NEW INFORMATION AND COMMUNICATION TECHNOLOGIES AND LOCAL CLUSTERING OF FIRMS: A CASE STUDY OF THE XINGWANG INDUSTRIAL PARK IN BEIJING[1]

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Abstract: Recent advances in telecommunications technologies have initiated debates on the changing balance between centralizing and decentralizing forces driving economic activities. The literature reveals that new information and telecommunication technologies (ICTs) have been driving new economic activities into a number of cities and regions with well-developed information infrastructures while within these cities and regions new industries tend to disperse as a result of the safe and sufficient communications across distance enabled by new ICTs. This finding suggests that the application of new ICTs is a strong decentralizing force in a firm's location at the local scale. It is against such a background that this paper examines the Xingwang Industrial Park located in the Beijing Economic and Technological Development Area (BDA) as a case study to focus on the dynamics of local industrial clusters enabled by new ICTs. The authors argue that new ICTs are an enabling or facilitating agent rather than a deterministic force. The application of new ICTs tends to lead to a "virtual clustering" of firms as this is an essential step of integration of supply chains while whether or not suppliers choose to locate in proximity to each other and to assemblers depends on a number of other factors. [Key words: new information and communication technologies, local industrial cluster, telecommunications industry, Xingwang Industrial Park.]

INTRODUCTION

Recent decades have witnessed extraordinary advances in information and communication technologies (ICTs), which have helped to change social and economic life (Graham and Marvin, 1996). Not surprisingly, geographers have been prominent, particularly

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in contesting the popular view that distance no longer matters and that "the end of geography" is at hand (see, for example, Graham, 1998; Malecki, 2000). One significant manifestation of the continuing importance of geography in the contemporary economy is the persistence and continuing creation of localized clusters or agglomerations of economic activity. Despite progressive reductions in communications costs—which, as argued by Alfred Marshall more than a century ago, should increase the dispersal of economic activities—local clusters remain a dominant feature of the economic landscape of the 21st century. A large number of studies have shown that such factors as face-to-face communication, local industrial atmosphere, and accumulation and transmission of tacit knowledge play a key role in these local clusters (see, for example, Malmberg, 1996; Malmberg et al., 1996; Malmberg and Maskell, 1997; Gordon and McCann, 2000). Recent research suggests that new ICTs have been driving economic activities into a number of cities and regions with well-developed information infrastructures, while within these cities and regions new economic activities tend to disperse as a result of safe and sufficient communication enabled by new ICTs. This finding suggests that the application of new ICTs is a strong decentralizing force in a firm's location at the local scale.

It is against such a background that we examine the Xingwang Industrial Park, located in the Beijing Economic and Technological Development Area (BDA), as a case to focus on the dynamics of local industrial spatial organization enabled by new ICTs. We attempt to provide a more comprehensive explanation of a firm's spatial organization with new ICTs by emphasizing that technology is not only "an enabling or facilitating agent" (Dicken, 2003, p. 85) but also one that is influenced greatly by the specific institutional environment within which it operates. The Xingwang Industrial Park is a recently developed cluster of telecommunication manufacturing activities, jointly developed by Nokia and the municipally owned BDA. At present, it includes an assembly plant operated by Nokia-Capitel, 14 suppliers, and one logistics firm. Because of its status as a virtual bonded area, the Park provides an excellent case through which to examine the role of new ICTs in the formation of industrial clusters. Through this case study, we argue that the application of new ICTs can lead to "virtual clustering" of firms. Whether suppliers choose to locate in *geographical* proximity to each other and to assemblers depends on a number of factors, e.g. institutional arrangements, quality of the transportation network, and so on.

THE INFLUENCE OF NEW ICTS ON MANAGEMENT OF FIRMS

The widespread use of new ICTs (in particular, PCs and the Internet) is both a driving force and an enabling force in the transformation of firms' management. On one hand, since new ICTs make information transmission much easier, the amount of information on commodities that customers can access in one geographical location has become enormous. This implies far more choice than previously available to customers and, therefore, intensified marked competition and more rapid market change for firms. Such a change implies that product life cycles are getting shorter and shorter because producers must continuously introduce new products to attract the attention of customers in order to maintain or increase market share. In addition, the application of B2C and B2B e-commerce has made a new manufacturing mode of "build-to-order" (BTO) more popular (i.e., mass customization), which also challenges the management of firms (Liu, 2002; Dicken, 2003). Thus, response to accelerating market change forces firms to reform their ways of

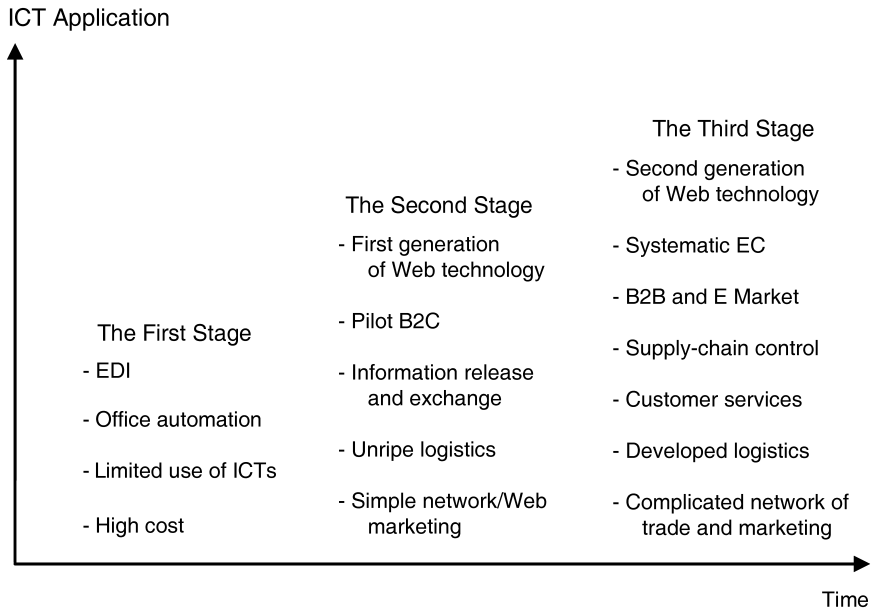

Fig. 1. Application of new ICTs in firms' management. *Source*: Interviews with companies employing new ICTs.

management (Cottrill, 2000). On the other hand, new ICTs allow firms to try new management practices through enabling them to handle increasingly complicated information flows, to coordinate more efficiently different internal functions, to form new supply linkages, and to develop new customer linkages.

It is now widely accepted in the business field that the capacity of response to 3C (customer, competition, and change) will greatly influence the survival and growth of firms. In this regard, three major changes in firms' management under new ICTs can be identified. The first is a change of management focus from one centered on production to one centered on customers. An indicator of such a change is the widespread adoption of BTO manufacturing. The second is a change of management structure from vertical hierarchy to flatter, more horizontal forms. Management of flows allows corporate decision-makers to respond to market changes more directly. The third is a change of management scope from internal management to supply chain control, which leads to changes in customer-supplier relationship. This implies that B2B e-commerce may become increasingly common between assemblers and suppliers. All of these management changes are closely related to the application of new ICTs by firms. Figure 1 summarizes the development of firms' application of new ICTs in management.

In summarizing the *2000 Symposium E-Commerce and Global Business*, Torre and Moxon (2001) indicated several important changes in the conduct of businesses that are driven by new ICTs:

- An international distribution of value-added activities that matched the relative competitive advantage of each geographic location;

- Immediate delivery to and superb service to customers in any part of the globe;
- Rapid and accurate product development, the result of combing extensive databases on customer preferences with specialized producers;
- Mass customization of products and services at no incremental cost relative to standardized mass production;
- A redefinition of corporate boundaries that would outsource all but the most central processes to specialized firms, leading to a reconfiguration of multinationals into virtual corporations and networks of alliances;
- Companies that would increasingly be "born global," immediately having a global presence and avoiding the long, expensive process of building an international network of affiliates and personnel.

Although these are "dreams" of a well-networked world economy, they do represent the nature of changes in the way of conducting businesses, and hence will influence the spatial organization of the economy and of firms. Thus, we agree that "there is little doubt that the new ICTs will indeed transform business processes, customer relationship management, supplier and procurement system, the structure of industries, and perhaps, the very nature of firms" (Torre and Moxon, 2001). However, we should be somewhat cautious in overexaggerating the extent to which this has occurred so far (Dicken, 2003, pp. 477–478).

UNDERSTANDING THE SPATIAL IMPACTS OF NEW ICTS

How such changes will transform the spatial organization of the economy and of firms is, of course, among the interests of economic geographers. Figure 2 provides a framework for understanding the potential spatial impacts of new ICTs. It emphasizes three major issues: the uneven spatial distribution of ICT infrastructures; the nature of the changing business environment; and the nature of the institutional environment.

Agglomeration or Dispersion: The Problem of Scaling and Sectoral Difference

More than 100 years ago, Alfred Marshall argued that every cost reduction in communications tended to decentralize economic activities (quoted in Gillespie et al., 2000). Recent studies of new ICT impacts suggest that both centralizing and decentralizing dynamics exist, working at different scales and in different economic sectors (e.g., Moss, 1998; Graham, 2002; Leamer and Storper, 2001; Sohn et al., 2002; Zook, 2002).

The uneven spatial distribution of ICT infrastructures has been taken as a starting point and a strong base for arguments in many studies. Sohn et al. (2002) argued that the influence of ICT will be manifest through the distribution and access to physical infrastructures rather than just software and applications. Indeed, the uneven distribution of ICT infrastructures can be easily observed and measured, and hence its impacts on economic spatial distribution are likely to be inferred from a geographical point of view. As Graham (2002) indicated, the societal diffusion of ICTs is still uneven at all scales. In particular, in cities, "clusters and enclaves of 'super-connected' people, firms and institutions

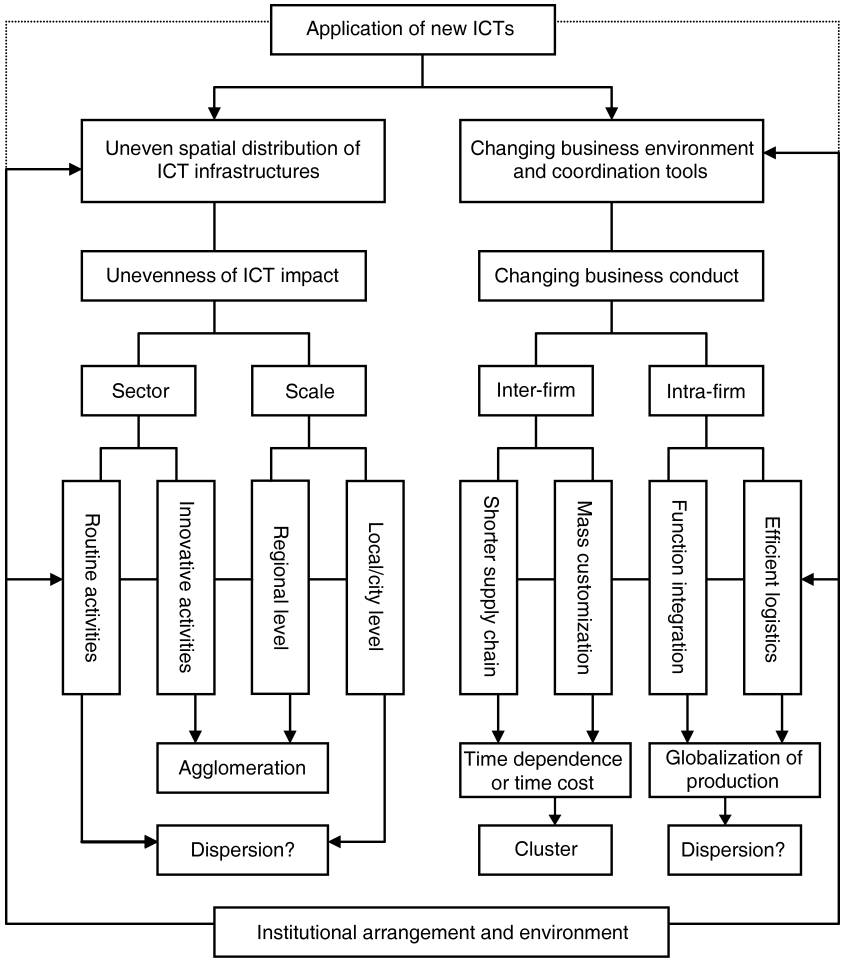

Fig. 2. A framework for understanding the spatial impacts of new ICTs on the economy.

coexist with large numbers of people with nonexistent or rudimentary access to communications techologies" (Graham, 2002). A case study of the Chicago region based in ICTs infrastructures revealed that "limited availability and accessibility of a well-equipped information network in certain areas seemed to restrict the favorable location of establishments and as a result more concentrated distribution pattern was observed" (Sohn et al., 2002). The study by Yen and Mahmassani (1997) also indicated that the uneven spatial distribution of ICT infrastructures will cause "dispersed concentration."

Leamer and Storper (2001) argued that while transportation and communications facilitated the dispersion of certain routine activities they simultaneously increased the complexity and time-dependence of production. On one hand, those routine activities that depend on coordination of standardized tasks can be successfully accomplished at remote but cheaper locations and thus there is an ongoing tendency toward dispersion of production with new ICTs. On the other hand, the complex and unfamiliar coordination

of innovative activities (i.e., "handshaking" activities) that depend on long-term relationships and closeness will still cluster in a certain location and thus there is another tendency of agglomerations of production in terms of innovative activities. However, it should be noted that whether or not routine activities of production are dispersed is a matter of scaling and of the specific sectors under study.

As Leamer and Storper (2001) pointed out, there seems to be no single new business model enabled by new ICTs but, rather, a situation of complex feedbacks to specialization and divisions of labor within and among sectors. A study of the Chicago region by Sohn et al. (2002) showed that the agglomeration processes of establishments take place in individual sectors and that center-orientedness appears differently in varying sectors. For example, the service sector as a whole is, in general, more sensitive to the availability of new ICT infrastructures while retailing tends to be "footloose" and manufacturing occupies various positions in the middle ground.

New ICTs can also facilitate the functional integration of large firms by overcoming the cost of handling bulk information and enabling efficient logistics, and thus they play a key role in the formation of global production networks of large firms (Henderson et al., 2002; see Dicken 2003). That is, new ICTs can enable the spatial fragmentation of economic activities globally while allowing them to be easily integrated functionally. According to Graham and Marvin (2001), new ICTs are used to tie together the following types of activity sites:

- Research and development centers in suburban techno-poles;
- Corporate headquarters and financial service houses in selected "global" cities;
- Cultural, media, and multimedia sectors in the emerging "digital clusters";
- Manufacturing plants in the peripheries and newly industrializing cities;
- Call-centers, data processing, and e-commerce management centers in newly emerging e-commerce enclaves across the world;
- Resource extraction activities in minerals, forests, oilfields, and fisheries;
- The logistics, seaport and airport hubs that serve as the transshipment and export processing zones.

Therefore, spatial transformations driven by new ICTs consist of complex processes, and their operations are highly differentiated by scale, sector, and functional activity. Hence, we cannot make a simple and clear assertion about whether economic activities will agglomerate (centralize) or disperse (decentralize) with new ICTs. Globally, new ICTs are intensifying the role of traditional large cities as demand for ICTs is overwhelmingly driven by the growth of metropolitan markets (Graham and Marvin, 1996), while some routine activities of production tend to decentralize to newly industrializing regions from a core-peripheral point of view. On the other hand, regions and cities with well-developed information infrastructures have been attracting new economic activities, as indicated by the case of Dublin (Dodge and Kitchin, 2000, pp. 49–51), which suggests some decentralization of production. At regional and local/city level, some new economic activities tend to disperse as a result of safe and sufficient communication enabled by new ICTs while case studies also show a more concentrated distribution pattern with new

ICTs (Sohn et al., 2002). However, there have been few studies of the spatial organizations of firms (both inter-firm and intra-firm relationships) transformed by new ICTs. In general, the spatial transformations driven by new ICTs are far from clear, particularly at the firm level.

Time Cost and Time-Dependence: The Nature of Change under New ICTs

Besides the uneven spatial distribution of ICT infrastructures, we can examine the spatial transformations driven by new ICTs from another perspective: what are the possible spatial results led by the changes in the way of conducting business at the firm level? We have previously discussed the changes in firms' management driven by new ICTs, and we would argue that these firm-level changes may transform the spatial economy. In particular, shorter product life cycles and mass customization will tend to lead to changes in the spatial organization of firms (Dicken, 2003). In relation to electronic commerce, Liu (2002) classified industries in the new ICT age into "soft" (digitized products) and "hard" (material products) sectors, and argued that "quicker response to market changes" and "better delivery of products to customers" are two main forces determining firms' spatial organization in the "hard" sector. These two factors illustrate the significance of time in the conduct of businesses of firms: new ICTs will increase the "*time-dependence*" of production, as argued by Leamer in Storper (2001).

Financial cost (or money cost) is, of course, a critical factor in firms' management, and minimizing production costs tends to be a primary goal of all firms. In the emerging new regime characterized by globalization and new ICTs, however, the lowest production (money) cost may not inevitably ensure firms' success in the market, as product life cycles get shorter and new products become increasingly critical to success. That is, the earlier a firm can put its new product into the market, the more it can earn, and the more successful it can be, given that the product fits into the right market at the right time. Thus, we could argue that *time-cost* of production is becoming more and more critical to the spatial organization of production.

Time-based competition has become a key business concern (Stalk and Hout, 1990; see, for example, Schoenberger, 2000). In the hyperbolized language of the business consultant, Jennings and Haughton (2002) fervently advocated using speed as a competitive tool in business, asserting that "the fast eat the slow."

"Fast thinking," "Fast decision," "Get to the market faster," and "Sustaining speed" are the titles of the only chapters in the Jennings and Haughton book. Although this, to a large extent, overly passionate commercial language, it does reflect the orientation of changes in conducting business: that is, time is becoming more significant in firms' decision making.

Indeed, the strategic value of time management in corporate success has been widely recognized, and time compression in production and product development continues to remain central to the managerial project to date (Schoenberger, 2000). Taylor's scientific management approach was nothing more than time control in assembly-line processes. More recently, the seemingly ubiquitous just-in-time (JIT) approach or "lean production" in manufacturing is clearly about time compression. However, Taylor's approach was used to reduce "money" cost; its departure point was to increase productivity. JIT or lean production was invented originally to reduce in-house inventory and to cut down on

wasted parts. Later on, JIT/lean production was found to be able to respond quickly to the rapid changes of the mature automobile market, as intensive daily communication and spatial proximity between assemblers and suppliers enabled the production assembly process to change much more rapidly. The benefits of the JIT approach, based upon spatial proximity between assemblers and suppliers, have been intensively discussed in the study of the automobile sector, although less so in other sectors. To save time-cost, it could be reasonably anticipated that JIT should grow in popularity in other sectors.

The original JIT approach indeed demonstrated the significance of time-cost to some degree—but it is the widespread application of new ICTs that has increased its importance. When the rather crude kanban system was replaced by computer networks, the flexibility of production was boosted (Echeverri-Carroll, 1996). Almost 10 years ago, Capello (1994) argued that, in the long run, new ICTs would lead to new production strategies, such as the "just-in-time" system that requires a physical proximity between firms and hence spatial clustering of economic activities. Both quick response to market change and built-to-order (BTO) require a time cost as low as possible. Quick response means that firms must introduce new products very quickly to grasp market opportunities that may go away in a short time (get to market faster) while customers do not like to wait for too long to get products ordered in the BTO model. Thus, time cost, if not more important than money cost, is at least as critical as the latter in firms' market success. It should be noted, however, that a low time-cost cannot be achieved only in the assembly line. Instead, the whole production chain must be fully integrated in order to be "agile." One way of achieving low time-cost is to employ "air-commerce," i.e., to use airlines in sourcing parts and components. Acer's production base of laptop computers in the Philippines is a good example of the use of such "air-commerce." Another way is to locate the entire production chain in one geographical location so as to take advantage of the spatial proximity between assemblers and suppliers to reduce time-cost.

Based on this analysis, our preliminary hypothesis is that the factor of time plays a critical role in transforming the spatial organization of the production chain under new ICTs, although the role of money-cost cannot be ignored. To pursue a low time-cost, shortening supply chain and hence clustering of assemblers and suppliers would, therefore, be a helpful step. On the other hand, new ICTs facilitate the global operation of large firms, i.e., globally, production can be more dispersed than before. Thus, the processes of spatial fragmentation and unity coexist under new ICTs.

Much of the discussion of these issues in the literature has been set at a fairly general level. However, there is a real need for more concrete, fully grounded empirical studies to explore how these complex processes produce specific outcomes in specific places. This is the intention of the next section, which presents a case study of an ICT-based telecommunications cluster in Beijing.

THE XINGWANG INDUSTRIAL PARK IN BEIJING

The Xingwang Industrial Park is a cluster of mobile-phone manufacturing activities located in the outskirts of Beijing. The cluster has been developed jointly by Nokia China Investment Co. Ltd. (NCIC) and the municipally owned Beijing Economic and Technological Development Area (BDA), although the original idea to establish a telecom cluster in China came from Nokia itself. At present, the cluster consists of one assembler

TABLE 1. Companies in the Xingwang Industrial Park, 2002

Company name	Major products	Investment (US$ in millions)	Home country/ region
Beijing Capital NOKIA Mobile Telecommuincation Co. Ltd.	Mobile phones, stations	173.90	Sino-Finland joint venture
Beijing ELCOTEQ Electronics Co. Ltd.	Electronic parts, and components	29.00	Finland
Beijing GKI Electronics Co. Ltd. (IBM and China Great Wall joint venture)	Mobile phone and PC electronic components	24.94	Sino-U.S. joint venture
SANYO Energy (Beijing) Co. Ltd.	Li battery	29.00	Japan
NOLATO Mobile Communication Polymers (Beijing) Co. Ltd.	Polymer junction and parts	7.10	Sweden
IBIDEN Electronics (Beijing) Co. Ltd.	High-density printed circuits board	29.90	Japan
Beijing Sun-Arrom & Chung-Ding Electronics Co. Ltd.	Buttons, silicon, and rubber parts	12.00	Hong Kong
FOXCONN Precision Parts (Beijing) Co. Ltd.	Motherboard and shell	29.80	Taiwan
Beijing RFMD Electronics Co. Ltd.	IC parts and components	29.99	U.S.
ALLGON Telecom (Beijing) Co. Ltd.	Antenna modules	2.60	Sweden
Beijing Sacor Coatings Technologies Co. Ltd.	Electronic parts coating	4.50	Finland
Molex Interconnect (Beijing) Co. Ltd.	Interconnected parts	3.00	Singapore
Friwo Electronics (Beijing) Co. Ltd.	Battery chargers	n.a.	Germany
Beijing S&C Electronics Co. Ltd.	Power-electronic products	n.a.	U.S.
Golden Eagle International Forwarding Co. Ltd.	Logistics of the industrial park	n.a.	Sino-U.K. joint venture

(Nokia-Capitel), 14 suppliers, and one logistics company (Table 1). It is expected by BDA that the number of suppliers will rise to about 30 after the second phase of the cluster is finished. Table 1 shows the major products, investment levels, and home countries of the suppliers in the cluster.

The Xingwang Park was chosen as a case for study because new ICTs have played an enabling role in the formation of the cluster. Data on the Xingwang Park were obtained both from interviews with companies in the Park and with official organizations and from BDA statistics. The interviews with Nokia-Capitel, two of its suppliers, the logistics firm (Exel-Sinotrans), BDA officials, and a vice general manager of the Xingwang Park were completed in late 2002. In the following discussion, we will first outline the recent development of the market for, and production of, mobile phones in China, with special attention to Nokia to provide a background for understanding the Xingwang Park, second discuss factors affecting the establishment of the telecom cluster, and finally analyze the

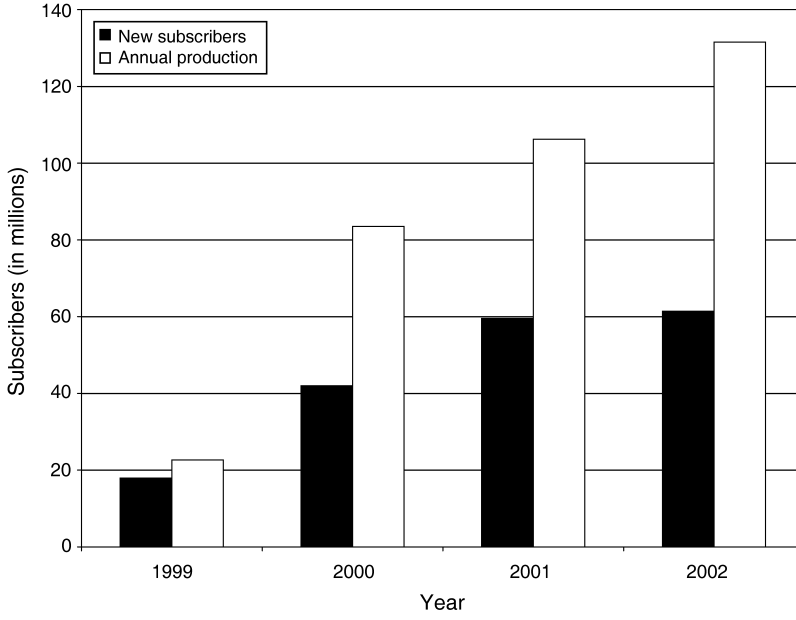

Fig. 3. Annual new subscribers and production of mobile phones in China. *Source*: Ministry of Information Industry of China, 2003.

role of new ICTs and institutional factors in the formation of a cluster having distinctive characteristics.

Recent Market Development and Production of Mobile Phones in China

China has become the largest market of mobile-phone subscribers in the world. By 2002, the total number of mobile-phone subscribers had reached 206 million, 15 times 1997's total, and annual increase of 73% in the five years. Figure 3 shows the annual growth in new subscribers and in the production of mobile phones in China from 1999 to 2002. In 2002, the number of mobile phones produced in China was 131.55 million, and new subscribers totaled 61.39 million. New subscribers from 1999 to 2002 accounted for 88% of the total subscribers by 2002, indicating a rapid growth of the mobile-phone market in China in the last few years. This huge market has attracted increasing investment, both domestic and international, into mobile-phone production in China. In 1998–2002, the accumulated foreign district investment (FDI) in mobile-phone production in China was more than US$13 billion, and in 2001 and 2002, respectively, an annual FDI inflow of US$4 billion into the sector was registered. As a result, recent years have witnessed a proliferation of mobile-phone producers in China. In 1997, there were only five mobile-phone producers in the country while the number had jumped to 37 in 2002 (including both GSM [Global System for Mobile Communication] and CDMA [Code Division Multiple Access] producers). The total production capacity of these producers is estimated to be 200 million sets per year, according to the Ministry of Information Industry of China.

TABLE 2. ANNUAL PRODUCTION SHARE AND MARKET SHARE OF MOBILE PHONES BY BRAND NAME IN CHINA[a]

	1999		2000		2001		2002	
Brand name	Production	Market	Production	Market	Production	Market	Production	Market
Motorola	42.21	39.38	33.78	35.42	25.89	29.26	23.84	25.76
Nokia	30.91	32.27	30.19	25.14	32.77	22.28	27.85	18.17
Siemens	5.21	5.95	7.30	8.14	11.68	9.65	9.96	4.66
Ericsson	6.09	6.44	9.75	9.23	8.75	6.48	4.72	2.09
Subtotal	84.42	84.03	81.02	77.94	79.09	67.67	66.27	50.68
Domestic	5.19	5.46	6.38	10.65	12.35	21.77	22.55	39.37

[a]Percentage of national total.
Source: Ministry of Information Industry of China, 2003.

Indeed, many transnational corporation in the sector have established production facilities in China, including Motorola, Ericsson, Nokia, Samsung, LG, Siemens, Alcatel, Panasonic, and Sanyo. Of these, Nokia and Motorola are the two largest producers of mobile phones. In 2002, they accounted for 51.7% of total production and 43.9% of the Chinese market. At the same time, huge domestic investment has also gone into the sector, resulting in the fast growth of domestic mobile-phone producers in the last several years. At present, major domestic producers include TCL, Bird, Capitel, Haier, Konca, Amoisonic, Kejian, Soutec, and Eastcom. In 2002, these domestic producers manufactured 26.15 million sets of mobile phones, which accounted for 22.8% of the total production in China. Table 2 reveals the changes in market share and production share of major foreign brand-names, and of domestic brand-names in total. A clear feature of change as reflected by Table 2 is that the market share and production share of domestic producers have been rising rapidly while foreign brand-names still dominate the market.

Nokia was one of the early entrants into China, though not the first.[3] In 1995, it set up a 50-to-50 joint venture with Capitel, a telecommunications producer in Beijing, and another joint venture with a local producer in Dongguan located in the Pearl River Delta. Both produce GSM mobile phones. In 1998, Nokia opened a wholly owned GMS station manufacturing plant in Suzhou, a city located near Shanghai. At present, Nokia ranks as the largest mobile-phone producer in China, while China itself is Nokia's second largest market in the world. In 2002, Nokia's two plants in Beijing and Dongguan produced 36.6 million sets of mobile phones, accounting for 27.85% of the total production in China.

[3] Nokia started its businsess in China in the ealry 1950s, but had no production facilities until 1995. Motorola was the first to set up mobile-phone production facilities in China with its wholly owned plant in Tianjin, which opened in 1990.

The share is higher than that of all domestic Chinese producers, but it has decreased slightly year by year (Table 2). A comparison to its market share in China, which has been decreasing much faster, indicates that the proportion of exports in the total production of Nokia in China is rising quickly. In 2002, Nokia accounted for 41% of the total exports of mobile phones, and exports accounted for two-thirds of Nokia's total mobile-phone production. China has undoubtedly become a "world factory" among Nokia's global businesses.

The Establishment of the Xingwang Industrial Park

As widely recognized in the business field, production of mobile phones is no longer a new and high-profit sector, and competition in the sector is growing more competitive worldwide. New market channels enabled by new ICTs have played a role in the intensification of competition as customers are facing tremendous choices exposed by information available from the Internet and other new channels. Indeed, a mobile phone, as a message sender and receiver and/or as a WAP (wireless access protocol) Internet platform, has added complexity and new channels to the marketing of firms. On the other hand, new entrants into the sector have also led to the intensification of competition. As a result, mobile-phone producing firms no longer enjoy a high-profit market. They have to introduce new models or modified models more frequently in order to attract attention from customers, i.e., they have to customize production and develop new models more quickly to satisfy market demands. Such a market condition offers a strong incentive for firms to try new business models to respond rapidly to market changes and to reduce production and delivery cost. Thus, it is essentially the fiercer competition in the mobile phone market that has driven Nokia to try the kind of new business model described in this case study.

In 1998, when the mobile-phone market started to boom, NCIC decided to look for a new production site to expand its production capacity. Extension of its joint venture plant with Capitel in the Beijing urban area was spatially limited by the availability of land. Although Nokia was interested in adopting a new business model in its planned new plant, it had no concrete idea of creating a cluster until its managers visited Volkswagen's automobile assembly plant in Barcelona, Spain, in late 2000 (Anonymous source, Exel-Sinotrans Freight Forwarding Co. Ltd., pers. comm., November 28, 2002). Indeed, the business model of assembler and suppliers clustering is nothing new in the automobile sector, since JIT or lean production is widely adopted to cut down production costs and respond to quick market change in the sector (Womack et al., 1990). Obviously, Nokia wished to learn, from the mature automobile sector, to control the supply efficiently but through means other than in-house production.

The two major reasons behind the adoption of a new business model by Nokia in the Xingwang Industrial Park were to increase time efficiency and to adopt production customization. One important indicator is that Nokia no longer makes long-term production plans in its plant in the Park. It is expected by Nokia that production plans will be made weekly and that the designated day of supply will be less than one week in the future. Such a practice exposes the significance of time in the organization of production. As revealed by an interviewee (Anonymous source, Elcoteq [Beijing], pers. comm., November 25, 2002):

> [Time is] extremely important because first of all a lot of money is tied up in inventory, … also because things change so quickly that you don't want to get stuck with obsolete material. That is the biggest risk. That's the real killer in this business—excess material so excess risk.

In fact, Nokia operates a four-hour call-up with suppliers in Xingwang Park. Thus it is important for suppliers to locate in proximity to the assembler, as noted by the same interviewee:

> … we're talking about days of supply … we're going into hours of supply and then, of course, if you are close to your end user, then this shortens the supply chain.

In the meantime, customized production is adopted in the Xingwang Park. Under fierce market competition, the assembler (Nokia-Capitel in this case) has to be flexible to satisfy demands from different geographical areas for a different channel and/or for a different operator. To do that, Nokia often goes to suppliers for modifications of parts and components. One interviewee indicates:

> It would work so that the customer would say here is a phone, can you make this and that kind of modification of this variant and come back with a prototype.

Such close communications and interactions, which are critical to mass customization of production, require spatial proximity between the assembler and its suppliers. In fact, this is nothing new because past research on industrial clusters and industrial districts have indicated that face-to-face communication is critical to innovative activities (Gordon and McCann, 2000; Leamer and Storper, 2001).

However, the Xingwang case also reveals another benefit from spatial proximity: it is convenient for suppliers to discuss and share market information with Nokia via informal meetings. Since Nokia does not make long-term production plans, suppliers have to figure out future markets by themselves and decide on outsourcing based on such market forecasts, which require both formal and informal communications with Nokia managers. Thus, it is important for suppliers to be spatially proximate to the assembler. In the Xingwang case, Nokia-Capitel has set up committees dealing with management, logistics, operations, and administration, comprised of managers from Nokia-Capitel itself and all the suppliers in the park. The managers gather with Nokia regularly to discuss the things that are going on and require involvement and to share other information related to production and market. Besides, Nokia-Capitel opens its catering center to all managers of suppliers in the industrial park so that managers can have close, informal meetings.

The establishment of the Xingwang Industrial Park is not solely explained by production requirements or by the possibilities generated by the use of new ICTs. The nature of the institutional environment has also been critical to the particular way in which the production cluster works. Hence, Chinese national and Beijing city government policies have played a key role. The BDA is one of the national development areas designated by the State Council of China, which aims to attract FDI and high-tech industries. Telecom manufacturing is one of the major pillar sectors planned by BDA. Thus, BDA offered a favorable land price to the Xingwang Park because the cluster is an investment project of billions of U.S. dollars. In fact, Nokia-Capitel and its suppliers in the Park received free

land from BDA because the latter used land as its input in the joint venture with NCIC (i.e., the Xingwang Industrial Park Co. Ltd.). Nokia and its suppliers enjoyed collective bargaining power in negotiation with BDA, which is also an incentive for suppliers to go to the Park.

The Role of New ICTs in the Establishment of Xingwang Park: A Virtual Bonded Area

The preceding analysis has shed light on the reasons Nokia and its suppliers chose to cluster. When Nokia decided to initiate the manufacturing cluster, however, it found that time efficiency could not be achieved because of institutional barriers in China, particularly those regarding customs procedures. First, imported parts and components are subject to differential duties according to the destination of the finished products, i.e., to domestic or international markets. Second, to promote exports, the Chinese central government employs a value-added tax (VAT) refunding mechanism; i.e., firms can get VAT refunds but only after the Customs house confirms the products have been exported. Traditionally, each firm must first report to the Customs House to get approval of the import of parts and materials and pay duty first. After the export of products is confirmed, the firm can obtain extra duty and VAT refunds. All these procedures are conducted via a customs handbook and take considerable time, and thus undermine the time efficiency enabled by clustering.

To overcome the institutional barriers to implementing JIT, it would be ideal to have a bonded area,[4] but the Chinese central government stopped approving bonded areas in the mid-1990s. To circumvent these bureaucratic problems, in late 2000, the logistics agent of Nokia-Capitel (Exel-Sinotrans)[5] proposed the development of an electronic platform based on new ICTs and to use the platform to set up a *virtual bonded area*. The proposed experimental project attracted interest from the State Customs House of China and got approval in 2001. In the virtual bonded area of the Xingwang Industrial Park (Fig. 4), all the computers of both Nokia-Capitel and its suppliers are, for the purpose of logistics, linked to the Xingwang logistics center, which is handled by Exel-Sinotrans. The logistics center is directly linked to the Customs House in BDA via a computer network so that the latter can operate a seven-day/twenty-four-hour customs inspection. All firms in the bonded area can use an electronic customs handbook instead of the previous paper handbook, allowing firms to report import and export to the Customs House via computer network.

The Xingwang logistics center (Fig. 4), which consists of a V-harbor (virtual) and an I-harbor (physical), is the "heart" of the virtual bonded area. All the parts and materials that flow in and all the products that flow out must go through the V-harbor (i.e., their information goes to the V-harbor) while physically they do not necessarily go through the I-harbor, i.e., the logistics center allows a high level of flexibility for shipment of parts

[4] A bonded area is a duty-free area, in which firms are free to import parts and materials without paying custom duty unless their products go to the domestic market.

[5] Exel is a global partner of Nokia, and the latter is Excel's largest customer. Exel expanded its business in China via a joint venture with Sinotrans. The joint venture, Exel-Sinotrans, handles all inputs and outputs in the Xingwang Park.

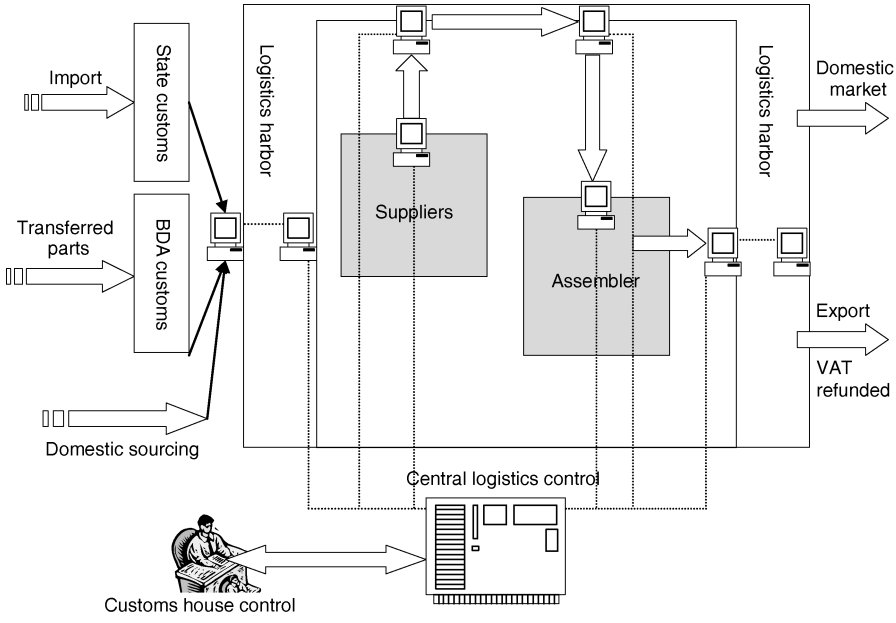

Fig. 4. A virtual bonded area of Xingwang Industrial Park in Beijing.

and components. Some suppliers prefer to use both the I-harbor and V-harbor to avoid the 24-hour and three-shift operation used by Nokia-Capitel, i.e. they send parts and components to the logistics center and normally have one- or half-day supply stored in the center. Others just use the V-harbor and send parts and components directly to the assembly plant of Nokia-Capitel. Thus the cluster is functionally bonded but not geographically bonded. Such an institutional arrangement enabled by the new ICTs allows Nokia to fulfill its target to increase time efficiency by clustering. The Xingwang virtual bonded area has been reported to be highly efficient in raising time efficiency. According to the plant manager of Allgon Telecom (Beijing) Co. Ltd., the day-of-production plan in Allgon plants in China is generally 26 days while that of the plant in Xingwang Park is only seven days.[6]

The virtual bonded area offers another benefit to firms located in the Xingwang Park. The firms do not pay duty when importing parts and materials. They receive information from Nokia-Capitel on the location of the final end user and then split the value of parts and materials imported and pay the customs duty accordingly. The Customs House allows these firms to pay duty later because it is clear that everything is under control via the computer network and there is no way to evade the customs duty. Besides, firms in the Xingwang Park do not pay VAT first and receive a refund after products are confirmed to be exported. The firms pay VAT after exporting is confirmed. These

[6] *Beijing Youth Daily* (in Chinese text), February 25, 2003, p. 1.

new practices help firms save a large amount of circulating capital and hence reduce production cost.

Therefore, new ICTs have played an important role in enabling the Xingwang telecom cluster to come into being, not only because they lead to a new firm-institution relationship based on computer network, which is critical to overcoming the institutional barriers to setting up the cluster, but also because they allow new practices of paying customs duty and VAT, which lead to extra cost-reducing solutions.

CONCLUSION

New ICTs have played an increasing crucial role in the spatial transformation of the economy in the last several decades, but they are "an enabling or facilitating agent," not a determining one. Since there exists a gap between the introduction of new ICTs and changes in the spatial pattern of firms (Capello, 1994), empirical evidence is still insufficient for drawing firm conclusions on new ICT impacts. The spatial transformations driven by new ICTs are complicated processes and their trends can be observed at different scales and from different sectors and activities. Analyses and observations are affected significantly by the geographical scale and sector in question. In this paper, we have argued that spatial transformations at the firm level have not yet been given enough attention by geographers, and that time-cost/time dependence are becoming critical to the spatial organization of production with new ICTs as a result of shorter product life and mass customization in particular, among other dynamics.

Our case study of the Xingwang Industrial Park in Beijing supports our hypothesis that firms are trying to work faster and be more agile, and that time-cost is becoming more significant in the spatial organization of the production chain with the spread of new ICTs. The study also indicates that new ICTs are a facilitator in the formation of the Nokia's manufacturing cluster in Beijing, as they help to overcome institutional barriers to integrating the supply chain. However, without differentiated tariffs and tax refunding mechanism and preferential price—i.e., without a favorable institutional environment—suppliers may not have chosen to locate near Nokia, given a virtual logistics center can efficiently control parts and product flows. This case study also suggests that clustering with new ICTs helps greatly reduce inventory and raise flexibility, which is not the anticipation of those theorists arguing that new ICTs will facilitate dispersion of production.

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