is and it is worth continuing to concern.

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