

Global knowledge linkages and the innovativeness of local clusters: Evidence from the Guangzhou software cluster in China

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Abstract

The aim of this research is to examine the importance of the nature and spatial dimension of knowledge sources on innovation of local firms in a cluster based on the regional innovation system approach. First, we introduce the “local buzz” and “global pipeline” argument. Second, we propose a conceptual framework incorporating two spatial dimensions of knowledge sources: local knowledge networks and global knowledge linkages, which include knowledge flows from inward foreign direct investment (FDI) to local firms as a part of global knowledge linkages. Third, we use qualitative analyses and firm survey data from a Guangzhou software cluster to show that global knowledge linkages and local knowledge networks are of similar importance to the innovation of local firms in a cluster, especially for local innovative firms. Customers, competitors, consultants and new personnel are the four most important knowledge sources to the innovation of local firms from both local knowledge networks and global knowledge linkages. The local firms with knowledge more from global knowledge linkages are more innovative. Finally, some policy implications, based on the research, are identified.

Key Words: Global knowledge linkages; local knowledge networks; innovativeness of local firms; local clusters

1. Introduction

The development of industrial clusters has become a world-wide economic phenomenon and is associated with globalization and the knowledge economy. Much innovation research identifies clusters as an important aspect of the innovation system (Rosenfeld, 1997). Research suggests that firms in clusters may be more likely to be innovative than their counterparts not in clusters (Porter, 2000). Local knowledge networks may be taken as the common elements for improving the innovativeness of firms in clusters by most cluster researchers.

But recently, there has been a growing interest in the relationship between global knowledge linkages and the innovativeness of local clusters. Some

researchers (Bathelt and Malmeberd, 2004) use global pipelines to explain this relationship. They have shown that global pipelines offer significant advantages for firms engaged in innovation and knowledge creation in local clusters. Some researchers (Birkinshaw and Solvell, 2000; Rugman and Verbeke, 2002) from the international business theory field have shown that Multinational Enterprises (MNEs) induce externalities in local clusters and improve innovativeness by providing access to assets, technologies, and management skills to the domestic components of the cluster. As noted by Porter (Porter, 1998), “cluster development can be seeded and reinforced by inbound FDI”. Other researchers (Simmie et al, 2002; Hendry et al., 2000; Cooke, 2001; Bresnahan et al, 2001; Humphrey and Schmitz, 2002; Bathelt et al., 2004 ; Enright, 2000) have found evidence that the global knowledge linkages are regarded in some aspects as more important than local knowledge networks within clusters in raising the innovativeness of local clusters using data from developed economies.

The importance of global knowledge linkages to the innovativeness of clusters has been increasingly highlighted by these researchers. Linkages with these external actors are indispensable in the development of clusters not only as an outlet for production but also as a conduit for advanced knowledge, especially for clusters in the developing countries, which have less local knowledge sources. In fact many clusters in developing countries, such as technology intensive clusters and trade oriented clusters, have more and more international linkages. However, little empirical research has focused on relationships between global knowledge linkages and the innovativeness of local clusters in developing countries.

The aim of this paper is to investigate the relationships among the local knowledge networks, global knowledge linkages and innovativeness of firms in clusters in a rapidly transitioning economy. This paper tries to provide a better understanding of the importance of the spatial dimension of knowledge interactions. More specifically, we will examine the following research questions by using the qualitative approach and firm survey data from

the software cluster in Guangzhou, China. The research questions this study attempts to answer are:

- Do the global knowledge linkages have a significant impact on the innovation of local firms in the software cluster?
- What kinds of global knowledge linkages are the important knowledge sources for local clusters in developing countries?
- How do the interactions of local knowledge networks and global knowledge linkages impact on the innovativeness of local clusters?

This paper is structured as follows. In Section 2 we start from the importance of knowledge flows in regional innovation systems and introduce the “local buzz” and “global pipeline” argument. We then propose a conceptual differentiation between two spatial dimensions of knowledge sources and interactions that serves as theoretical background for the empirical part of this research. Section 3 presents the methodology and processes for the empirical analyses and then provides a background on key features of the software cluster. Section 4 and 5 use qualitative analyses and firm survey data from Guangzhou software cluster to show that global knowledge linkages and local knowledge networks are nearly similar important to the innovativeness of local firms in a cluster, especially for local innovative firms. Customers, competitors, consultants and new personnel are the four most important knowledge sources to the innovativeness of local firms from both local knowledge networks and global knowledge linkages. The local firms with knowledge more from global knowledge linkages are more innovative. Finally, Section 6 draws some conclusions and implications.

2. Literature Review and Theoretical Framework

In this section, based on a regional innovation systems approach, we start to identify different types and the spatial dimension of knowledge sources in local clusters, and then introduce the “local buzz” and “global pipeline” argument and propose a conceptual differentiation between two spatial dimensions of knowledge sources and interactions that serves as theoretical background for the empirical part of this research.

(1) The nature and the spatial dimension of knowledge sources in regional innovation system

There is now considerable interest in the workings of regional innovation systems, that is, the linkages and interactions between enterprises, universities, specialist research institutes and other actors involved in the production, distribution and application of economically useful knowledge (Freeman, 1995; Lundvall, 1992; Nelson, 1993). They believe that innovations are carried out through a network of various actors underpinned by an institutional framework. This dynamic and complex interaction constitutes what is commonly labelled

systems of innovation, i.e. systems understood as interaction networks (Edquist, 1997; Kaufmann and Tödtling, 2001).

The importance of knowledge flows in regional innovation systems for successful innovation processes has been intensely discussed in the regional innovation system literature (Freeman, 1995; Lundvall, 1992; Nelson, 1993; Keeble, 2000). Segelod and Jordan (2006) note that strong knowledge interactions are crucial in the innovation process in local clusters, and they have shown knowledge interactions are not only a precondition but also a result of successful innovation activities. In the research on knowledge flows and innovation of firms, a special emphasis is given to innovative clusters, which suggests that knowledge flows from other firms and organisations, such as vertical and horizontal linkages, influence the accumulation and diffusion of knowledge required for firm innovation (Nelson and Rosenberg, 1993; Porter, 1990).

Our analyses take the perspective that knowledge flows are very important processes for clusters in developing countries, if they expect to improve innovativeness of firms in a local cluster. With regard to knowledge sources of local firms in a regional innovation system, Keeble (2000) noted that some firms innovate with their own resources, others with the help of suppliers, clients and related firms, with consultants, or with other private and public sources of knowledge information. For the spatial dimension of knowledge sources for local firms in the background of the global economy, we divide the spatial dimensions of knowledge sources into local knowledge networks and global knowledge linkages. In order to answer our research questions, we mainly focus on the spatial dimension of knowledge sources for local firms.

(2) Local knowledge networks and innovation of local firms in a cluster

A key implication that could be derived from the cluster literature is that local knowledge transfer and exchange are of vital importance for the innovation of firms in a cluster. Localised flows of know-how and expertise are regarded to be of key significance for the innovation capacity and competitive strength of clusters and regions (Porter, 2000; Malmberg and Maskell, 2002). Most research links the knowledge spillovers with locality, and takes it as tacit knowledge flow pervasive within a spatially-bounded cluster (Audretsch and Feldman, 1996; Baptista, 2000).

Local knowledge networks provide the platform for collective learning and the social trust relationships which are conducive to innovation in local clusters. As Capello(1999) put it: “the mechanisms for the spatial transfer of knowledge are social because new knowledge is transferred to other agents, whatever the will of the original inventor, thanks to common technological, organisational and institutional routines and behaviours which facilitates the sharing

of information and know-how. Local knowledge networks also provide the platform for a mobile local labour pool, which is a very important mechanism for knowledge transfer in technology-based industrial clusters (Malecki, 1997). In Porter's famous diamond model from the public knowledge flow perspective, cluster participation also offers advantages in perceiving new technological, operating, or delivery possibilities. Participants can be exposed to richer insights into evolving technology, component and machinery availability, service and marketing concepts, and the like. Ongoing relationships with other entities within the cluster (including universities) facilitate such learning and knowledge flows, as do the ease of site visits and face-to-face contact (Porter, 2000). The importance of local knowledge networks has dominated cluster innovation literature.

(3) Global Knowledge Linkages and innovation of local firms in a cluster

While the literature on clusters has originally centred on domestic firms, the process of globalisation has meant that clusters increasingly have significant levels of foreign ownership (Birkinshaw, 2000). So it is particularly problematic that studies have traditionally focused only on local innovative advantages, while underestimating the impact of global knowledge linkages. There seems to be a growing consensus among many scholars that it is not only local knowledge circulation that fuels innovations, but knowledge from outside local clusters is also important to the innovation of firms in the local cluster. Current studies (Simmie, 2003; Bathelt et al, 2004; Owen-Smith and Powell, 2004) pay attention to the fact that innovative clusters in advanced economies cannot be self-sufficient and raise the importance of external linkages or the so-called "trans-local pipelines".

Non-local linkages, namely the "pipelines", constitute channels for the entry into the cluster of new knowledge regarding new markets and technologies (Bathelt et al., 2004). For example, Simmie (2003) considered the interface of local and global and found that in the United Kingdom, innovative firms are concentrated in a few locations, but at the same time, innovative regions have more linkages with international actors than less innovative regions. In his interpretation, global knowledge linkages (with customers and clients) are more important for obtaining leading edge knowledge concerning market trends than for obtaining technological information. In other words, Simmie raises the important issue of understanding the drivers of innovation and stresses the significance of global knowledge linkages for local firms in a cluster in advanced economies (Simmie, 2003).

According to these new insights, clusters need to establish and maintain external relations in order to sustain their innovativeness in the long run.

Meanwhile the literature on knowledge transfer from the outside in developing countries has recognised the importance of accessing and absorbing international knowledge for long time (Evenson and Westphal, 1995; Szirmai, 2005). To tap into international knowledge sources obtaining access to expertise and skills that are not available within the limited context of the region is considered to be of crucial importance (Camagni, 1991; Bunnell and Coe, 2001). In order to avoid becoming locked-in to the low end of production, knowledge flows from external sources are crucial to developing countries because of limits of resources in the local milieu of developing countries. Global knowledge linkages can be taken as an open gate for regional innovation systems (UNIDO, 2003). These researchers underline the fact that the main sources of innovation in less developed countries originate in the external domain. This has provided the basis for our decision to examine the relative importance of local knowledge network versus global knowledge linkages.

(4) The type of global knowledge linkages and FDI activities

Global knowledge linkages can be generally considered a source of knowledge, in a broad sense, including product, process and distribution expertise, as well as management and marketing skills for developing countries. Knowledge flows can globally transfer through several channels, such as global value chain, multinational enterprise activities, global personnel movement. Multinational enterprise activities have important effects on national competitiveness which are not adequately covered by the facet "firm strategy, structure, and rivalry" (Rugman and Verbeke, 2002). Each facet of the diamond is linked to multinational activity, as multinational activities can influence factor conditions, related and supporting industries and demand conditions, as well as strategy, structure and rivalry. MNEs are seen as global networks of firms, and one of the main characteristics of these networks is the creation, diffusion and commercialisation of technological innovations (Dunning and Gugler, 1994). Knowledge can transfer through global buyers – suppliers' relationship (Global Value Chain theory), in fact, global customers and suppliers in a global value chain (GVC) are an important role for global knowledge transfer (Gereffi & Kaplinsky 2001; Gereffi, Humphrey & Sturgeon 2005). Firms and in particular contract suppliers, can get knowledge by being incorporated in global value chains and in particular learn from demanding customers and large corporations.

In addition, knowledge interactions between international R&D centres in a local cluster and local firms are more and more important for innovativeness. Yun-Chung Chen took Shanghai as a sample of regional innovation system and illustrated how MNEs' R&D plays an important role

in the development of the Chinese high-tech industry. Their research takes foreign R&D as a significant contribution to understanding the rapid growth and development of one of China's high-tech clusters. Knowledge flows through the global social networks and global labour movements to local firms are taken as important sources for improving innovativeness of local firms. As Saxenian and Hsu concluded from their work on the connection between the Taiwanese IT cluster and Silicon Valley, new centres of technology and entrepreneurship cannot be created with global social ties, spin-off and labour movement. In our research, we identify knowledge flows from FDI to local firms, including from foreign R&D and foreign firms in local cluster, as one type of global knowledge linkages, although they are different from knowledge flows through global value chain and direct global knowledge trade in terms of geographically external knowledge for local firms in a cluster.

To summarise, the evidence on the effect of spatial dimension of knowledge sources on the innovativeness of local clusters is at least contradictory. Meanwhile it is concerned that the importance of different types of knowledge sources and spatial dimension of knowledge sources may have different evidence in developing countries because there are less local knowledge sources.

3. Research Methodology and Case Description

(1) Research methodology

Based on the literature review and theoretical framework, we use the two attributes of knowledge flows to construct the research model. First, we examine the different types of knowledge sources in local clusters. Hauschildt (1992) has developed a model of the various linkages involved in innovation termed "The informational relations of the innovating firm". The relations are divided into four groups: Markets; Scientific System; Government /Public Authorities; and Mediating System. Håkansson (1990) distinguishes between customer relations, supplier relations, and horizontal relations of knowledge interactions. The latter includes complementary producers, competitors, universities, etc. Based on our qualitative research we identify market type of knowledge flows as knowledge derived from customers, suppliers, competitors, service firms, new personnel, consultants, and identify scientific type of knowledge flows as knowledge derived from R&D centres, universities, public research institutes, and identify open type of knowledge sources as knowledge derived from fair and exhibitions, professional and industry associations, scientific journals and publications, electronic information. So we can examine the effect of different types of knowledge flows on the innovativeness of local firms in a cluster.

Second, based on the community innovation survey model we divide the spatial dimensions of

knowledge sources into four geographic levels, regional, national, local FDI and international. So we can examine the impact of global knowledge linkages versus local knowledge networks on the innovativeness of local firms in a cluster. In order to answer our research questions, third, we conducted the innovative firm survey and some phone interviews on Guangzhou software cluster. In addition to basic firm information and self-assessed innovativeness of firms, firms were asked in the survey to assess the importance of various knowledge sources of assistance for their upgrading or innovation efforts on a Likert scale (0=unimportant, 1=less important, 2=neutral, 3=important, 4=very important). We provided them with different potential sources of knowledge based on the knowledge source model. Moreover, firms were requested to report how important the different spatial dimension of knowledge sources that they use for innovation of firms.

(2) The requirement of case selection

Although the software sector is quite young (Weterings and Boschma, 2006), the sector is already of considerable size, both in terms of number of firms and employees (Florida et al., 2003), even in developing countries. Due to the high pace of innovation in the software industry and the dominance of small-medium firms, knowledge linkages and partnerships are recognised to be of vital importance for innovation (Segelod and Jordan, 2004).

The emergence of a new software development paradigm, the internationalisation of markets and the resulting increased global competition, thus, enhance the significance of knowledge linkages and further fuel the pace of innovation. It is concerned that the different types of knowledge sources as well as the spatial dimension of knowledge sources may have significant impact on the innovation of local firms in the software cluster. In fact, external knowledge linkages have been found to be more frequent in emerging and dynamic industries (Auster, 1992) like the computer software industry, and Hagedoorn (1993) points out the computer software industry as the best example of an industry in which firms external knowledge interactions are especially important.

Nevertheless, most of recent research about external knowledge linkages and innovativeness of clusters have focused on developed countries. In the past 10-20 years, the software sector has emerged in many developing countries, and is currently expanding steadily. In the specific case of Guangzhou, the software cluster is dynamic, both in terms of technology and economic performance. The Guangzhou software cluster was also selected because it has many global presences, thus being useful for the comparison of the importance of local versus global knowledge flows.

(3) Characteristics of the Guangzhou software cluster

Guangzhou is a national software industry centre and a national software export and innovation centre. The overall strength of the software industry is leading in China. By the end of 2006, there were 1,284 software enterprises, the technology and trade income was RMB 34.1 billion, of which software income amounted to RMB 22 billion. At present, there are five software firms in Guangzhou with a staff over 1,000, i.e., Netease, Huifeng software, Jiesai Technology, Guangzhou Shukong and Haige Telecom there and 12 enterprises with 500-1,000 employees. In 2006, there were two enterprises with annual sales income over RMB 1 billion in Guangzhou and 33 enterprises with annual sales income between RMB 100 million and RMB 1 billion. There are two companies obtained CMMI-5 certificates, Guangzhou Benbu Computer Software Co., Ltd. and Guangzhou Huawei Mingtian Company. Over 20 enterprises have obtained certificates over CMM-2, 193 enterprises have passed ISO9000 quality system certification, 684 enterprises have passed "Double Soft" certification, and 11 firms are listed as key software base enterprises by the national torch plan.

4. Regional innovation system, FDI activities and knowledge flows in Guangzhou software cluster

In this section, we depict the knowledge flows of Guangzhou software cluster based on the regional innovation system approach.

(1) Regional innovation system and local knowledge networks

Guangzhou is a key industrial base in China and a production centre of the Pearl River delta. Guangzhou has relatively advanced regional innovation system related with software industry. Local knowledge networks of Guangzhou software cluster are embedded in regional innovation system of Guangzhou.

A. Local training centres as knowledge sources in the cluster

In our empirical results, we can see new personnel from local training centres (including universities) have been the important knowledge sources for many local firms. In last 6 years, there are more than 27,000 people having received software-related training and education in Guangzhou from Zhongshan University Software Personnel Training Centre, South China University of Technology Software and Animation Personnel Training Centre, Guangzhou Tianhe Software Park's Personnel Exchange Training Centre, etc. Meanwhile we can observe the cooperation of the cluster and training entities in offering tailored personnel training programs for the enterprises, personnel qualification training, international certification training and teaching faculty training etc.

B. Local public technology service platforms as knowledge sources in the cluster

In improving the innovativeness of software industry, Guangzhou has built Software Product Exhibition and Trade Centre, the Software Project Bidding Centre, China Cyber Software Test Centre, Guangzhou IC Design and Training Centre and the Guangzhou IC Test Centres as a software test platform, a prototype development platform and a software exhibition and trade platform for the software industry. These Local public technology service platforms provide a good technology development condition for software and IC design firms. Based on universities, research institutes and large software firms, the close cooperation among the firms, academic organizations and research institutes is encouraged. Large public software R&D organizations are introduced in the region to enhance technology and product R&D and to improve competitiveness of products. It is suggested from observation that local public technology service platforms may have been the important knowledge sources for many local firms.

C. Local leading innovative firms as knowledge sources in the cluster

Some local firms in Guangzhou software cluster are very innovative in terms of technology and market in the fields of telecom, finance and insurance, fiscal and tax, E-commerce, office automation, education and computer and network security. Local innovative competitors have been seeing as the knowledge sources for other local firms. Local other firms can get knowledge by observing and monitoring the activities and improvements of the innovative firms (Lorenzen and Maskell, 2004).

*(2) Global presences and global knowledge linkages***A. Knowledge interactions between local foreign R&D facilities and local firms**

The famous software outsourcing enterprises such as IBM software innovation centre, Microsoft (China) industrial base, Intel international security data solution centre and so on, have established software R&D, outsourcing programs in Guangzhou. Among them, Microsoft (China) established the South China technology support centre of Microsoft in Guangzhou, as the advanced software training centre and the software outsourcing base for international markets. It is noted that receiving services and knowledge from these foreign R&D facilities may have become the very important knowledge sources for many local firms.

B. Knowledge interactions between FDI affiliates and local firms

Through the cooperation with multinational firms or introduction of world famous software enterprises in Guangzhou software cluster, many local innovative software firms have explored the international markets and improved the absorptive capabilities of leading technology. In receiving internal outsourcing from international firms, many domestic firms have

formed software outsourcing development teams with international firms. In fact, our observation has shown that this is very important way to get knowledge from external environment for some local innovative firms.

C. Knowledge interactions between local foreign training programs and local firms

With the government subsidies, joint training of software service outsourcing personnel home and abroad has been promoted to provide general and senior professionals, marketing and management professionals. Local foreign training program have been a very important way to improve knowledge sharing in Guangzhou software cluster. For example, the IT technology and engineering outsourcing training for export to Japan, Europe, the USA and India was supported. The support also goes for the training of software personnel jointly carried out together with many international firms. Meanwhile, the foreign software personnel and overseas students from Hong Kong, US and other regions and countries are attracted. Now there are over 300 software service outsourcing senior experts working in Guangzhou and 33 software service firms have been established by personnel from these training program.

Based on the analysis of the Guangzhou regional innovation system, first, we can see that local universities, local public research platforms and local innovative firms can have been seen as knowledge sources in local knowledge networks. At the same time, local foreign R&D activities, local foreign export-oriented alliances, local foreign training programs can have been seen knowledge sources from global knowledge linkages. The knowledge interactions of FDI activities and local firms are very important knowledge flows in Guangzhou software cluster.

5. The importance of the type and the spatial dimension of knowledge sources on innovativeness of Guangzhou software cluster

In order to examine our research questions, we have conducted firm survey in Guangzhou software cluster, mostly focusing on the local firms in the Guangzhou Tianhe software park. There are 662 local firms in the Guangzhou Tianhe software park. In our firm survey we sent out 100 survey questionnaires through the Tianhe software management committee to managers of local firms, and the total effective responses that we have got are 30 local innovative firms, which are 4.5% of total sample (See Table 1).

Table 1: Size of sample firms in Guangzhou software cluster

Annual turnover	<10M	10-50M	50-100M	100M-1B	>1B	Total
Number of firms	225	323	85	28	1	662
Share of firms	33.99	48.79	12.83	4.23	0.15	100
Number of sample firms	9	14	5	2	0	30
Share of sample firms	30	46.7	16.7	6.66	0	100

Sources: Database of Guangzhou software industry and Survey data of Guangzhou Tianhe Software Park

Exploring the type and the spatial dimension of knowledge sources, it has been found that regional knowledge sources are assessed much more important than global knowledge sources if we do not put FDI activities into account. In our research we can find that the key knowledge sources in local knowledge networks for local firms result from local customers, local consultants, local universities, local new personnel and local competitors. The local firms in the Guangzhou software cluster, however, also use global customers and global competitors as knowledge sources. Customers are the most important partners of all knowledge links both from local knowledge networks and global knowledge linkages. Relations to the knowledge infrastructure

(local universities, local research institutes and local R&D centres), in contrast, are strongly local in nature. Furthermore, a role of global consultants and global new personnel can be found in the global knowledge linkages although there are less important than local knowledge networks. Meanwhile, for local firms in the Guangzhou software cluster the internet is an important channel for knowledge flows, whether it is local or national or global. It has provided a knowledge interaction channel to discuss problems with other software developers dispersed around the world, to keep ahead with the latest technologies, and to monitor markets and competitors for local firms in Guangzhou software cluster (See Table 2).

Table 2: Importance of different knowledge sources

(Mean Response)	Local	Global	T-value
Customers (1)	3.40	2.50	4.642***
Suppliers	2.23	1.76	5.037***
Competitors(2)	2.96	2.30	5.525***
Service Firms	2.10	1.63	2.728***
New personnel(3)	2.93	2.20	5.430**
Consultants(5)	2.63	2.03	4.871***

R&D centres	2.50	1.43	7.059***
Universities (4)	2.67	1.30	8.068***
Public research institutes	2.40	1.40	6.289***
Fair and exhibitions	2.26	1.63	3.739***
Professional and industry associations	1.80	1.23	3.084**
Scientific journals and publications	1.90	1.87	0.372
Electronic information	2.07	2.10	-0.571

Source: Survey data of Guangzhou Tianhe Software Park

Note: *** p<0.01, **p<0.05, *p<0.1 (Mean T-test)

Second step, if we divide sample into local basic firms and local innovative firms in terms of innovation capability, the result becomes different with the above one. (Note: to make a distinction between local basic firms and local innovative firms, we compare firms according to their innovative activities and their innovative abilities using our survey results. We get 8 firms as local innovative firms and 22 firms as local basic firms in our sample.) The firms which have been classified as "local basic firms" are mainly specialised in adaptations and development of existing software and services. Our analyses have shown that these firms are overwhelmingly concentrated on the local and national market. This research shows that the relationships to local competitors, local new personnel and local customers play a vital role for innovativeness of local firms. Additionally, the relationships with local universities, local R&D centres and local consultants are still of importance for local basic firms on innovativeness of firms in

Guangzhou software cluster comparing to the relationship with global counterparts. Other types of knowledge flows such as the participation in local fairs and exhibitions are also relevant. Knowledge sources from global knowledge linkages are less important for local basic firms.

A different picture can be found for the group of local innovative firms. Firms belonging to this group have developed own software solutions in the past, which are now improved continuously in an incremental way. Three firms have strong export activities (Note: more than 60% of turnover). In contrast to the patterns found for local basic firms, many knowledge sources through global knowledge linkages can be easily found in local innovative firms. International customers and competitors, who are monitored via internet and global trading, turned out to be important (See table 3).

Table 3: Importance of knowledge sources and types of firms

(Mean Response)	local basic firms			Local innovative firms		
	Local	Global	T-value	Local	Global	T-value
Customers	3.50	2.11	6.934***	3.25	3.08	0.616
Suppliers	2.00	1.56	3.688**	2.58	2.08	3.317***
Competitors	2.88	2.06	5.000***	3.08	2.66	2.803**
Service Firms	1.89	1.50	1.686	2.42	1.83	2.244***
New personnel	3.00	2.05	4.994***	2.83	2.41	2.803***
Consultants	2.44	1.66	4.507***	2.91	2.58	2.345***
R&D centres	2.16	1.28	4.189***	3.00	1.66	7.091***
Universities	2.50	1.17	5.497***	2.91	1.50	6.189***
Public research institutes	2.11	1.22	4.973***	2.84	1.66	3.924***
Fair and exhibitions	2.11	1.39	3.708**	2.50	2.00	1.593
Professional and industry associations	1.94	1.11	3.828***	1.58	1.41	0.561
Scientific journals and publications	1.77	1.67	1.000	2.08	2.17	-0.561
Electronic information	2.03	2.06	0.000	2.08	2.12	-1.000

Source: Survey data of Guangzhou Tianhe Software Park

Note: *** p<0.01, **p<0.05, *p<0.1 (Mean T-test)

Third step, if we divide the sample into local basic firms and local innovative firms again, meanwhile put FDI into the equation, the results more support the view that firms with more innovation get knowledge more through global knowledge linkages. For local innovative firms in the Guangzhou software cluster, the knowledge interactions with global (F) consultants, global (F) personnel and

global (F) service firms even more important than with local counterparts. So we can see from our sample that global knowledge linkages are to some extent more important to the innovative-ness of local innovative firms than local knowledge networks. In our sample, for local innovative firms in Guangzhou software cluster, both local knowledge networks and global knowledge linkage are suggested high

relevant. In other words, It is the combination of “local buzz” and “global pipelines” (Bathelt et al. 2004) that matters for innovation. In line with some recent research, our analyses of the spatial dimension of knowledge sources confirms the same important relevance of the local level as space for knowledge flows as global linkages (Simme, 2004). Meanwhile if we take type of knowledge flows into account, we can see global knowledge linkages are to some extent more important to innovativeness of

local firms in the market type of knowledge sources than scientific type of knowledge sources in Guangzhou software cluster because knowledge interactions between global customers and local firms and between global competitors and local firms and between global new personnel and local firms are more relevant (See table 4). We might draw a view that the local firms are more engaged in the innovation exploitation, instead of exploration based on these empirical results.

Table 4:Importance of different types knowledge sources

(Mean Response)	Local basic firms			Local innovative firms		
	Local	Global (FDI)	T-value	Local	Global (FDI)	T-value
Market type	2.620	2.259	2.806**	2.847	2.916	-0.624
Scientific type	2.315	1.510	9.824***	2.686	2.055	7.131***
Open type	1.963	1.793	1.432	2.06	2.05	0.000

Source: Survey data of Guangzhou Tianhe Software Park

Note: *** p<0.01, **p<0.05,*p<0.1(Mean T-test)

6. Conclusion and Implication

Taking the Guangzhou software cluster as a study of the impact of global knowledge linkages on the innovativeness of local clusters in developing countries, we draw the following conclusions and present some policy implications based on the research results:

First, this study provides evidence which suggests that local knowledge networks do matter for the innovation of firms within clusters in developing countries, which is in line with the main hypothesis in the literature that local knowledge networks are the main reason for the increased innovative and economic performance of the firms within clusters (Saxenian, 1994; porter, 2000). However, global knowledge linkages play a crucial role for the innovative performance of the firms in the Guangzhou software cluster. Global knowledge interactions mostly occur between local firms and FDI affiliates; between firms and global vertical and horizontal linkages. Conversely, local knowledge networks in Guangzhou software cluster are based on geographically close relationships between firms and universities and between local basic firms and local innovative firms.

Second, we have observed that the knowledge flows from the local presence of global components to local firms have been significant in Guangzhou software cluster. FDI activities have brought about advanced technology, management skills and various international knowledge linkages to local firms. At the same time, international firms as customers and competitors are the very important role for global knowledge transfer. FDI R&D activities, local foreign training programs and local foreign personnel movements being knowledge sources for local firms can directly be observed to improve innovativeness of local firms.

Third, global knowledge linkages are to some extent more important to innovativeness of local firms in the market way than the scientific way in Guangzhou software cluster. According to the observation of the foreign presences of the employees in local entities, local foreign personnel movements to innovativeness of local innovative firms are high relevant in Guangzhou software cluster. In addition, international movement of people associated with nationals studying or working abroad for a limited period and applying their new knowledge when they return or the inward movement of foreign nationals into the country is also very important channel for international knowledge transfer.

Some policy recommendations can be drawn based on the above research: Geographic proximity generates advantages related to the fast circulation of knowledge, not only in advanced economies but also in developing countries. This suggests that local knowledge networks can benefit firms within clusters. In addition to focusing attention upon local knowledge networks, it is also essential to keep in mind that global knowledge linkages continue to play a major role in the innovative performance of firms in developing countries. Firms that are well connected to the global economy are likely to gain through global knowledge linkages. Thus, it is crucial that these countries establish policies to encourage foreign direct investments.

More importantly, a prerequisite for the absorption of external knowledge is the internal building of capabilities (Cohen and Levinthal, 1990). In the case of the software cluster in Guangzhou, personnel movements within the cluster and improvement of R&D investment are the very important mechanisms not only for improving absorptive capacity, but also for improving innovative capabilities. Thus, on the one hand, the local government should invest more

in education and training of high-skilled employees, and should facilitate labour mobility by promoting more flexible labour markets; on the other hand, the local government should encourage local firms to increase the R&D investment. In addition, difference in knowledge absorptive capacity and innovation attitude is wide between firms in the cluster. In addition, some innovative firms and local universities who are able to use global knowledge linkages should be encouraged to serve as knowledge interactions agents for the local cluster to strength local knowledge networks, because firms in developing clusters are inexperienced learners, and some large innovative firms and local universities must play a role as a local center of knowledge interactions.

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