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Industrial clusters and global value chains as complementary channels of knowledge and information: A case study of China's mobile phone-set industry

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Abstract

Industrial clusters (ICs) and global value chains (GVCs) are important analytical concepts for the industrial upgrading of economically developing countries. Regarding earlier debate on the issue, some studies have emphasized that knowledge spillovers inside clusters are critical for industrial upgrade strategies, whereas other studies have emphasized the knowledge flows from outside clusters play a crucially important role. Further need exists to elucidate the complementary roles of GVCs and ICs in facilitating knowledge and information diffusion, which are indispensable for local manufacturers' learning and capability formation. For this purpose, we used a unique firm-level dataset of China's mobile phone-set industry to analyze the division of roles between GVCs and ICs in gathering knowledge and information necessary for local manufacturers. Our empirical analysis reveals the following: (1) Personal connections embedded inside ICs play important roles when local manufacturers gather widely diverse information. (2) Actually, GVCs, especially those with platform leaders, play important roles when local manufacturers gather core technical know-how or information. (3) Knowledge and information of both types are evaluated as highly important by local manufacturers. Results show that GVCs and ICs work complementarily to gather different but important knowledge and information that is necessary for local mobile phone-set manufacturers.

Keywords: industrial cluster (IC), industrial district (ID), global value chain (GVC), knowledge, information, platform, China, mobile phone-set industry

1 Introduction

It has been widely accepted that industrial clusters (ICs) facilitate industrial upgrading in economically developing countries. A wide body of literature has brought forth several salient points: clustering enables local actors to mobilize financial and human resources by breaking down investments into small-risk steps (Schmitz and Nadvi, 1999): knowledge spillovers help various local actors to improve their knowledge base, and along with other types of local externalities, improve efficiency (Marshall, 1920); collective actions taken by cluster firms help to mitigate problems which they are mutually confronting (Nadvi, 1999; Schmitz, 1995a; 1999b; Schmitz and Nadvi, 1999); harsh competition and rivalry among cluster firms forces leading firms to carry out "new combinations" followed by other eligible cluster firms, leading to a whole cluster's upgrade (Sonobe and Otsuka, 2009). Numerous IC case studies, most of which have specialized in a sector of labor-intensive industries, have contributed to adoption of these consensuses.

But how do matters differ for high-tech industries? Empirical studies of modern ICs in economically developed countries are helpful. Several points are clear from a review of the extensive body of the relevant literature: geographical and social or cultural proximity between local actors in an IC enhances the innovative capability of an industry. This enhancement occurs mainly because these proximities facilitate dense and frequent face-to-face communication among local actors, enabling tacit knowledge possessed by a local actor to diffuse throughout the cluster, whereas actors locating outside the cluster cannot share knowledge of this kind (e.g., Saxenian, 1994). Inter-firm and informal contacts among employees in a cluster are important vehicles of knowledge and information (Dahl and Pedersen, 2004). These studies share a common perspective: ICs can be regarded as a kind of knowledge and information conduit through which valuable knowledge and information are diffused to local actors, facilitating local actors' learning.

A question naturally arises: How do local high-tech firms in economically developing countries obtain knowledge and information necessary to learning for upgrading? There are, however, only a few empirical studies particularly addressing the role of ICs as knowledge and information system to answer this question (e.g. Wang and Lin, 2010; Wu et al., 2014 for the case of China's high-tech industries). Rather, most existing

studies have emphasized learning through global value chains (GVCs). It makes sense that the emphasis is placed not on ICs, but on GVCs. Knowledge and information sharing within ICs in economically developing countries might not contribute greatly to enhancement of learning because the knowledge base of local actors is generally weak (Morrison et al., 2013). In contrast, global lead-firms are willing to provide useful knowledge and information to economically developing countries' suppliers participating in a GVC insofar as learning and capability formations by local firms are beneficial to the global lead-firms themselves. This tendency can be identified in studies of China's high-tech industries, in which the authors are interested. Existing studies have specifically examined GVC participation and its effects (Sun and Zhou, 2011).

In addition, a body of recent cluster studies has also acknowledged the role of external linkages in local learning. This avenue of inquiry has pointed out several aspects of linkage: Global buyers play important roles in IC upgrading process in economically developing countries (e.g., Schmitz, 1995b; Humphrey and Schmitz, 2002). However, the upgrade pattern of local firms is partly decided by the type of governance that they are subject to (Humphrey and Schmitz, 2002). Gatekeepers in modern clusters of economically developed countries play important roles in transmitting knowledge and information from external actors all over the world to cluster firms (Giuliani, 2007; Morrison, 2008; Morrison et al., 2013). The common view of this line of study explained in the literature is that the diffusion or the circulation of knowledge and information taking place both in ICs and GVCs is important to facilitate learning and innovation. This view has encouraged the pursuit of our present research.

The aim of this article is to contribute to this line of study in the literature, based on case studies of China's high-tech industry (i.e. mobile phone-set industry). Many difficulties remain unresolved. Both the "local buzz" and the "global pipeline" are important as a knowledge and information conduit that facilitates local learning and innovative activities (Bathelt et al., 2004). However, a conclusion of this kind was drawn based exclusively on experiences in economically developed countries. It is highly probable that matters are considerably different in the case of economically developing countries. However, we still know little about it. In contrast, the existing literature on high-tech industries in economically developing countries tended to draw on the GVC perspective, assuming that economically developing countries' suppliers with an insufficient knowledge base accumulate advanced knowledge and valuable information from global

lead-firms. This avenue of study explained in the literature glosses over the important roles of ICs.

Our hypotheses suggest themselves: ICs work as a conduit to diffuse generic type of information, but GVCs, especially those with platform leaders, function as a conduit to diffuse core and tacit technical knowledge into cluster firms. Both conduits are important for cluster firms. In other words, these two categories of conduit work complementarily, leading to the rapid upgrading of China's high-tech industries. Moreover, interfirm differences in the acquisition of knowledge and information can be explained partly by firm heterogeneity. To test these hypotheses, a unique firm-level dataset of China's domestic mobile phone-set manufacturers was collected. Moreover, intensive interviews were conducted with local firms. Our analyses fundamentally supported our hypotheses, with an exception that ICs also play important roles when some local firms obtain technical knowledge. Our findings are expected to shed new light on the unique upgrading pattern of emerging high-tech giants such as China.

This article is organized according to the following structure. The second section briefly reviews reports of the literature explaining the role of industrial clusters and global value chains in gathering knowledge and information. The third section introduces the method and data used for this research. The fourth section reports our empirical results and relevant discussion. Finally, the fifth section presents salient conclusions derived from this study.

2 Industrial clusters and global value chains as channels of knowledge and information

It has long been noted that ICs play a crucially important role in the industrial development. Attention by economists to ICs can dates back at least to Alfred Marshall, who attributed the efficiency of localized industries to external economies emanating from localized knowledge spillovers, localized supplies of inputs, and local skilled labor pools (Marshall, 1920). Since the 1980–90s, strong competitiveness of IDs in some countries such as Italy has attracted special attention from many economists. The competitive edge of these IDs was attributed mainly to the flexibility of production arrangement, which was enabled by the dense inter-firm networks in the underlying social fabric of the localities.

In the field of development studies, some researchers have undertaken extensive studies of ICs in economically developing countries (e.g., Nadvi 1999; Schmitz, 1995a, b; Schmitz, 1999a, 1999b; Schmitz and Nadvi, 1999). Early studies of ICs in economically developing countries inclined to analyze them related to the existing model (e.g. the Italian ID model), but later their concern shifted to analyses of the trajectories of various ICs in economically developing countries. The concept of collective efficiency (i.e. the passive effects of local external economies along with the positive effects originating from deliberate join actions toward market failure) was introduced to analyze ICs (Nadvi, 1999; Schmitz, 1995a; 1999b; Schmitz and Nadvi, 1999).

With the progress of empirical studies of ICs in economically developing countries, researchers have devoted more attention to the upgrading of local firms in economically developing countries. Regarding the process of upgrading, local firms must learn from the superior experiences and accumulate capabilities. There must be ways to acquire necessary knowledge and information from outside the firm. However, how do they obtain knowledge and information necessary to this learning process? Two areas of emphasis emerged: (1) ICs as knowledge systems and (2) the external link through global buyers. Regarding (1), some researchers proposed the perspective of viewing ICs as knowledge systems rather as production systems to understand clusters' long-term competitiveness and technological dynamism (Bell and Albu, 1999)[1]. This perspective is the starting point of our analyses. Regarding (2), empirical studies have shown that global buyers play important roles in the upgrading of ICs in economically developing countries because global buyers provide valuable knowledge and information to local firms to improve their own profits (Schmitz, 1995).

[1] Some development economists have theorized the development pattern of ICs in eastern Asia (Sonobe and Otsuka, 2009). Their theory of cluster-based industrial development conceptualized the trajectory of cluster-based development by three stages: (1) initiation stage, (2) quantity expansion stage, and (3) quality improvement stage. In their theory, the upgrading of ICs (corresponding to the shift from quantity expansion stage to quality improvement state) was explained by the new combination carried out by entrepreneurs. However, they did not fully analyze the process of learning and knowledge acquisition by local firms in ICs.

Most previous studies examined up to this point have analyzed the upgrading of labor-intensive industries. However, with the growing presence of some emerging economies such as China and India in global high-tech industries, researchers have gradually recognized the need to analyze the upgrading of high-tech industries in economically developing countries.

We examine an example from the case of China. China's high-tech industries achieved remarkable progress over a couple of decades. According to a report of the Asian Development Bank, China's share of Asia's exports of high-tech products rose to 43.7 percent in 2014 from 9.4 percent in 2000. As a result, China surpassed Japan as the champion high-tech exporter in Asia (Bloomberg, 2015). China's share in the high-tech export must be discounted because of problems related to outdated trade statistics that are inconsistent with trade based on global supply chains (Xing, 2012). It is nevertheless undeniable that China's high tech industries have achieved outstanding advances in many respects.

Taking the mobile phone-set market as an example, the volume of domestic production rose considerably to 1.63 billion units in 2014 from 5.25 million units in 2000, with annual growth up to 41 percent (NBSC, 2016). The competitiveness of domestic brands has also been strengthened greatly, as demonstrated in the rising market share of China's national brands. According to a report released by the International Data Corporation, the top three Chinese brands, i.e. OPPO, Huawei, and VIVO, grabbed a total of 48 percent of the Chinese smart-phone market in 2016. On the other hand, the shares of Apple fell to 9.6 percent in 2016 from 13.6 percent in 2015 (China Daily, 2017). If it were 10 years ago, the mobile-phone-made-by-China might remind many of the "Shanzhai" cell phone, which means low-end (or in many cases, counterfeit) phones produced by unauthorized firms, often with minor differentiation in the product appearance and sold at an extremely low price. However, the golden age of "Shanzhai" cellular telephones has gradually faded as the pace of China's industrial upgrade rocketed upward.

Given that China' mobile phone-set industry has made a vast improvement with this rapid pace, we cannot but pose a question: How do Chinese local firms obtain knowledge and information indispensable to the business of mobile phone-set, by any criterion, belonging to high-tech product? Given that Chinese local mobile phone-set

manufacturers, on average, have accumulated little knowledge capital and other managerial resources to date, with the exception of a few national champions such as Huawei and ZTE, it is quite unrealistic to assume that the most novel knowledge and information necessary to them is produced mainly in house. Rather, it is more reasonable to infer that Chinese local firms have upgraded through constant learning, which invariably involves the ceaseless acquisition of necessary knowledge and information from external sources, along with the investment to accumulate knowledge capital in house. To understand the upgrading process of China's high-tech industries further, it is imperative to elucidate how Chinese firms obtain knowledge and information that is indispensable to their business.

The discussion related to localized knowledge spillovers (LKS) in ICs is a proper starting point when one regards the research question stated above. A body of empirical studies of modern ICs such as Silicon Valley showed the wide existence of LKSs in ICs and their contributions to innovativeness. People engaging in the same business or closely related activities inside a cluster naturally share common sets of values, codes of rule, and similar social backgrounds. This kind of social proximity, along with spatial proximities, helps them to have intensive face-to-face communication (e.g. informal personal contacts) and to cooperate mutually. Frequent face-to-face communications and close collaboration enable people and firms in the same cluster to share valuable information and tacit knowledge more easily. Valuable information and tacit knowledge become a kind of "public good" as a result of LKS in ICs, facilitating improved innovativeness of cluster firms (e.g., Saxenian, 1994).

The following results of empirical studies reported in the literature have added various new findings on LKSs in ICs. (1) Knowledge is diffused in ICs in highly selective ways (Giuliani, 2007; Morrison, 2008; Morrison and Rabellotti, 2009). Cluster firms are not homogeneous in many respects, such as knowledge bases and capabilities. Consequently, it is natural to think that the knowledge network of each cluster firm is highly idiosyncratic. Providing valuable knowledge and information to other firms can be regarded as reciprocal behavior. Therefore, it is natural that knowledgeable firms are not willing to share a knowledge network with a number of non-knowledgeable firms in the cluster, but that they are willing to share only with a few of knowledgeable firms from which they can expect to obtain valuable knowledge in exchange of their own. In this respect, knowledge should be regarded as a kind of club good that is shared only

with a few fully qualified cluster firms. (2) Informal contacts among employees working in a cluster play important roles not only in interfirm diffusion of generic information but also in interfirm knowledge diffusion of important knowledge (e.g. know-how). However, knowledge diffusion is affected by the firm's policy toward such knowledge diffusion (Dahl and Pedersen, 2004). (3) Along with "local buzz," which facilitates actors co-locating in a cluster to have active interactions and knowledge creation, global-pipelines or external linkages bring knowledge and information into the cluster (Bathelt et al., 2004). So-called gatekeepers serve important roles in this process. They have strong traded or non-traded linkages with global actors located outside the cluster and accumulate knowledge through these linkages. They possess a knowledge base and absorptive capabilities that are sufficiently strong to assimilate new knowledge and transmit it to various local actors located in the same cluster. However, the strategy of these gatekeepers might affect knowledge diffusion in the cluster (Morrison, 2008; Morrison and Rabellott, 2009).

Another line of study explained in the literature that is useful to our analysis is those using the GVC perspective. A body of literature has acknowledged the crucially important role of external linkages in conveying valuable knowledge and information to firms locating in a cluster. Previous studies using a GVC perspective have pointed out the following generalizations: (1) The power relation between global lead-firms and economically developing countries' suppliers in a value chain is asymmetric. (2) Global leading firms generally take the leadership of chain governance by which transactions between firms are coordinated. (3) Local suppliers in economically developing countries, however, can obtain knowledge and information necessary for learning, enabling them to upgrade. (4) The pattern of upgrade is affected by the type of chain governance, which is presumed to be a function of various factors that include the complexity of transactions, the characteristics of knowledge involved, and the level of local suppliers' capabilities (Gereffi, 1994; 1999; Schmitz, 1995b; Humphrey and Schmitz, 2002; Gereffi et.al. 2005; Kawakami,2011 among others).

Although these existing studies serve as useful references, empirical studies examining high-tech industries in economically developing countries, especially those which specifically examine the knowledge and information acquisition of local firms, are wholly inadequate to elucidate this subject. To fill this gap left by the inadequate results of empirical studies, we decided to analyze how local firms in high-tech industries

obtain necessary knowledge and information, based on a case study examining China's mobile phone-set manufacturing firms, most of which are located in a high-tech cluster: Shenzhen of Pearl River Delta region, China.

This study specifically examines the role of ICs in diffusing knowledge and information to local firms, drawing on existing studies that have been overviewed to date. However, we must be highly aware of differences between high-tech clusters in economically developed countries and economically developing countries. Two points are noteworthy: (1) the importance of the platform vender and (2) the typically insufficient knowledge base of local manufacturers.

Mobile phone sets typically belong to the modular type of product architecture. Platform venders play important roles in its value chain. Because of the modularity, even local firms with only a slight stock of knowledge can participate in the production of mobile phone-sets using a turn-key solution provided by platform leaders (Brandt and Thun, 2011; Imai and Shiu, 2011; Ding and Pan 2014). In the case of Shanzhai cell-phone, its value chain was driven by a Taiwanese platform vendor, MediaTek (MTK). MTK has succeeded in providing a turnkey solution to its underserved customers, which includes a platform (baseband IC) that conducts most system design and a part of the software design and a reference design that makes most of the feature phone components easy to use. This turnkey solution has greatly reduced the technological barriers to entry in the feature phone sector. However, only marginal autonomous innovations were made to the platform (Ding and Pan, 2014), which leads us to the first hypothesis:

Hypothesis 1a: Chinese local manufacturers mainly acquire core technological knowledge from platform vendors, which provide local phone-set manufacturers with core components (e.g. baseband ICs) and related services.

This hypothesis holds that the platform-leaders in modular-type value chains are main channels of technological knowledge to economically developing countries' firms which have a small knowledge base.

However, we must consider that firm heterogeneity matters in this proposition. In the era of 4G, which is far more technologically complicated than 3G, another vendor,

Qualcomm, has become increasingly prominent in Chinese markets. Qualcomm, as the developer of the world's first smartphone and the largest owner of 3G and 4G technology patents, entered the smartphone baseband IC market soon after Apple released the iPhone. Qualcomm adopted a strategy enabling platform users to conduct product differentiation at a deep level [2], whereas MTK, with few technological capabilities, had to continue its turnkey solutions, which was intended to lower technological barriers and enable more underserved mobile phone firms to enter the market. These circumstances demonstrate that China's local mobile phone-set manufacturers now are extremely heterogeneous: groups of famous brand companies now have large market shares. They are eager to make major innovations to their products and services to meet rapidly upgrading needs of Chinese domestic and global markets. For this purpose, they have established more close relations with platform vendors with higher technical standards. It is natural that there exist more dense interexchange of knowledge and information between big brand companies and platform venders such as Qualcomm. Compared to this, small firms with inferior technological capabilities (such as Shanzhai producers) rely on turn-key solutions that are less demanding in terms of user knowledge and capabilities. It is possible that there only exist sparse exchanges of knowledge and information between this type of firm and platform vendors providing turn-key solutions. Their products tend to be fairly standardized using common turn-key platforms with slight differentiations. The products are sold mainly in the low-end markets in China or other economically developing countries. Consequently, it is not plausible that they need dense exchanges of knowledge and information with platform vendors so much. Most technically minor problems that they often encounter might be solved by knowledge and information

[2] Qualcomm opened about 80% of the source codes of its hardware drivers to mobile phone companies, whereas MTK opened only 20%. Moreover, Qualcomm allowed platform users to adjust some hardware specifications such as radiofrequency specifications on the platform, although MTK users were not allowed to do likewise. Indeed, based on Qualcomm platforms, three of the top four Chinese smartphone makers (OPPO, VIVO, and Xiaomi) have designed one or more of the world's first new functionalities in their new smartphone models. Qualcomm's position remains unwavering in the middle and high-end markets. Of the top ten smartphone makers in the Chinese market in 2015, eight are Chinese. Among these, five have primarily adopted Qualcomm's platforms: Xiaomi (No. 1, 70%), OPPO (No. 4, 70%), VIVO (No. 5, 60%), Coolpad (No. 7, 60%), and ZTE (No. 10, 50%) (Humphrey et al., 2017).

exchanges through personal contacts. This consideration leads us to the second hypothesis:

Hypothesis 1b: Firm heterogeneity makes a difference. Local firms with different levels of capabilities tend to use different channels of knowledge and/or information when they gather highly technical knowledge, know-how, and information. Firms with higher levels of technological or absorptive capabilities, with higher level of R&D intensity, tend to use GVC channels when they gather these types of knowledge and information. Firms with lower levels of capabilities, however, tend to use human networks embedded inside the cluster.

As we have surveyed to date, numerous reports of the literature describe analyses of modern clusters in economically developed countries. They have revealed the critical importance of ICs as knowledge and information systems. This importance also holds in the case of economically developing countries, but with some modifications. One can plausibly assume that local firms in ICs of economically developing countries have only a small knowledge base. If the knowledge base of local firms is weak, then it is possible that shared knowledge and information does not contribute in any significant way to enhance collective learning (Morrison et al., 2013). If so, how should we regard the role of ICs in diffusing knowledge and information? For this purpose, we distinguish technical knowledge from more generic information. The former relates to core technology and embodies some degree of tacitness. Know-how and solutions that firms encounter in the process of R&D might be good examples. However, the latter relates to various information or codified knowledge such as price information of core components, reputation of supplier capabilities and information about human resources. We assume that local firms obtain the latter type of information or codified knowledge (generic information) mainly through various types of traded or non-traded relations embedded in ICs. Given that “Guanxi” networks play important roles in the present Chinese business context, it is expected that human networks webbed over the cluster play important roles when local firms gather various generic information. This consideration leads us to a second hypothesis.

Hypothesis 2: Various relations in local clusters, especially human networks, webbed inside the cluster at which local firms locate tend to convey generic types of knowledge

and/or information (e.g. reputations of suppliers and customers, information related to human resources) to them.

3 Methodology and data

3.1 Research design

Simply stated, our hypothesis is that the most important channel for local firms to acquire core technological knowledge and information is GVCs, in which local firms learn from platform leaders, whereas the most important channel for local firms to gather various generic information is a various type of network webbed inside ICs. Consequently, to test this hypothesis, we must categorize knowledge and information of different types. For this purpose, we classified knowledge and information necessary to local firms into 21 categories based on the opinion of experts who were very familiar with China's mobile phone-set industry. Table 1 presents 21 categories of knowledge and information, with an index number of each type.

One point with respect to our research design is particularly noteworthy. Dahl and Pedersen (2004), who have provided the most important report of the literature for our research, asked employees in a high-tech cluster to analyze the importance of LKS through informal contacts between employees. In contrast to this strategy, we preferred to ask top managers of each sample firm to get a much broader picture regarding knowledge and information acquisition of local firms. In general, China's top managers are quite familiar with the actual circumstances of every department in their firms, compared to employees who are not always familiar with other sections of the firm.

In our questionnaire research, we asked each sample firm to specify one most important channel when the respondent firm obtains each type of knowledge and information. Although we acknowledged that firms might use multiple channels to gather one type of knowledge and information, we asked respondents to choose only one to avoid too much complication. Based on what we knew from our interviews, we specified 10 alternative channels, from which each respondent firm was asked to choose the most suitable answer. The 10 alternatives of knowledge and information channels are listed on the left side of Table 2 with an index number. When we present the results of our analyses in the next section, we aggregate "Colleagues in the past workplaces" (channel

#1), "Friends and acquaintances engaging in the same business" (channel #2) and "Alumnus and landsman engaging in the same business" (channel #3) into one category, i.e. "Personal connection channel" for the sake of simplicity. One important object of our analysis is to elucidate the role of GVCs in diffusing necessary knowledge and information to local manufacturing firms. For this purpose, we aggregated "Suppliers (channel #4) and "Customers (channel #5) into one category of "Value chain channel" in the next section.

Table 1 Types of knowledge and information and their index numbers

Index	Definition of knowledge or infromation
KI#1	The direction of product development and the product planning by global brand companies
KI#2	The direction of product development and the product planning by Chinese domestic brand companies
KI#3	The product roadmap and technological direction of baseband ICs of Mediatek, Spreadtram and Qualcom etc.
KI#4	Technology trends of hardware such as screen,camera, touch screen and video etc. and software related to them
KI#5	Product innovation and product function definition
KI#6	Solutions of technical difficulties encounterd in the process of product research and development
KI#7	Product sales of brand companies' mobile phone-sets and peer companies' products
KI#8	Changes in policies of telecommunications carriers
KI#9	Changes in marketing channels and marketing methods
KI#10	Changes in product prodcut needs or purchasing behaviour of end users
KI#11	Changes in regulatory policies (e.g. customs regulation, trade protection, and IPR protection etc.) of each country
KI#12	The development of key custormes such as telecommunications carriers, large chain-stores etc.
KI#13	Trends in mobile phoneset appearance and related production technology
KI#14	Trend in price, demand and supply of parts and components used in mobile phoneset
KI#15	Reputations about key-componet suppliers' capabilities
KI#16	Sharing of supply chain resources with peers, joint purchasing and mutual adjustments of materials with peers
KI#17	Methods dearing with inventory shortage or glut of materials
KI#18	Selections of contract manufacturs, logistics companies and trade companies
KI#19	Recruitment of key personnels in marketing, R&D and project management
KI#20	Team building and the the upskilling of company stuffs
KI#21	Risk management in the case of quality defections, good return, contract violation etc.

Source: Authors' questionnaire survey data.

Table 2 Types of channel and Varieties of location and their index numbers

Index	Channel	Index	Location
C#1	Colleagues in the past workplaces	L#1	Huaqiangbei district in Shenzhen
C#2	Friends and acquitances engaging in the same business	L#2	Chegongmiao district in Shenzhen
C#3	Alumnus and landsman engaging in the same business	L#3	Nanshan science park in Shenzhen
C#4	Suppliers	L#4	Suburb of Shenzhen city and other area of Pearl River Delta region
C#5	Customers	L#5	Shanghai
C#6	Media, Web site, SNS(e.g. QQ, Weibo)	L#6	Yangtze River Delta region other than Shanghai
C#7	Exhibition and symposium	L#7	Beijing
C#8	Government authorities and industry groups	L#8	Rest of China mainland and overseas
C#9	Research institutes and consulting companies		
C#10	Other channels		

Source: Authors' questionnaire survey data.

In addition to the question about the channel, we asked firms at which place the most important source locates for each channel. We prepared eight alternatives, from which respondent firms were asked to select the most suitable one. The location alternatives are listed on the right side of Table 2 with an index number.

3.2 Procedures of empirical analyses

The empirical analyses are organized in the next section according to the following structure: (1) confirming the importance of types of knowledge and information; (2) analyzing the role of value chains as knowledge and information channels; and (3) analyzing the role of ICs as a knowledge and information channel.

3.2.1 Importance of each type of knowledge and information

First, we will confirm that the types of knowledge listed in Table 1 are actually thought to be important. We followed the opinions of industrial experts and what we knew from our field interviews to specify 21 types of knowledge and information necessary for local firms engaging in mobile phone-set manufacturing and related activities. Although we expect all of these types of knowledge and information are important, they still require validation. Therefore, we analyzed how important respondent firms evaluate each type of knowledge and information. In the questionnaire, we asked respondents to evaluate the importance of each type of knowledge and information using a 5-grade evaluation scheme: (1) Not important at all, (2) Not important, (3), Medium, (4) Important, and (5) Very important. We used the results of evaluation to do this task.

3.2.2 Role of value chains as a knowledge and information channel

The results of our questionnaire research showed that we can understand which the most important channel is for local firms when they gather each type of knowledge and information. By analyzing the results, we can test our hypotheses related to the roles of value chain in the diffusion of knowledge and information. In our research design, KI#3, KI#5, and KI#6 are regarded as types of core technological knowledge and information. KI#3 (i.e. Knowledge and information pertaining to the product roadmap and the technological direction of baseband ICs by key platform venders such as MTK and Qualcomm) is crucially important technological knowledge and information for mobile phone manufacturers. For example, local mobile phone-set manufacturers who want to develop a new brand usually must consult closely with platform venders; they must understand the product roadmap of platform venders deeply (Ding et al., 2017; Humphrey et al., 2017). The product roadmaps are so complicated that mobile phone-set manufacturers, in many cases, must have repeated communications with their platform vendors. For similar reasons, it is natural to think of KI#5 and KI#6 because innovations and solutions of technological difficulties are presumed to require a higher level of technical knowledge and know-how.

To test hypothesis 1a, we checked if many local mobile phone-set manufacturing firms selected the value chain channel, especially suppliers, as the most important channel to obtain knowledge of these three types. One caveat existed in our original design of questionnaire. That is, we did not specify the platform vender as an independent alternative for knowledge channel. To compensate for this point, we use results of other questions in our questionnaire asking sample firms about the flow of technical knowledge between them and their key platform venders. By connecting the results of these two results, we can ascertain whether hypothesis 1a is supported or rejected.

When testing hypothesis 1b, we run regressions in which the dependent variable (i.e. each firm's selection for the most important channel to acquire KI#3, KI#5, or KI#6) is regarded as a function of explanatory variables (i.e. each firm's characteristics such as firm scale and R&D intensity), controlled by other firm-level factors such as years in business and firm location. If we find a statistically positive correlation between the firm's choice of a "supplier" channel and explanatory variables, then hypothesis 1b is

supported. Data for explanatory and control variables are available from responses to other questions from our questionnaire.

3.2.3 Role of ICs as knowledge and information channel

To test hypothesis 2, we first see if respondent firms obtain various types of generic information mainly from inside the cluster, and mainly through a personal connection channel. This survey of firms can be done using the same procedure we adopted in 3.2.2. Following this, we analyze at which place the most important source of knowledge and information is located when they gather information through the personal connection channel. If they locate inside the cluster in which respondent firms locate, then we conclude that personal connections webbed inside the cluster might play important roles when cluster firms gather a variety of knowledge and information.

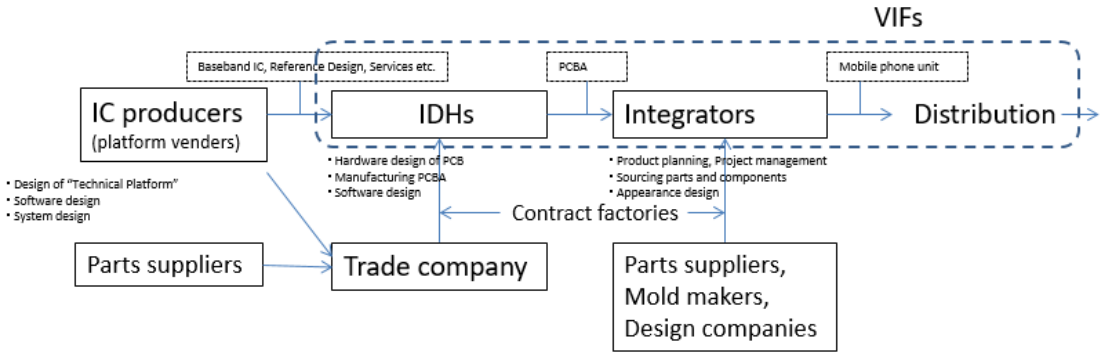
3.3 Data collection

We conducted questionnaire studies two times during 2013–2015. In the first study, 177 answers were collected from mobile phone-set manufacturing firms and firms of other types such as parts suppliers. There were 112 mobile phone manufacturing firms in this sample. The data of this subsample were used mainly for this study. The first questionnaire was designed to obtain basic sample firms' basic information and information related to their acquisition of knowledge and information. With the second questionnaire, a sample of 56 mobile phone-set manufacturing firms was drawn. Most of 56 firms had also been included in the first sample. The second questionnaire was designed to elucidate exchanges of knowledge and information between mobile phone-set manufacturing firms and their platform venders. We commissioned the implementation of those two questionnaire studies to China's state-owned research institute specializing in China's electronics industry. This commission highly improved the reliability of our data. In line with questionnaire research, we also conducted interviews of managers and employees of local mobile phone companies several times. These interviews greatly deepened our understanding of the relevant industries.

By the term "mobile phone-set manufacturing firms," we mean firms of three types (i.e. independent design houses [IDHs], integrators, and vertically integrated firms [VIFs]) constituting mobile phone value chains in China (see Figure 1). The platform venders or platform-leaders (e.g. MTK, Qualcomm, Spreadtrum) provide baseband ICs, core components of mobile phone sets, to IDHs VIFs. Then the IDHs engage in the design and the provision of core intermediate components, printed circuit board assemblies

(PCBA) to integrators, which produce a final mobile phone set and which sell them under their own brand name. The VIFs are firms in which functions fulfilled by IDHs and integrators are vertically integrated. The first sample comprises 112 mobile phone-set manufacturing firms and 65 firms engaging in sectors related to mobile phone-set production. The second sample of 56 mobile phone-set manufacturers was mostly drawn from firms existing in the first sample. Data related to mobile phone-set manufacturers were used for this research.

Figure 1 Value chains of China's mobile phone-set industry.



Source: Ding and Pan (2014) with slight modification.

Most of our samples were drawn from the Pearl River Delta (PRD) region including Shenzhen, Guangdong province, China. Among the 112 mobile phone-set manufacturers in our sample, 81, 19, and 12 firms were located respectively in the PRD region, the Yangtze River Delta region, and the rest of mainland China. Shenzhen is the largest industrial cluster for cell phone and other electronic products in the world. As China's first special economic zone, a large amount of foreign investment has flowed into Shenzhen since the 1980s. These companies have fostered numerous local suppliers, which have formed the most comprehensive electronics-supportive industrial area in the world. A company can purchase all the necessary parts to produce a cellular telephone within a mere two hours' distance. However, a huge specialized market for electronics, the North Huaqiang Market, is located in the center of Shenzhen. A cell phone company can trade directly with buyers from domestic and emerging markets merely by operating a booth in this market. These advantages of production and distribution stimulated an

increasing number of start-ups to emerge in Shenzhen. In 2015, among the total population of 11.38 million, 1.12 million companies exist.

4 Results

4.1 How important is each type of knowledge and information?

Results of evaluations by respondent firms are presented in Table 3. For illustrative purposes, we assigned a numerical value to each grade of evaluation: unity to "Not important", two to "Not important", three to "Medium", four to "Important", and five to "Very important". Based on this parameterization, we calculated the simple arithmetic means for all types of knowledge and information. Means of all categories are larger than 4; modes of all categories are 5. Therefore, local mobile phone-set manufacturers, on average, view all of these types of knowledge and information as highly important to their businesses, as we expected.

Table 3 Sample firm's evaluations on the importance of each type of knowledge or information

Category	Obs.	Frequency					Mean	Median	Mode
		Not important (1)	Not so important(2)	Medium (3)	Important (4)	Very important (5)			
KI#1	112	1	2	8	23	78	4.56	5	5
KI#2	112	0	2	2	24	84	4.70	5	5
KI#3	112	1	2	3	17	89	4.71	5	5
KI#4	112	3	1	11	35	62	4.36	5	5
KI#5	112	0	5	6	26	75	4.53	5	5
KI#6	112	0	1	7	37	67	4.52	5	5
KI#7	112	1	5	22	38	46	4.10	4	5
KI#8	112	1	5	22	33	51	4.14	4	5
KI#9	112	0	4	15	29	64	4.37	5	5
KI#10	112	0	5	6	26	75	4.53	5	5
KI#11	112	0	7	24	28	53	4.13	4	5
KI#12	112	0	3	15	24	70	4.44	5	5
KI#13	112	3	3	7	39	60	4.34	5	5
KI#14	112	4	2	10	20	76	4.45	5	5
KI#15	112	2	1	11	36	62	4.38	5	5
KI#16	112	0	5	29	33	45	4.05	4	5
KI#17	112	1	6	20	38	47	4.11	4	5
KI#18	112	1	3	18	32	58	4.28	5	5
KI#19	112	1	1	10	34	66	4.46	5	5
KI#20	112	0	1	11	42	58	4.40	5	5
KI#21	112	1	1	5	32	73	4.56	5	5

Source: Authors' questionnaire survey data.

4.2 Role of value chains as knowledge and information channels

4.2.1 Testing Hypothesis 1a

Table 4 presents the distribution of the most important channels for each type of knowledge and information. Shaded numbers in the 2nd and the 6th column mean that they gain equal to or greater than 34 percent in the total. In other words, when the total frequency of a channel, say the personal connection channel for a type of knowledge and information surpasses 1/3 of the total frequency of the channel, then we infer that the personal connection channel plays important roles in gathering this type of knowledge and information.

As for KI#3, more than half of the sample firms regarded the value chain channel, especially the supplier channel, as the most important channel when they obtain this type of knowledge and information. Therefore, it can be concluded quite safely that hypothesis 1a is supported with respect to KI#3.

However, matters differ with respect to KI#5. Regarding this type of knowledge and information, only 25 firms (about 23 percent in the total) selected the value chain channel as the most important channel to obtain this type of knowledge and information. In comparison to this, the personal connection channel gained a larger share, amounting to 40 percent. This result demonstrates that the value chain channel has only secondary importance when local firms gain this type of knowledge and information. Therefore, we conclude that hypothesis 1a is rejected with respect to KI#5.

As for KI#6, 44 firms replied that the value chain channel is the most important factor when they obtain this type of knowledge and information. Although the personal connection channel has the largest share (46 percent) of the total, the share of the value chain channel (40 percent) is quite a large number. Moreover, almost all firms selected the supplier channel as the most important one to acquire this type of knowledge. This result is compatible with our expectation quite well, leading us to the next procedure.

Table 4 Distribution of the most important channel for each type of knowledge or information

KI#	Personal connection channel				Value chain channel			Other channels					Total
	Total	C#1	C#2	C#3	Total	C#4	C#5	C#6	C#7	C#8	C#9	C#10	
kI#1	32	3	28	1	18	15	3	31	19	1	7	1	109
kI#2	67	4	60	3	13	9	4	13	8	1	5	3	110
kI#3	25	3	22	0	61	59	2	5	10	2	4	4	111
kI#4	24	0	20	4	71	66	5	7	5	0	2	1	110
kI#5	44	2	41	1	25	11	14	14	12	2	6	8	111
kI#6	51	4	47	0	44	43	1	3	4	0	4	5	111
kI#7	58	5	51	2	7	4	3	19	7	2	16	2	111
kI#8	26	3	19	4	10	5	5	15	3	47	4	5	110
kI#9	42	3	39	0	23	5	18	8	11	6	14	7	111
kI#10	15	2	11	2	39	2	37	13	18	2	15	8	110
kI#11	16	4	11	1	7	5	2	7	3	64	7	7	111
kI#12	36	6	27	3	25	9	16	10	11	15	2	12	111
kI#13	42	2	36	4	36	19	17	7	13	0	9	4	111
kI#14	41	3	36	2	55	46	9	3	5	0	2	5	111
kI#15	49	4	42	3	43	38	5	4	5	1	3	5	110
kI#16	68	6	60	2	28	23	5	2	5	0	1	7	111
kI#17	57	3	49	5	41	35	6	0	3	2	0	7	110
kI#18	68	2	60	6	14	9	5	3	5	2	4	15	111
kI#19	74	9	61	4	4	3	1	9	3	1	5	13	109
kI#20	39	2	36	1	7	2	5	2	8	0	15	40	111
kI#21	43	1	35	7	19	5	14	0	4	4	4	35	109
Average	43.7	3.4	37.7	2.6	28.1	19.7	8.4	8.3	7.7	7.2	6.1	9.2	110.4

(Note) C#1: Colleagues in the past working place, C#2: Friends and acquaintances in the same business, C#3: Alumnus and landsman in the same business, C#4: Suppliers, C#5: Customers, C#6: Media; Web site and SNS, C#7: Exhibitions and symposiums, C#8: Go

Source: Authors' questionnaire survey data.

The results of the second questionnaire research showed intensive mutual exchanges of technological knowledge and information between platform venders and their users, convincing us that the value chain, especially that with platform venders, is the main conduit through which they obtained KI#3 and KI#6. We addressed questions about their relation with platform venders to 56 sample firms. The 56 firms comprised 22 IDHs, 23 VIFs and 11 integrators. Because integrators usually do not purchase baseband ICs directly from platform venders, but purchase PCBAs from IDHs, whereas IDHs and VIFs purchase baseband ICs from platform vendors (see Fig. 1), the trade linkage of integrators with platform vendors differs from that of IDHs and VIFs. For this reason, integrators were asked questions different from those of IDHs and VIFs. To IDHs and VIFs, we posed two questions: "Does your company ask platform vendors to provide related knowledge, information or solutions when your company confronts technological problems?" and "Are platform vendors proactive at providing technological knowledge and information related to their IC products to your company?"

The responses are summarized in Tables 5 and 6. From these two tables, it is apparent that there are quite frequent mutual exchanges of technological knowledge and information between manufacturing firms and their platform venders.

Table 5 "When facing platform-based technological difficulties, do you often ask technical questions for solutions to the baseband IC maker? "

	IDHs	VIFs	Total
Often	18	20	38
Sometimes	1	1	2
Occasionally.	3	2	5
Never	0	0	0
Total	22	23	45

Table 6 “Does the baseband IC maker take the initiative to provide technical information to you?”

	IDHs	VIFs	Total
Often	14	17	31
Sometimes	5	4	9
Occasionally	2	2	4
Never	1	0	1
Total	22	23	45

Source of Table 5 and Table 6: Authors’ questionnaire survey data.

To integrators, we asked about the existence and the frequencies of information exchanges with platform venders. All of the 11 integrators in our sample replied that there exist exchanges of technological information. This evidence, taken altogether, is sufficient to confirm to us that the value chain channel, especially the business relation with platform venders, is one important channel for local manufacturers to obtain core technological knowledge and information. We conclude that hypothesis 1a is supported with respect to KI#3 and KI#6.

4.2.2 Testing Hypothesis 1b

Results showed that both personal connection channels and the value chain channel are regarded as important to acquire KI#6. This interesting finding naturally leads us to ask what factors can explain the split of firm’s choice in this type of knowledge. As already explained in relation to the hypothesis 1b, we assume that this is the function of firm

attributes related to firm capabilities. To test this hypothesis, we tried to run a multi-nominal logit regression model. We specified the model as

$$\ln \frac{\Pr(\mathrm{y} = \mathrm{vcc}|\mathrm{X})}{\Pr(y = \mathrm{pcc}|\mathrm{X})} = X'\beta_{\mathrm{vcc|pcc}}$$

where y=vcc denotes the choice of the value chain channel as the most important one and y=pcc denotes the personal connection channel as the most important one. Also, X is a vector of firm-specific explanatory and control variables. β is a vector of coefficients to be estimated. If the coefficients of firm scale and R&D intensity are significant and positive, then hypothesis 1b is supported. Because our principal interest a is comparison of the role of the personal connection channel and the value chain channel in knowledge circulation to local firms, we used the subsample that contains only firms selecting one of these two channels as the most important one. When we conducted regression analyses, we set the personal connection channel as the base category as expressed in the equation above. Regressions were done only for KI#3 and KI#6 because hypothesis 1a was rejected with respect to KI#5.

Summary statistics of explanatory variables are presented in Table 7. The results of regression analysis are reported in Table 8. Both results of these regressions show that the scale of firms is significant and positive, as we expected. However, the estimated coefficient regarding R&D intensity in regression for KI#3 is not significantly different from zero and that in regression for KI#6 is positive, but only at a 10 percent significance level. Based on this result, we conclude that hypothesis 1b is partly supported. We should make an additional remark with respect to locational factors. In both equations, the estimated coefficient of the location dummy is significant and positive, demonstrating that the probability of a firm to choose the value chain channel as the most important will increase if the firm locates in Pearl River Delta cluster, caeteris paribus.

Table 7-1 Descriptive statistics (Sample used in the regression of KI#3)

Variable	Obs	Mean	Std. Dev.	Min	Max	Description
logEMP	76	5.92	1.88	2.30	11.92	Log of number of employee in 2012
RAD_Share	76	0.39	0.26	0.00	0.83	Share of R&D personnel among the total number of employees in 2012
AGE	76	8.39	6.14	1	29	Years of operation in 2013
Location Dummy	76	0.71	0.46	0	1	Dummy variable: value is 1 if the firm locates in PRD region, otherwise 0.
Business type Dummy	76	0.47	0.50	0	1	Dummy variable: value is 1 if the firm is IDH, otherwise 0.

Table 7-2 Descriptive statistics (Sample used in the regression of KI#6)

Variable	Obs	Mean	Std. Dev.	Min	Max	Description
logEMP	85	5.93	1.76	2.30	11.41	Log of number of employee in 2012
RAD_Share	85	0.38	0.27	0.00	0.83	Share of R&D personnel among the total number of employees in 2012
AGE	85	8.08	5.82	1	29	Years of operation in 2013
Location Dummy	85	0.73	0.45	0	1	Dummy variable: value is 1 if the firm locates in PRD region, otherwise 0.
Business type Dummy	85	0.47	0.50	0	1	Dummy variable: value is 1 if the firm is IDH, otherwise 0.

Source: Authors' questionnaire survey data.

Table 8 Results of multinominal regression analysis

	KI#3		KI#6	
logEMP	0.444*	(0.256)	0.473**	(0.201)
RAD_Share	0.022	(1.646)	2.346*	(1.358)
AGE	0.036	(0.057)	-0.063	(0.047)
Location dummy	1.500**	(0.622)	1.286**	(0.597)
Business type dummy	0.256	(0.729)	-0.508	(0.609)
Constant	-2.900	(2.012)	-4.184**	(1.705)
Obs	76		85	
log likelihood	-37.351		-52.369	
chi2	10.536	(*p=0.061*)	10.178	(*p=0.070*)

Standard errors in parentheses. * p<0.10 ** p<0.05 *** p<0.01
Sample firms established after 2013 were removed.

Source: Authors' questionnaire survey data.

4.2.3 Roles of the value chain channel to obtain other generic types of information

We find from Table 4 that the value chain channel also plays important roles in gathering various types of information such as KI#4, KI#10, KI#13, KI#14, KI#15, and KI#17. Broadly speaking, information of these types is mostly associated with products

or materials provided by suppliers (e.g. development trends and price trends of key parts and components, how to address inventory of material inputs, and reputations of key parts and components suppliers). Information of other types is related to demands or preferences of end-users (e.g. changes in product needs and purchasing behavior of end-users and trends of the appearance of phone sets). It is quite natural for mobile phone set manufacturers to gather information about these types mainly from their suppliers and customers.

One important finding is particularly noteworthy. The value chain channel does not dominate outstanding shares as the conduit of these types of information with the exception of KI#4. In most cases, the personal connection channel is also regarded by many firms as the most important one, whereas another group of firms prefer to the value chain channel. This finding acknowledges the importance of the personal connection channel, as discussed in the next section.

4.3 Role of the ICs as knowledge and information channel

Table 4 clarifies that the personal connection channel, especially friends and acquaintances in the same business, is regarded as the most important channel when local firms obtain information of many types.

Table 9 Location of sample firm and the most important informant belonging in C#2 (friends or acquaintances in the same business)

Location of sample firm \ Location of the most important informant (C#2)	A	B	C	D	E	F	G	H	Total
A: North Qiangbei District, Shenzhen	1	0	0	1	0	0	0	0	2
B: Chegongmiao district, Shenzhen	4	6	4	1	0	0	0	0	15
C: Nanshan science park, Shenzhen	3	6	21	4	0	1	0	1	36
D: Suburb of Shenzhen and other regions in PRD	5	1	8	12	0	0	0	0	26
E: Shanghai	2	1	1	0	12	1	0	0	17
F: YRD region except Shanghai	0	0	1	0	0	0	0	0	1
G: Beijing	0	0	1	0	0	0	2	0	3
H: Rests of mainland China	1	1	2	2	1	0	1	0	8
Total	16	15	38	20	13	2	3	1	108

(Note) Category H also contains overseas when it is used as the location of the informant.

Source: Authors' questionnaire survey data.

Based on this result, we further inquired of each sample firm at which place the most important informant belonging to C#2 (i.e. friends or acquaintances in the same business) is located. In doing this, we again allow a firm to select only location to grasp the geographical distribution of the most principal personal connection channel. Results

are tabulated in Table 9. We think that the North Qiangbei district (A), Chegongmiao district (B), and Nanshan Science Park (C) in Shenzhen and suburbs of Shenzhen and other regions in Pearl River Delta regions altogether constitute a huge cluster of the electronics industry including mobile phoneset manufacturing sectors. Shanghai (E)) and its surrounding region (F), such as Kunshan city, also makes up a cluster. Table 9 clearly presents that the important informant belonging to friends and acquaintances now engaging in the same business is located inside the cluster where the firm is located. More than 97 percent and 72 percent of sample firms located in the PRD and YRD cluster replied that the most important sources related to C#2 are inside the cluster in which they were located. Stickiness of the important personal connection sources to the near-by locality might be readily apparent compared to the case of the value chain channel.

Table 10 Location of sample firm and the most important informant belonging in C#4 (suppliers)

Location of the most important informant (C#4) / Location of sample firm	A	B	C	D	E	F	G	H	Total
A: North Qiangbei District, Shenzhen	0	0	0	0	1	0	0	1	2
B: Chegongmiao district, Shenzhen	1	0	4	5	4	0	0	1	15
C: Nanshan science park, Shenzhen	2	1	16	12	3	0	0	2	36
D: Suburb of Shenzhen and other regions in PRD	1	2	9	13	0	0	0	1	26
E: Shanghai	2	1	0	3	7	2	0	2	17
F: YRD region except Shanghai	0	0	0	1	0	0	0	0	1
G: Beijing	1	0	1	0	0	0	1	0	3
H: Rests of mainland China	1	2	0	4	0	0	0	1	8
Total	8	6	30	38	15	2	1	8	108

(Note) Category H also contains overseas when it is used as the location of the informant.

Source: Authors' questionnaire survey data.

Table 11 Location of sample firm and the most important informant belonging in C#5 (customers)

Location of the most important informant (C#4) / Location of sample firm	A	B	C	D	E	F	G	H	Total
A: North Qiangbei District, Shenzhen	1	0	0	1	0	0	0	0	2
B: Chegongmiao district, Shenzhen	3	0	0	3	0	1	0	8	15
C: Nanshan Science Park, Shenzhen	7	1	3	6	0	1	0	18	36
D: Suburb of Shenzhen and other regions in PRD	3	2	0	3	2	0	2	14	26
E: Shanghai	5	0	3	3	1	1	0	3	16
F: YRD region except Shanghai	0	0	0	0	0	1	0	0	1
G: Beijing	0	0	0	0	0	0	2	1	3
H: Rest of China mainland	1	1	0	0	0	0	0	6	8
Total	20	4	6	16	3	4	4	50	107

(Note) Category H also contains overseas when it is used as the location of the informant.

Source: Authors' questionnaire survey data.

According to Table 10, about 20 percent and 50 percent of sample firms located in the PRD and YRD cluster answered that the most important suppliers are outside the cluster in which they were located. Stickiness to the PRD cluster might still be readily apparent, but this is mainly because of the huge presence of electronics industries in this region. As Table 11 shows, C#5 has much more outward origins. About 60 percent and 80 percent of sample firms locating in the PRD and YRD cluster replied that the most important customers are located outside of their own cluster.

Based on the findings stated up to this point, we can naturally conclude that the personal connection nested mainly inside the cluster is one of most important channels through which various types of knowledge and information are diffused to cluster firms. Our empirical evidence firmly supports hypothesis 2. With comparison to the personal connection channel, the value chain channel plays important roles when local firms acquire core technical knowledge and information, along with other types of information closely related to the product or services provided by suppliers or to the demands of end-users. The important source of the value chain channel locates inside or outside the cluster. However, compared to that of the personal connection source, it has much more readily apparent outward origins. In other words, the value chain channels

function more as bridges over the cluster border, through which many types of knowledge and information come into clusters[3].

Table 4 shows that either the personal connection channel or the value chain channel plays a dominant role in conveying a specific type of information. Such cases are exemplified by the cases of KI#2, #3, #4, #9, #10, #16, #18, #19, #20, and #21. In other words, there is a kind of "division of labor" between the personal connection channel and the value chain channel in circulating information of different types. In this sense, these two channels play complementary roles when local actors learn knowledge and gather necessary information.

There is another finding worth noting. For knowledge and information of some types such as KI#6, #13, #14, #15, and #17, there emerged splits into two large groups in terms of an answer: one group of firms reported personal connections as the most important channel; the other group of firms replied that the value chain is the most important. Among the types of knowledge indicated above, KI#6 deserved to be described because this is core technical knowledge and information. This finding is somewhat contradictory to Wang and Lin (2010) who reported that core technologies were developed mainly in-house and interfirm knowledge interactions were rare in the Shenzhen ICT cluster. This finding is also beyond our original expectation that the personal connection channel cannot play a vital role in circulating knowledge and information of this type because the present level of knowledge base of local actors might be quite poor. Therefore, firms cannot but rely on suppliers, especially platform venders, when they acquire core knowledge of this type.

In our view, two possible explanations exist: (1) it is possible that preference for relying on personal connections by one group of firms embodies a kind of "mutual help among the weak." Small firms with few capabilities, such as "Shanzhai" producers, specialize

[3] The value chain of mobile phone-set industry in China has marked global characteristics. Many important components are provided by companies of foreign origin. Especially, as we have noted up to this point, the main platform venders, which provide important knowledge and information to local manufacturers, are foreign companies. More accurately speaking, the value chain channel should be interchanged to the *global* value chain channel.

in low-end and highly standardized products. This group of firms cannot afford large sums of investments necessary to make major innovations. Rather they are inclined to use "open source inputs" (e.g. common molds and common PCBAs) and to make minor changes for differentiation (Ding and Pan, 2014). Consequently, firms of this type do not encounter fundamentally difficult technological problems so often. They are willing to exchange minor knowledge and information and help each other when they encounter minor technological difficulties. The fact this group of small firms use similar turnkey solutions provided by same platform vendors such as MTK might facilitate such mutual help because the use of common platform works as if it were a common language[4]. Our regression analysis reveals that smaller firms have a greater tendency to select the personal connection channel as the most important instead of the value chain channel (Table 8). This result supports this explanation: (2) it is possible that a kind of open innovation has been emerging in China. Dahl and Pedersen (2004) reported that engineers working in a high-tech cluster share valuable technical knowledge along with generic information with informal contacts. Our finding is consistent to theirs in that the importance of personal connections in the cluster in diffusing technical knowledge is underlined. How are informal contacts done in Shenzhen? The reply from an interviewee provides a hint: such informal contacts are done in groups of, say, 7–8 persons including 1 staff member of the platform vender, 3–4 staff members of the design house, and 2–3 staff members as integrators. It is usual that all members or a part of members regularly have meals or meetings. Because each firm specifically examines a different market, they are not concerned that such communications will provoke intense competition among them. Such communications, in many cases, are concentrated on issues related to fundamental, open, and standardized technological information as well as market and technology trends in the whole industry. It is not impossible that such frequent interfirm diffusion of knowledge facilitates the evolution of open innovations.

[4] We asked 56 mobile phone manufacturing firms about their use of baseband ICs. On average, the share of MTK and Qualcomm in the total of baseband ICs used by sample firms amounted to 64% and 20% respectively. We also asked "Did the selection of baseband IC that your company currently uses have influences on interactions between your company and peer companies?" To this question, 43 firms replied that there were "very important" or "important" beneficial influences. These results support our discussion here.

5 Conclusion

This paper presents an investigation of how Chinese mobile phone-set manufacturing firms obtain necessary knowledge and information. For this purpose, we classified 21 types of knowledge and information, ranging from key technical knowledge to varieties of more generic information. The most important channels through which firms obtain each type of knowledge and information and the geographical distribution of knowledge and information source were identified based on our questionnaire research and field interviews.

Results of our empirical analyses revealed the following: (1) Personal human connections networked inside industrial clusters play important roles when local firms gather knowledge and information of many types, mostly related to varieties of generic type information. In other words, we found the importance of LKSs through personal contacts in China's high-tech cluster. (2) Global value chains, especially those with platform venders, serve as important conduits through knowledge and information of many types, including core technical knowledge, are obtained by local manufacturing firms. (3) A "division of labor" prevails between the IC and the GVC channels in circulating information of different types. These two channels play complementary roles when local actors learn knowledge and gather necessary information. (4) What is beyond our original expectation, however, is that personal contacts with friends and acquaintances in the cluster also serve as an important conduit of technical knowledge, along with the GVCs. (5) Local firms' preferences of the GVC channel or the personal connection channel is partly explained by firm attributes of local manufacturing firms. The larger the local firm is, the more importance they assign to GVC channels in getting key technical knowledge and information, compared to the importance of the personal connection.

The world has undergone an era of rapid emergence of economically developing countries such as China and India in high-tech industries. A question that naturally arises is knowledge/information systems of what kind enable, support, and facilitate rapid growth in high-tech industries? An aim of this article is to shed light on this problem by comparing the roles of ICs and GVCs in knowledge and information diffusion using evidence from the China's mobile phone industry.

A limitation of this study should be considered further in our future research. In many high-tech clusters in economically developed countries, research institutes such as universities play crucially important roles in diffusing advanced knowledge to local firms located in the same cluster. As described in this paper, we took a close look at the relation between platform venders and local firms in diffusing higher levels of knowledge, not at their relation with local and national research institutes. Devotion of close attention to platform leaders is a valid strategy, given the reality of China, especially Shenzhen's mobile phone-set industry. However, circumstances might be somewhat different in Beijing or Shanghai, where China's top-level higher research institutes agglomerate. Consequently, further research on this topic is imperative.

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