SPACES online

Spatial Aspects Concerning Economic Structures

Harald Bathelt and Gang Zeng

Against the new economy? The changing social and spatial divisions of labor in the larger Shanghai chemical industry

UNIVERSITY OF TORONTO

RUPRECHT-KARLS-
UNIVERSITÄT
HEIDELBERG
EXZELLENZUNIVERSITÄT

Issue 2009-03 | Volume 7
www.spaces-online.com

SPACES online

SPACES aims to present conceptual frameworks and empirical studies on economic action in spatial perspective to a wider audience. The interest is to provide a forum for discussion and debate in relational economic geography.

Please quote as Bathelt, Harald and Zeng, Gang (2009) Against the new economy? The changing social and spatial divisions of labor in the larger Shanghai chemical industry. SPACES online, Vol. 7, Issue 2009-03: Toronto and Heidelberg: www.spaces-online.com

Author Harald Bathelt, University of Toronto, Department of Political Science and Department of Geography, Sidney Smith Hall, 100 St. George Street, Toronto, Ontario, Canada M5S 3G3, E-mail: harald.bathelt@utoronto.ca, URL: http://www.harald-bathelt.com

Gang Zeng, East China Normal University, Department of Human Geography, 3663 North Zhongshan Road, Shanghai 200062, China, E-mail: gzeng@re.encu.edu.cn

Keywords Shanghai, industrial restructuring, chemical industry, regional knowledge networks, market access, knowledge brokers

JEL codes D85, L16, L65, O18, O19, P25

Abstract

Although initially excluded from the Chinese opening policy, Shanghai increasingly attracted international investors in the 1990s. The new policy was to support a shift from traditional manufacturing toward advanced services and high-tech sectors. These industries, however, were strongly hit by the Asian financial crisis. To decrease the dependence on these activities, a broad support policy was introduced that put stronger emphasis on traditional industries. The goal of this paper is to analyze the changing spatial and social divisions of labor in the larger Shanghai chemical industry, and its potential to develop self-sustaining cluster-like knowledge networks. Empirical evidence suggests that the latter is unlikely at this point as both regional producer–user linkages and intra-cluster R&D capabilities are weak and require strengthening in the future.

Editors: Harald Bathelt, Johannes Glückler
Managing Editor: Heiner Depner
ISSN: 1612-8974

Against the new economy? The changing social and spatial divisions of labor in the larger Shanghai chemical industry

1 Introduction: changing policies in the larger Shanghai political economy

Until the late 1980s, Shanghai was primarily a location of large vertically-integrated state-owned industrial firms with a strong focus on the textile, shipbuilding, steel and chemical industries. Initially, the city was excluded from the opening policy in China and did not benefit from early foreign direct investments and corresponding economic growth effects. Politicians and planners, at that time, were convinced that state monopolies had to be kept to secure wider societal interests and goals. Therefore, decision-makers were hesitant to open the Shanghai economy. They aimed to minimize the risk of potential economic failure. Instead, the idea was to wait and see what would happen in other Chinese regions. In the early 1990s, a drastic shift took place in regional policy when it became clear that formerly poor regions, such as Guangdong and Fujian, were beginning to experience an unexpected economic upswing due to the opening policy. Deng Xiaoping, who visited the Pearl River Delta in 1992, decided to apply the experiences made in this region elsewhere and initiated a radical shift in regional economic policy in Shanghai (Giese and Zeng 1993; 1997).

Due to this new policy, the city attracted foreign direct investment and began to grow at a high pace. As a consequence, many people from other parts of China migrated to Shanghai, even though there were strict government regulations. The city expanded rapidly from the Huangpu River toward the West and South. Pudong, originally a less industrialized suburb of Shanghai, located between the Pacific coast and the Huangpu River, became a new center of economic growth and a primary development core within China (e.g. Olds 1997; Wu 2000; Follath, Lorenz and Simons 2002). This development was supported by extensive state investment programs. In the mid 1990s, the support programs concentrated on the establishment and extension of large infrastructure projects, such as power plants, bridges, highways, a new international airport, and free trade zones.

During the 1990s, a change in economic policies took place as the new political goal was to support a shift from traditional manufacturing sectors, based on large state-owned firms, toward new industries and services of the new knowledge economy. In addition to existing industries, advanced service and high-tech sectors, such as information and communication technology (ICT), finance and logistics were to become the new core sectors. As a consequence, large technology parks were established, such as the Zhangjiang Hi-Tech Park in Pudong (Lin 2007). Further, the stock exchange was relocated from Hongkou, near Shanghai's Bund, to Lujiazui in Pudong. Along with this, foreign firms achieved access to the financial markets.

The new economic core sectors, however, proved to be quite vulnerable which became clear with the financial crisis in Asia after 1997. This crisis temporarily slowed down economic growth, led to a reduction in domestic wealth, disrupted existing economic development plans, and contributed to increased social instability (Zeng 2000; 2001). Due to this unexpected economic downswing, the goals of economic policies were once again restructured. Policy makers felt that it was premature to concentrate primarily on the industries of the "new economy" and its new business services. To decrease the dependence on these activities, a broader economic support policy was introduced which put stronger emphasis on "old economy" industries, such as machinery

and automobile production (e.g. Depner and Bathelt 2005; Depner 2006), as well as the chemical industry (including pharmaceuticals) (Zeng and Bathelt 2009).

This paper will take this policy shift as a starting point to investigate its effects on the chemical industry of the larger Shanghai region. We aim to analyze how strong government support combined with continuous foreign direct investment in a high-growth environment can instigate new economic development paths after only a few years. Our hypothesis is that the larger Shanghai region will develop into one of the world's most important centers for chemical production, which will eventually export its products to other countries. It will be shown that the chemical industry, which did not have a high priority in economic development during the 1990s, has experienced tremendous growth since 2000. The goal of our analysis is to provide evidence that new social and spatial divisions of labor have emerged in Shanghai. In analyzing these developments, we carry out a firm-based investigation, instead of emphasizing the role of the "developmental state", to explore the potential for the development of regional knowledge and innovation networks with long-term growth potential.

This paper is organized as follows. In the next section, the cluster model will be briefly discussed as a conceptual tool to conduct an analysis of interfirm networks. From this, a connection will be drawn between market access, R&D capabilities and innovation. Our methodology will be briefly discussed in section 3. Section 4 will describe the context of the growing chemical industry in China and the Yangtze Delta region. Section 5 investigates the development prospects of the chemical industry in different sub-regions of Shanghai, comparing older locations with new developments. Finally, section 6 will raise the question as to whether the larger Shanghai region has the potential to develop into a global chemical industry cluster. As part of this, opportunities and challenges associated with the fast growth of the chemical industry will be identified.

2 Conceptual basis: clusters, markets and knowledge brokers

A field of substantial debate, which has been key to the development of economic geography, is that of understanding and explaining industrial agglomeration processes, and developing policies that will produce or maintain such concentrations. Porter's (1990) introduction and discussion of the cluster concept has in many ways served to push the debate surrounding agglomeration further, and revived older debates concerning industrial location. This work has also been decisive in strengthening the policy relevance of clusters and related concepts, which are now widely used to support regional and national economic development policies. Having said this, it is arguable to which degree different self-proclaimed cluster policies are actually based on the same model, as the link between academic conceptualization and policy formulation is often weak (Martin and Sunley 2003). We have placed our research in the context of this debate. In this paper, clusters are viewed as regional concentrations of firms of a value chain, and their service infrastructure, which are linked through traded and untraded interdependencies (Malmberg and Maskell 2002; Bathelt 2005). For the analysis of potential clusters, we suggest distinguishing different cluster dimensions and investigate them separately in order to identify their strengths and/or weaknesses. In this respect, the horizontal and vertical cluster dimensions are especially important because they impact cooperation, interactive learning and product differentiation within a cluster. Furthermore, the institutional, external and power dimensions provide general preconditions for interfirm interaction, and support reproductivity, coherence and ongoing economic growth (Bathelt, Malmberg and Maskell 2004; Bathelt and Zeng 2005).

Cluster dimensions can also be identified in agglomerations of the chemical industry, although the structure of supplier relations is here somewhat different from that in other industries. Regional producer–user networks are often more focal in character and do not involve intensive horizontal and vertical interaction. Suppliers establish close transactional relations with their main customers, but do not necessarily engage in intensive

interaction or joint product development. These relationships often appear as relatively standardized but are stable, as the firms specialize in complex production processes of products that are sometimes dangerous to handle and expensive to transport (Bathelt 1997). Nonetheless, customization is an important source of market success, especially in the area of specialty chemicals. In conclusion, we cannot expect the development of chemical industry clusters to have the same structure as those in other industries.

Another unresolved question in the cluster debate, which is relevant to our study, is that of how large the maximum size of a regional cluster can be and whether there are limitations to the extent of "local buzz" and knowledge flows depending on the cluster's size (Bathelt, Malmberg and Maskell 2004). This is especially important in a huge region like larger Shanghai which covers a territory of about 6,340 km2, and hosts more than 20 million people. As clusters are characterized by a "localized thickening" of linkages and knowledge flows related to a value chain, and not by their spatial expansion, it might be more realistic to assume that several interconnected clusters exist in the Shanghai and surrounding Yangtze Delta region.

The context of the developing Chinese economy requires that we analyze the production chain of the chemical industry, and its co-evolution and linkages with national/regional markets. If firms in a cluster are familiar with their markets and have close contact with their customers, this generates possibilities for learning about product characteristics or customer wishes. The results may later become the basis of innovation and be translated into new products. This requires both direct customer interaction and R&D competencies through which new insights can be transformed into marketable ideas. In the case of the Chinese market, and the chemical industry in particular, we may be faced with two sets of problems:

First, an increasing number of firms, especially in the area of specialty chemicals, enter China as wholly foreign-owned enterprises (WFOEs) without Chinese partners. A consequence of this is that these firms cannot draw from established market knowledge and, instead, rely to a large extent on traders to distribute their products to their customers. These intermediaries operate as knowledge brokers who connect different sets of agents operating in otherwise unconnected network configurations. As suggested by Burt (1992; 2005), these knowledge brokers are capable of bridging otherwise unconnected social networks ("structural holes"), cashing in on their knowledge monopoly and market experience. They connect producers and users but typically do not create close social ties between them. The disadvantage of this is that opportunities for direct interactive learning from user experience are limited. Whether this is a pervasive feature of the chemical industry, or whether it changes over time, is still an open question at this point as the development is still relatively recent. Also, local Chinese firms often do not engage in close supplier and customer interaction. As a result, industry clusters might develop with little internal coherence and low innovation potential.

Second, research, development and engineering are necessary in order to explore and test products modifications and new products prior to their introduction to the market. To accomplish this, and to stimulate additional buzz and innovation in the cluster, firms either have to have intra-firm development capabilities or specialized intra-cluster research organizations that help develop new ideas into products. Both aspects are limited in the case of the Shanghai chemical industry as will be illustrated in subsequent sections. In addition, local chemical firms often do not have the financial resources to establish their own R&D centers.

3 Methodology

The research presented in this paper is based on a variety of information and data sources, including statistical data, firm publications, business/news reports and government documents. Further, the research involved interviews with industry experts and with managers and technical specialists of chemical firms in the Yangtze Delta region. This paper is based on more than 50 interviews with representatives of Chinese, German and

other foreign (mainly European) chemical firms, as well as local experts, in the larger Shanghai region. These interviews were conducted between September 2003 and June 2007. The firms interviewed were not chosen randomly. In order to gain an overview of the most dominant and important trends in the chemical industry, Chinese and foreign market leaders, trend setters or particularly innovative firms were identified. More than 80% of the firms approached were willing to participate in this initiative. Although the overall number of interviews is too small to provide a representative picture of the entire chemical industry, our data allows us to explore important trends and restructuring processes, as we included the most important firms, key industry observers and industrial park managers in our study.

Interviews with Chinese firms were done in Chinese and translated into German. All other interviews were conducted in German or English. Except for those interviews conducted in Chinese, the interviews were usually recorded on tape and transcribed. Information from the remaining interviews was recorded in the form of detailed protocols. The transcriptions and interview protocols were intensively discussed between the researchers. Answers for the key questions were classified to provide an overview of the bandwidth of responses. Interview results were also compared with other information sources and publications to avoid misinterpretations and provide consistent results (Miles and Huberman 1984; Eisenhardt 1989; Silverman 2001).

In the case of foreign investors, the interviews began with an analysis of the start-up processes, involving questions of why, when and how decisions to establish production facilities in the region were made. This also included questions about their prior experience in China. The next set of questions revolved around producer–user relations, focusing on the main locations of and the structure of interactions with customers, suppliers and machinery providers. Finally, questions concerning experiences with Chinese joint-venture partners, business contacts and employees were posed and a personal evaluation of the development prospects of the regional chemical industry requested. Although interviews with Chinese firms were structured in a similar way, the questions focused more particularly on contacts and experiences with foreign partners and the business conduct of foreign managers.

Before turning to the results of this research, the next section will give an overview of the growth of the chemical industry in China in recent years.

4 Growth of the chemical industry in China and the Yangtze Delta region

Since the 1990s, cities in the Yangtze Delta region have developed into major economic centers, witnessing tremendous growth in the chemical industry, as well as other industries. Due to the economic reforms and opening policy, China's economy generally experienced strong growth. This growth was largely due to continued industrialization which began in the 1980s and accelerated during the 1990s based on large foreign direct investments. Although this has not been widely discussed in academic work, the chemical industry played a central role in this process (Mu 2006). According to the gross industrial output, the chemical industry was ranked fourth in the Yangtze Delta region after the information technology, iron/steel and machinery industries. Considering present economic dynamics, it is foreseeable that the chemical industry will grow further in importance, at least in the short-/medium-term (Sun and Gu 2004). It has been estimated that China will be the second largest producer of chemical products after the US by the year 2015 (Perlitz 2005). Even though the Yangtze Delta region was already an important site for chemical production before the economic reforms began, its development accelerated in the late 1990s (Cheng and Bennett 2007; Hui 2007). Many multinational chemical firms, especially those from Europe, were in the process of extending their production base in China (Mueller 2005; Perlitz 2005). Two stages in the development can be distinguished:

(i) Initial growth period (1978-1997). During this time period, economic liberalization created substantial growth impulses for the chemical industry, similar to other industries. For the first time since the establishment of the People's Republic of China, the focus of national policies was now to support economic production rather than social cohesion or national unity. To satisfy the increasing demand in the country, many small and medium-sized firms were established in the chemical industry. As a consequence, the gross production value of the Yangtze Delta chemical industry increased from 46.68 billion Yuan (5.8 billion US-$) to 333.18 billion Yuan (41.6 billion US-$) between 1987 and 1998 (Table 1).

Table 1: *Gross production values of the chemical industry in the Yangtze Delta region by industrial sector, 1987 - 2005 (Source: Jiangsu Bureau of Statistics 1988 - 2006; National Bureau of Statistics of China 1988 - 2006; Shanghai Bureau of Statistics 1988 - 2006; Zhejiang Bureau of Statistics 1988 - 2006)*

	Gross production value of the chemical industry (in billion Yuan)				
Year	**Shanghai province**	**Jiangsu province**	**Zhejiang province**	**Yangtze Delta region**	**China**
1987	17.44	20.74	8.50	46.68	193.84
1988	21.18	28.67	15.82	65.67	247.71
1989	24.84	35.52	15.60	75.96	300.13
1990	26.88	40.58	16.54	84.00	325.76
1992	36.86	63.84	27.43	128.13	469.92
1993	44.83	80.99	35.15	160.97	612.67
1994	58.89	108.69	48.66	216.24	803.43
1995	70.11	128.53	58.77	257.41	955.67
1996	76.22	122.06	70.20	268.48	1072.42
1997	81.22	145.67	75.62	302.51	1163.98
1998	92.06	155.97	85.15	333.18	1142.02
1999	103.06	181.87	106.61	391.54	1423.02
2000	120.50	210.65	129.84	460.99	1623.31
2001	122.25	226.99	139.31	488.55	1698.52
2002	133.23	263.23	169.58	566.04	1905.78
2003	136.46	313.99	208.06	658.51	2039.81
2004	202.51	436.72	346.65	985.88	2874.01
2005	264.00	593.35	447.55	1304.90	4248.36

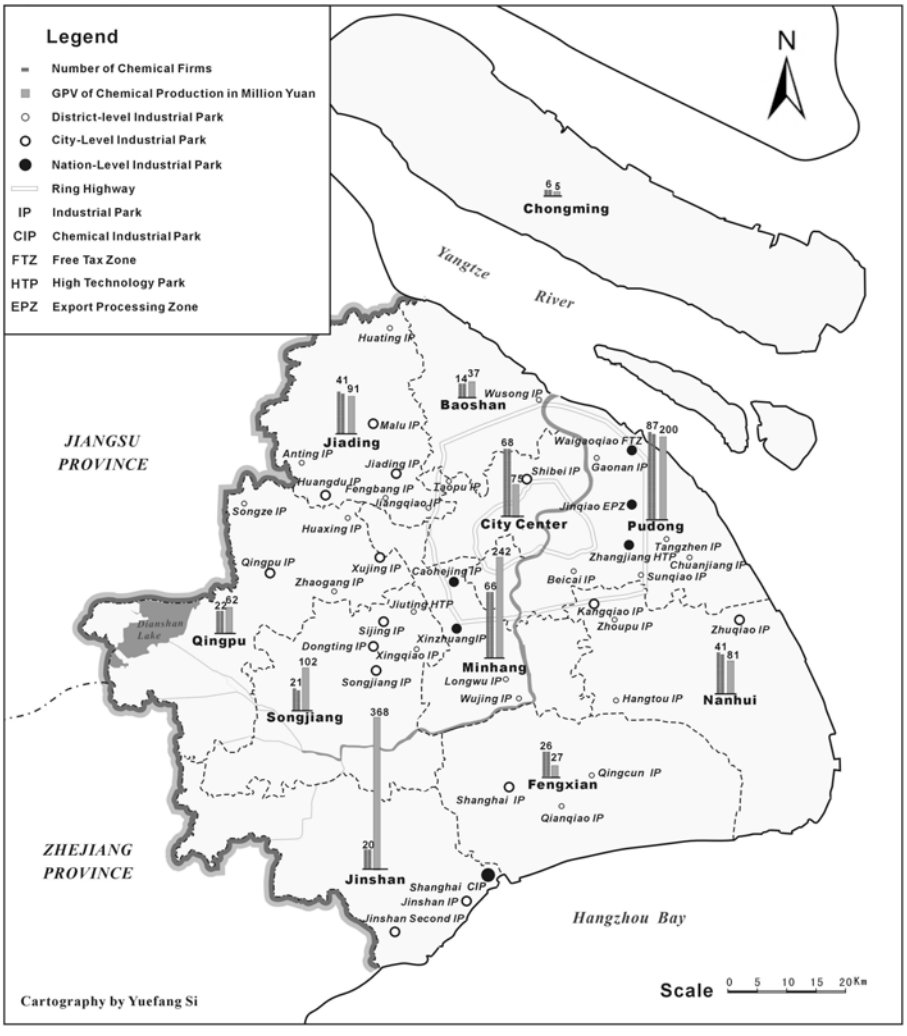
Note: 1 US-$ = 8 Yuan

(ii) Boom period (1998-2008). As a consequence of the financial crisis in Asia in 1997, which abruptly halted the hype surrounding the new economy, the Chinese government began to rethink its former economic focus on knowledge-intensive, advanced services. New policies were implemented to further open up the Chinese economy and redirect growth for old economy industries (Zeng 2000; 2001). This had a strong effect on the development of the chemical industry. Chemical industry parks were established in cities, such as Shanghai, Nanjing, Wuxi, Ningbo and in other places. The gross production value of the Yangtze Delta chemical industry increased from 333.18 billion Yuan (41.6 billion US-$) to 1,304.90 billion Yuan (163.1 billion US-$) between 1998 and 2005 (Table 1). Overall, the region's share of the Chinese total gross production value in the chemical industry increased from 24.1 % in 1987 to 30.7 % in 2005. Since 2007, the central government has, however, revised its support policies for the chemical industry in light of global warming and environmental protection. Even though some provincial and city governments still actively support the development of a re-

gional petrochemical industry, the central government has reduced its incentives for the expansion of this industry, in favor of the service industry (Wu 2005).

Along with the growth of customer industries, the chemical industry in the Yangtze Delta region has also benefited from improvements in infrastructure and access to investment capital for new projects. Due to its economic strengths, the region has become a traditional location for China's chemical industry. Some cities have access to deep sea harbors, while others benefit from the possibility of conducting bulk shipments along the Yangtze River. As a consequence, chemical firms have easy access to raw materials, especially crude oil. Due to the enormous growth of manufacturing industries, such as information technology and automobiles, whose production value in China grew by 536.5 % between 1995 and 2004 (National Bureau of Statistics of China 2006), the demand for chemical products continues to remain very high. New infrastructure projects to improve highway and pipeline networks, as well as the extension of harbors and deepening of rivers for larger shipments, have greatly improved the production conditions of the chemical industry. In addition, the developments of the financial markets and cooperation with foreign firms have been important factors for improving access to investment capital.

Figure 1: *Spatial distribution of the chemical industry in the Shanghai region, 2005 (Sources: Statistical Yearbooks of the Municipalities in the Province of Shanghai 2006)*



*Only industrial parks with chemical industrial firms are shown

5 Different development trajectories of the chemical industry in the larger Shanghai region

The rise of the Shanghai chemical industry was neither a homogenous nor a continuous process. As will be subsequently shown, the growth of this industry was a punctuated, ruptured process with locational differences. In the following subsections, we will investigate the development trajectories in different parts of the larger Shanghai region and investigate their present structure (Figure 1). This will underlie a discussion of the retreat of the industry's initial urban locations, their relocation to the periphery, and the rise of Pudong and the Shanghai Chemical Industry Park (SCIP) in Caojing as important new locations.

5.1 Older chemical industry plants in urban locations since the 1960s

Shanghai was traditionally an industrial core region in China. The city had a strong presence in heavy manufacturing industries consisting mainly of large hierarchical, vertically-integrated, state-owned companies. As part of this, the larger Shanghai region developed an important chemical industry base related to the production of basic chemicals. This industry remained fairly stable until the 1990s when the city began to expand rapidly due to economic growth and related population gains. Some large-scale plants for the production of inorganic chemicals/petrochemicals were located in the northern corner of Pudong between the Yangtze and Huangpu Rivers (Figure 1). This was an advantageous location because it was close to harbor facilities, through which raw materials were imported.

An example of this development is the Gaoqiao Petro-Chemical Corporation (GPCC), which is part of the second largest chemical/petrochemical group in China, i.e. Sinopec. The operations were originally established as an US investment in the 1930s along the Huangpu River where, at the time, a large amount of land was available for industrial development. Here, the firm established the first petrochemical production complex in China. After the foundation of the People's Republic in 1949, the firm was transformed into a state-owned corporation. As of today, the operations occupy a territory of 3.8 km2 comprised of older production facilities. At the time of our visit, direct customer/user relations of the firm were rare because products were distributed through a state-controlled system of intermediaries. The firm was also not regionally embedded through close supplier relations. Most supplies were purchased through corporate networks from international locations. The original advantage of being relatively removed from the city's core turned into a disadvantage as Shanghai expanded rapidly. Residential neighborhoods developed in the vicinity of the firm, leading to conflicts in recent years concerning environmental standards. Another problem was that emissions were sometimes blown directly into the core of the city. As a consequence, the pressure increased to relocate to a location in the periphery, especially since the city aimed to increase the recreational value of the areas along the Huangpu River and turn them into attractive urban spaces. Relocation is envisioned to take place around 2020. Based on our research, we suggest that this might not be a realistic time frame, however, due to the problems that already exist today.

During the 1990s, the chemical industry still expanded in this area although the limits became increasingly visible. This was due to the fast growth of other industries, as well as commercial and residential developments, through which most locations were occupied, and not much space remained for further expansion; this resulted in increasing land-use conflicts. Such conflicts were even more drastic in other parts of the city where older Chinese companies, originally located outside of Shanghai, were surrounded by urban development radiating from the city's core. Some of these areas were in the southern parts of the Shanghai region, such as Wujing. Formerly state-owned firms did not have sufficient financial resources for modernization or relocation after they were privatized in the 1990s. They were characterized by relatively old technologies and low envi-

ronmental and safety standards. Industrial infrastructure, such as massive oil and gas tanks located within the metropolitan area, provided additional threats to the urban population in the adjacent areas. The consequences of this were conflicts with other land uses, high risks for residential neighborhoods, and increasing pollution levels inside the urban core of Shanghai.

As a direct consequence of the financial crisis in Asia, existing relocation plans for some of these industries, aiming at replanting firms from central locations toward the periphery, were postponed (Zeng 2000). It seems clear though that these chemical firms cannot remain at urban locations for long. In recent years, the central and provincial governments also began emphasizing the role of environmental protection and high environmental standards. Governments have implemented new policies in this respect. For instance, pressure was placed on intra-urban industries to relocate their activities to special industrial zones, located beyond the urban fringe. In the case of the chemical industry, the Shanghai Chemical Industry Park (SCIP) is a good example of this. It is, however, obvious that older chemical plants often do not have the financial resources to pay for these investments on their own. They will therefore remain in their traditional locations for as long as possible, or go bankrupt.

Due to relocations from Shanghai in the 1970s, surrounding cities such as Wuxi and Suzhou, which are located one to two hours driving time away from Shanghai, also developed a chemical industry (Xu 2006). Today, the chemical industry in these cities largely consists of older plants, some of which are characterized by dated production technologies. The firms are sometimes located in small industrial parks not too far from the center, but the industry is generally widely spread out across these cities. Although our interviews suggested that these firms did not form wider producer–user networks, the existence and maintenance of traditional Chinese guanxi relations with former state-owned corporations seemingly played an important role in gaining access to longer-term contracts. This differed, however, between firms. In addition, linkages with the Shanghai region had often remained strong. One Wuxi producer, for instance, acquired its chemical supplies largely from foreign subsidiaries located in the larger Shanghai region. The major customers were not local, but were generally located within the Yangtze Delta region. Some of the relocated plants in Wuxi were facing another round of relocations, as their sites had once again been infiltrated by urban growth.

5.2 Dispersed growth poles in the Shanghai periphery during the 1980s and 1990s

Since the 1980s, new chemical plants were established by Chinese firms that were located further away from the city's core in areas such as Baoshan, Waigoaciao or Jinshan, close to today's Shanghai Chemical Industry Park (Figure 1). The chemical facilities at these locations were medium-sized operations, characterized by older technologies and machinery. Due to capital shortages, the firms had difficulties modernizing their operations. Their market shares, however, appeared stable due to the overall growing demand.

Some of the peripheral locations were able to attract branches of foreign chemical firms. In many respects, these facilities developed structures similar to those that were established later in Pudong. In contrast to the activities in Pudong, these firms were characterized by production processes with a larger scope and scale of emissions. Since many customers of these foreign firms were branches of long-term multinational partners, new producers already had a customer base in the larger Yangtze Delta region when they moved here. Basic chemicals and raw material supplies were usually purchased from within China, while specialty chemicals were acquired through corporate networks, often from overseas. Surprisingly, a substantial proportion of the machinery used was acquired from Chinese firms located in the region.

One producer of specialty chemicals from Switzerland started operations in 1996 in the south of the region in Min Hang. The firm started off as a WFOE because it already had a customer base in the region. Almost all of

the final customers were local facilities of foreign firms, located in the Yangtze Delta region. Although the firm did not send its products directly to these customers, as a second-tier supplier it distributed them to first-tier suppliers, and hence was able to rely on long-term delivery commitments. An increasing percentage of standard supplies were acquired from within the Yangtze Delta region, particularly from the Shanghai and Nanjing Chemical Industry Parks.

5.3 Foreign direct investments in specialty chemicals, cosmetics, pharmaceuticals and biotechnology since the late 1990s in Pudong

During the 1990s, Pudong already became a focus of foreign direct investments in low-emission industries (e.g. Old 1997). This was a result of excellent infrastructure access regarding the new Shanghai-Pudong international airport and highway networks, and the proximity to Shanghai's city core (Figure 1). Due to these amenities, it was relatively easy to attract qualified Chinese and foreign talent which, in turn, contributed to the development of a very positive image as a location for knowledge-intensive, technology-based industries (Lin 2007). While the growth of the chemical industry in other parts of the Yangtze Delta region was based on basic chemicals and related products, Pudong specialized in areas such as pharmaceuticals, biotechnology, cosmetics, and specialty chemicals. The area became especially interesting as a location for branch operations of multinational firms entering the Chinese market. Some of the firms interviewed relocated their regional headquarters to Pudong from locations such as Taiwan and Hong Kong.

The interviews with chemical firms suggested that local production activities were limited, however, focusing on relatively simple production stages. Many supplies and intermediary products were purchased through corporate networks from international sources. Firms were often established as WFOEs and, thus, did not have access to an existing customer network of a Chinese partner. Direct sales contacts were therefore limited to major long-term customers with whom supplier relations had already existed beforehand. Otherwise, the distribution of the products was handled through intermediary firms that had excellent knowledge of the Chinese market. Interestingly, a number of these traders were still located in Hong Kong or the adjacent Guangdong province. They operated as knowledge brokers in the sense of Burt (1992; 2005) by connecting production and consumption. This is exemplified by a German firm that established a small branch plant in Pudong in 2003. At the time of our interview in 2004, the firm had a local labor force of 110 people and purchased about 60% of its supplies from Germany. Local supplier linkages seemed to develop quickly, however, as more foreign suppliers established operations in the region. The firm's main customers were operations of European and North American chemical firms in the Yangtze River and Pearl River Delta regions. Strong corporate ties were maintained which became especially important when potential suppliers were assessed. In these cases, specialists from the headquarters were directly involved in the decision-making processes and frequently traveled to Shanghai.

One trend that became apparent through our research was that reciprocal producer–user relations had sometimes developed between foreign chemical branches in Pudong. This even occasionally occurred when such close linkages did not exist in the firms' home markets. Such close relations were typically based on and developed through regular personal meetings. Many of the foreign managers of the firms lived in the same quarters of the city and met during cultural or social events in their free time. It appears that these expatriate networks have become an important basis for the development of trust-based customer relations. Overall, multiplex ties (Uzzi 1997) have seemingly grown through which "secure contacts" can be made that can be activated to solve problems.

Another trend that was especially visible in Pudong was related to the increasing customization of products to Chinese markets. This was associated with the need to develop local R&D capabilities. Sometimes, necessary

product adjustments were possible through the establishment of an on-site technical center or development facility. This is exemplified by a newly established technical center of a leading foreign chemical firm. The center was established in 2005 and operated with a total of 60 employees. Originally established as a 50/50 joint venture with a Chinese partner, the firm was transformed into a WFOE before the investment in the technical center took place. This decision was related to concerns surrounding the potential for unintended knowledge spillovers through Chinese guanxi networks, a process that has often been emphasized in our interviews with foreign firms.

In addition to foreign R&D facilities, the number of small Chinese development and engineering firms has also increased. The start-up processes of pharmaceutical R&D facilities in the Zhangjiang Hi-Tech Park in Pudong are heavily subsidized by the city government. Wang (2005) highlighted the role of return migrants, e.g. Chinese engineers and scientists returning from North America and other countries, in the process of establishing new high-tech ventures. These entrepreneurs kept close contact with the foreign research institutes where they had previously worked or studied (Sternberg and Müller 2005). Through these contact networks, they were able to acquire contracts, similar to what has been described by Saxenian (2006). However, thus far the overall research potential seems limited. Some start-ups primarily conduct low-cost laboratory work and standardized test runs for foreign customers. A study of these facilities found that many were characterized by low sales figures and minimal profit margins (Wang 2005). They appeared vulnerable and their survival in the market was in danger. Major challenges that these start-ups had to face were initially related to capital shortages in developing new technologies, and also to problems in acquiring new customers. Potential Chinese customers often did not have sufficient capital to externalize their development activities, and foreign subsidiaries in Shanghai did not recognize the capabilities of these firms.

Two recent start-up firms exemplify this situation. One engineering firm was focused on finding new applications for existing process technologies. The firm was established in the Zhangjiang Hi-Tech Park in 2001 and had 100 employees in 2005, two thirds of which were in Pudong. The owner emphasized how difficult the start-up phase was until they found a strong Chinese partner. He emphasized that the primary reasons for being located in this industrial park were related to its positive image that helped attract potential customers. As our interviewees mentioned, local networks seemed rare in the park despite the high potential for such contacts. The firm was not interested in having closer contact with Chinese competitors because of the threats of unintended knowledge spillovers; linkages with universities were also not important. Another firm in the Zhangjiang Hi-Tech Park was a spin-off from a pharmaceutical research laboratory that was jointly established by a state-owned firm and a local university. The firm was established in close vicinity to its incubator facilities, an indication that university contacts were still important. The founder of the firm also mentioned that regional networks with other firms were not very dense and that those which existed were based on personal relationships in the form of guanxi. According to some observers, a disadvantage of the Zhangjiang Hi-Tech Park is that it does not have strong linkages to top universities or research hospitals located near-by.

5.4 Integrated large-scale investments in the Shanghai Chemical Industry Park (SCIP) since 2004

Since 2004, the SCIP has developed into a modern, world-scale industrial site for chemical production. It has a size of 29.4 km2 and is located in Caojing, about 50-60 km south of Shanghai's core at the north side to Hangzhou Bay (Tan 2003; Festel and Geng 2005; Krumberger 2005; Shanghai Chemical Industry Park Development Co. 2007). As such, it has direct access to the Pacific Ocean (Figure 1; Figure 2). Shipments of basic chemicals can be received via integrated jetties and harbor facilities. The park is a fully developed industrial area equipped with infrastructure, such as streets, internal pipelines, public utilities and environmental protection facilities; all of which are provided by the Shanghai Chemical Industry Park Development Corporation,

which operates and manages the park. A newly developed chemical industry park of this size would be unthinkable in the context of the North American or European chemical industry, which is stagnating rather than expanding. The northern half of the SCIP (13.4 km2) is located on sediments of the Yangtze River. The southern part (10.0 km2) is land reclaimed from the Hangzhou Bay through embankment and the installation of drainage systems. The southwestern part (6.0 km2) was not yet fully drained at the time of our visit in 2006. Once completed, this part will connect the SCIP with an older petrochemical park in Caohejing that is located in the west. The latter park consisted of older facilities of large Chinese chemical/petrochemical groups. Presently, linkages between these facilities and the new developments in the SCIP do not exist.

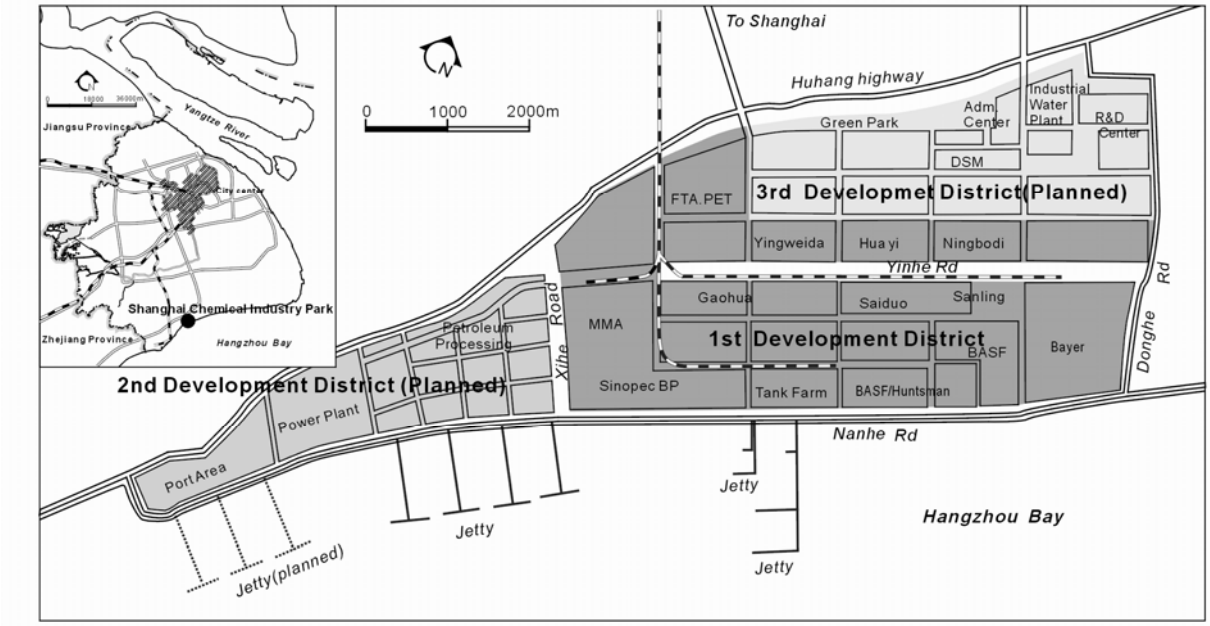
The goal of the Development Corporation was to develop the SCIP into an integrated site of petrochemical/organic chemical production and provide a basis for the continued growth of the manufacturing sector in China. Furthermore, it was aimed to transform the park into a hub for the chemical industry throughout Southeast Asia. Based on an analysis of chemical industry parks in Europe and North America, the SCIP was designed to host an extended production chain based on petrochemical/chemical production. An ethylene cracker forms the heart of the SCIP, which produces basic organic chemicals. In selecting new investment projects, the Development Corporation announced to prioritize operations that will establish long-term material linkages with other facilities in the park to process basic chemicals further. The park offers a large variety of production-related services to its tenants. This includes high-quality logistics infrastructure for the supply and delivery of chemical goods. In addition, the park aims to pursue an integrated environmental protection strategy. As part of this, the energy supply in the SCIP will be based on natural gas. Furthermore, new investors are requested to install modern low-emission technologies; waste water is collected and cleaned; and a green belt will be built. The Development Corporation negotiates and mediates the park relations and expansion policies with near-by farmers, residents and other agents. The park management aims to develop into an integrated agency, which deals with all problems and requests of local firms through a one-stop service philosophy (Shanghai Chemical Industry Park Development Co. 2005; 2007). Representatives of the Development Corporation emphasized that the growth of the park will not be based on low-cost production, but rather on its integrated long-term conception. One of the means used to establish initial trust with new tenants is to engage some of the long-term service providers and suppliers of the new firms in ongoing infrastructure projects. The provincial government is also directly involved in the development of the park and has a permanent on-site office.

At the time of our first visit in 2004, there was only one older Chinese chemical firm in full operation. In addition, there were about 20 mostly small or medium-sized firms from other industries that were operating. Many new facilities were under construction, including foreign investments by Air Liquide, BASF, Bayer, BP, Degussa, and Huntsman, as well as investments by Chinese groups such as Sinopec, SPC (Shanghai Petrochemical Corporation), and GPCC (Gaoqiao Petro-Chemical Corporation). Many projects were joint ventures of foreign–Chinese co-leadership. In 2004, Bayer opened its first of a total of six planned operations in the SCIP (Shanghai Chemical Industry Park Development Co. 2004). This was viewed as a major trigger for the development of the SCIP. As interviews with industry observers suggested, the firm's location decision for Shanghai was not only directed toward the Chinese market. Shanghai will develop into the firm's major center for production and decision-making in Asia. The SCIP was an attractive site because of its central location, logistics infrastructure, the fast growing regional and national market, as well as cost advantages. The total investment of Bayer in the SCIP is about 3.1 billion US-$.

The only older chemical plant in the park that existed prior to 2004 was a Chinese firm that was originally located in Shanghai's Changning district. The firm had some 500 employees and sales of about 313.8 million Yuan (39.2 million US-$). The park management was seemingly not very pleased about hosting this firm (Shanghai Economic Commission, Shanghai Municipal Statistics Bureau and Shanghai Development Park Association 2004). One interviewee described its technologies as outdated and environmentally problematic. Al-

though another observer mentioned that one of the goals of the park was to attract plants from inner-city locations in the Shanghai region, negative experiences with this relocation did not seem to stimulate much interest in pursuing this strategy further.

Figure 2: *Spatial setting of the Shanghai Chemical Industry Park (SCIP) (Source: Developed from Shanghai Chemical Industry Park Development Co. 2005; 2007)*



The structure of the SCIP has drastically changed since 2004 and will further change as more chemical production facilities will be under operation. In 2006, the park already hosted 14 chemical firms with a labor force of 3,250 employees. The firms had total sales of 29.0 billion Yuan (3.6 billion US-$) and paid taxes of 675.2 million Yuan (84.4 million US-$) (Shanghai Economic Commission, Shanghai Municipal Statistics Bureau and Shanghai Development Park Association 2007). By 2007, contracts for investment projects of more than 8.8 billion US-$ were signed, half of which related to investment projects of the German BASF and Bayer groups (Kreimeyer 2005; Stachels 2005; Shanghai Chemical Industry Park Development Co. 2007). The investment project of BASF, however, was associated with technical problems that were a burden on the firm's 2006 profits in Asia (*FR-online.de 2007*). It is foreseeable that these developments will lead to a substantial increase in production capacities and employment. One of the park representatives suggested that the new investments will lead to a total chemical labor force in the region of 20,000 people.

To support the training and qualification of employees, the plan of the Development Corporation is to establish branches of the East China University of Science and Technology and the Shanghai Research Institute of Petrochemical Technology in the SCIP. German firms have also begun sponsoring the introduction of new programs in vocational schools that have adopted the German dual training system, combining practical and conceptual knowledge. These and other projects aim to secure a constant inflow of skilled labor.

As of today, most industrial operations in the SCIP are, however, not closely interlinked with each other or with other regional firms. The interviews conducted indicated that the firms were still heavily dependent upon corporate networks for supplies of specialty chemicals, know-how and other high-end services. In addition, direct linkages of foreign-owned chemical firms with customers in China were generally weak or non-existent.

Firms that were established as WFOEs especially tended to ship their products to specialized traders which distributed these products, in turn, to user industries. These seemed typically to be located in Hong Kong or the core of Shanghai. From this, we can expect that this reliance on knowledge brokers (Burt 1992; 2005) will slow down learning and innovation processes related to producer–user interaction. As one manager explained, decisions to invest into a WFOE project were made based on former experiences in China, and the desire to avoid knowledge spillovers to Chinese competitors. The interviewee said: "We are convinced that we are technology leader. We don't want to loose any know-how. So it was clear for us to do it in a 100% … investment". Chinese firms, in turn, also seemed to have customer relations that were relatively loose and did not focus on aspects of learning and innovation.

The interviews conducted indicated that firms were only partially informed about other investment projects in the SCIP or possibilities for future interaction. As such, local information flows seemed weak. We expect, however, that local information flows through informal networks and producer–user relations will become stronger over time as more tenants settle in the SCIP. Since the new projects involve different combinations of Chinese and foreign chemical groups, we anticipate that intended and unintended knowledge flows between these projects will develop in the future, especially since some firms are simultaneously involved in projects with different partners. Although "local buzz" in the sense of Bathelt, Malmberg and Maskell (2004) is still low and does not travel easily between the different locations in the region, other information flows, even between competing firms, can already be found. These typically operated through private networks of foreign expatriates that foster detailed information exchange, as our interviewees pointed out. This exchange does not, however, occur within the SCIP or its vicinity. Interestingly, it materializes mainly within the city of Shanghai where many of the expatriates have their residences.

6 Conclusions: toward a chemical industry cluster of global scale?

Overall, this paper has identified the enormous growth potential that exists in the old economy of the larger Shanghai region, especially in relation to the chemical industry. This potential is a consequence of the large agglomeration of industrial users in the Yangtze Delta region. The region hosts deep sea harbors and oil pipelines which enable easy access to resources and raw materials required for chemical production. Even though the production capacities were extended substantially in recent years, the demand for chemical products is still higher than domestic supply. In the area of fine and specialty chemicals, China is still a large importer of chemical products. Furthermore, structural problems continue to exist in branches of the industry, such as a low degree of integration across the value chain, low competition, and low technological standards (Qin and Zhang 2003; Perlitz 2005; Scott and Ramesh 2007). The rapid growth process identified in this paper is associated with a number of potentials, as well as challenges, for the development of a chemical industry cluster of global importance:

1. *Multiple locations*. The region is too large to be conceptualized as one coherent cluster. Knowledge flows between the different locations and vertical production linkages are weak. A lot of the bulk input materials are traded through largely anonymous markets and transactions do not involve personal interaction. Rather than a single cluster region, we observe the development of different chemical production centers, which are only partially related to one another.

2. *Growing specialized labor markets*. Local labor markets begin to develop in different subregions of the larger Shanghai region, which are specialized in a broad range of chemical fields. These include a wide scope and scale of university graduates and skilled production workers. The development of these labor markets is supported by specialized training programs at regional universities and technical schools. This is also actively supported by foreign multinationals, which fund the implementation of new programs. Direct employment

effects of the new investment projects have, however, remained relatively small until now, as the new operations are characterized by a high degree of automation.

3. *Idle regional transaction linkages*. Opportunities to establish regional transaction networks are opening up because more multinational chemical firms are investing in the region, sometimes in cooperation with large Chinese firms. The potential for such linkages is greatest if the firms are related to each other in the form of value-chain linkages. Linkages between foreign branches and older Chinese production sites hardly exist.

4. *Strong commitment to corporate networks*. Many foreign production facilities are still strongly committed to their corporate networks securing the supply of specialty chemicals and engineering know-how. Strategic decisions are made at the firms' global headquarters, largely in Europe. The foreign branches have only limited local R&D functions, which could help convert the experiences from interactive learning processes into new products. Likewise, Chinese firms are also tied to intra-group networks and have not established extensive R&D competencies.

5. *Supportive institutional basis*. The growth of the chemical industry generally benefits from a developing institutional basis, involving supportive government policies at the central, provincial and city state level, and the establishment of efficient logistics systems.

Although this research suggests that the growth process of the chemical industry is likely to continue, we are skeptical about the potential for the development of a strong coherent chemical industry cluster under current circumstances. Notwithstanding enormous problems related to environmental issues, global warming and "peak oil", we believe that the present industry structure displays a set of structural weaknesses. First, producer–user linkages are limited as foreign firms starting of as WFOEs have limited direct market contact and rely on traders who operate as knowledge brokers in connecting production and consumption. As a consequence, the potential for interactive learning processes is limited. Second, a lack of intra-cluster R&D capabilities restricts the possibilities to develop market experiences into future products. Third, local Chinese operations often do not engage in systematic producer-user linkages or R&D which could form the basis for further innovation. Therefore, the regional growth paths may be more vulnerable than what it first appears.

Acknowledgements

This paper draws upon research which was jointly conducted by both authors, who contributed equally to this paper. In conducting this research, we received valuable support and comments from Heiner Depner, Ulrich Dewald, Nicole Kogler, Fei Li, Yuefang Si, Peter Süß, Fei Wang and Qin Xiao for which we are very grateful. We would also like to thank Volker Langbein for providing us with important contacts in the chemical industry in China. We are especially indebted to all chemical industry experts, policy makers and company representatives from Chinese, German and other foreign chemical firms in China who participated in our interviews. This research was, in part, supported by the National Natural Science Foundation of China, East China Normal University and the Canada Research Chair program.

References

Bathelt, H. (1997): *Chemiestandort Deutschland: Technologischer Wandel, Arbeitsteilung und geographische Strukturen in der Chemischen Industrie (German Chemical Industry: Technological Change, the Division of Labor and Geographical Structure)*. Berlin: Edition Sigma.

Bathelt, H. (2005): Chanye jiqun yanjiu de xin shijiao (Toward a re-conceptualization of clusters). *World Regional Studies – Shijie Dili Yanjiu* 14(1): 1 - 8.

Bathelt, H., Malmberg, A., Maskell, P. (2004): Clusters and knowledge: local buzz, global pipelines and the process of knowledge creation. *Progress in Human Geography* 28: 31 - 56.

Bathelt, H., Zeng, G. (2005): Von ressourcenabhängigen, unvernetzten Industrien zu Industrieclustern? Das Beispiel der südchinesischen Großstadt Nanning (From resource-dependent, isolated industrial firms to industrial clusters? The example of Nanning, Southern China). *Zeitschrift für Wirtschaftsgeographie* 49: 1 - 22.

Burt, R. (1992): *Structural Holes: The Social Structure of Competition*. Cambridge, MA: Harvard University Press.

Burt, R. (2005): *Brokerage and Closure: An Introduction to Social Capital*. Oxford: Oxford University Press.

Cheng, J., Bennett, D. (2007): Success strategies in the Chinese chemical industry: a survey and case study investigations. *Journal of Chinese Economic and Business Studies* 5(2): 91 - 112.

Colvin, R. (2006): Heading east, BMS sets its sights on the Middle Kingdom. *Modern Plastics Worldwide* 83(11): 46 - 48.

Depner, H. (2006): Transnationale Direktinvestitionen und kulturelle Unterschiede: Lieferanten und Joint Ventures deutscher Automobilzulieferer in China (Transnational Direct Investment and Cultural Difference: Suppliers and Joint Ventures of German Automobile Suppliers and China). Bielefeld: Transcript.

Depner, H., Bathelt, H. (2005): Exporting the German model: the establishment of a new automobile industry cluster in Shanghai. *Economic Geography* 81: 53 - 81.

Eisenhardt, K. M. (1989): Building theories from case study research. *Academy of Management Research* 14: 532 - 550.

Festel, G., Geng, Y. (2005): Chemical industry parks in China. In Festel, G., Kreimeyer, A., Oels, U., von Zedtwitz, M. (eds) *The Chemical and Pharmaceutical Industry in China: Opportunities and Threats to Foreign Companies*. Heidelberg: Springer, 53 - 62.

Follath, E., Lorenz, A., Simons, S. (2002): Der Kopf des Drachen (The head of the dragon). *Der Spiegel* 50/2002: 134 - 152.

FR-online.de (2007): BASF legt für 2006 Rekordwerte bei Umsatz und Gewinn vor (BASF presents new records in sales and profits for 2006). February 22.

Giese, E., Zeng, G. (1993): Regionale Aspekte der Öffnungspolitik der VR China (Regional aspects of the opening policy in the PR China). *Geographische Zeitschrift* 81: 176 - 195.

Giese, E., Zeng, G. (1997): Wirtschaftliche Entwicklung und außenwirtschaftliche Verflechtung der VR China (Economic development and international linkages in the PR China). *Geographische Rundschau* 49: 708 - 716.

Hui, C. S. (2007): What's the buzz about Asia? *ICIS Chemical Business Americas* 271(1): 26 - 27.

Jiangsu Bureau of Statistics (1988 - 2006): *Jiangsu Statistical Yearbook*. Beijing: China Statistics Press.

Kreimeyer, A. (2005): Swimming ahead of the shoal – the history of BASF in greater China. In Festel, G., Kreimeyer, A., Oels, U., von Zedtwitz, M. (eds) *The Chemical and Pharmaceutical Industry in China: Opportunities and Threats to Foreign Companies*. Heidelberg: Springer, 159 - 170.

Krumberger, O. (2005): Establishing a competitive production network in Asia. In Festel, G., Kreimeyer, A., Oels, U., von Zedtwitz, M. (eds) *The Chemical and Pharmaceutical Industry in China: Opportunities and Threats to Foreign Companies*. Heidelberg: Springer, 171 - 179.

Lin, L. (2007): *Jishu kuisuan he gaojishu qiye quwei yanjiu – yi zhangjiang gaojishu yuanqu weili (Technology Transfer and Location Decisions of High-Tech Enterprises – The Case of the Zhangjiang Hi-Tech Park, Shanghai)*. PhD thesis. Shanghai: Department of Human Geography, East China Normal University.

Malmberg, A., Maskell, P. (2002): The elusive concept of localization economies: towards a knowledge-based theory of spatial clustering. *Environment and Planning A* 34: 429 - 449.

Martin, R. and Sunley, P. (2003): Deconstructing clusters: chaotic concept or policy panacea? *Journal of Economic Geography* 3: 5 - 35.

Miles, M. B., Huberman, A. M. (1994): *Qualitative Data Analysis: An Expanded Sourcebook*. 2nd edition. Thousand Oaks, CA: Sage.

Mu, J. (2006): *Changjiang sanjiaozhou shihua gongye kongjian jiegou yanhua yanjiu (Research on the Spatial Structure of the Petrochemical Industry in the Yangtze Delta Region)*. Masters thesis. Shanghai: Department of Human Geography, East China Normal University.

Mueller, H. (2005): Activities of European chemical companies in China. In Festel, G., Kreimeyer, A., Oels, U., von Zedtwitz, M. (eds): *The Chemical and Pharmaceutical Industry in China: Opportunities and Threats to Foreign Companies*. Heidelberg: Springer, 23 - 46.

National Bureau of Statistics of China (1988 - 2005): *China Statistical Yearbook*. Beijing: China Statistics Press.

National Bureau of Statistics of China (2006): *China Statistical Yearbook 2006*. Beijing: China Statistics Press (URL: http://www.stats.gov.cn//tjsji/ndsj/2006, date accessed June 17, 2007).

Olds, K. (1997): Globalizing Shanghai: the 'global intelligence corps' and the building of Pudong. *Cities* 14: 109 - 123.

Perlitz, U. (2005): *Chemieindustrie in China: international auf der Überholspur (Chemical Industry in China: Overtaking Internationally)*. Frankfurt/Main: Deutsche Bank Research – Aktuelle Themen 333: China Spezial.

Porter, M. E. (1990): *The Competitive Advantage of Nations*. New York: The Free Press.

Qin, Z.-y. and Zhang, W.-y. (2003): Discussion on structure adjustments of china's chemical industry in the 21st century. *Hebei Journal of Industrial Science & Technology* 20(5): 1 - 19.

Saxenian, A. (2006): *The New Argonauts: Regional Advantage in a Global Economy*. Cambridge, MA: Harvard University Press.

Scott, A., Ramesh, D. (2007): Fine chemicals in China. *Chemical Week* 169(35): 17 - 19.

Shanghai Bureau of Statistics (1988 - 2006): *Shanghai Statistical Yearbook*. Beijing: China Statistics Press.

Shanghai Chemical Industry Park Development Co. (2005): *Shanghai Chemical Industry Park*. Shanghai.

Shanghai Chemical Industry Park Development Co. (2007): *Shanghai Chemical Industry Park*. Shanghai (URL: http://www.scip.com.cn, date accessed May 29, 2007).

Shanghai Economic Commission, Shanghai Municipal Statistics Bureau, Shanghai Development Park Association (2004): *Shanghai Development Park Annual 2004 (in Chinese)*. Shanghai.

Shanghai Economic Commission, Shanghai Municipal Statistics Bureau, Shanghai Development Park Association (2007): *Shanghai Development Park Statistical Manual 2007 (in Chinese)*. Shanghai.

Silverman, D. (2001): *Interpreting Qualitative Data: Methods for Analysing Talk, Text and Interaction*. 2nd edition. London: Sage.

Stachels, E. (2005): Bayer – a multinational committed to China. In Festel, G., Kreimeyer, A., Oels, U., von Zedtwitz, M. (eds) *The Chemical and Pharmaceutical Industry in China: Opportunities and Threats to Foreign Companies*. Heidelberg: Springer, 181 - 188.

Sternberg, R., Müller, C. (2005): Return migration in regional innovation systems. *Asian Journal of Technology Innovation* 13: 71 - 95.

Sun, J., Gu, C. (2004): Jiangsu yanjiang kaifa yanjiu (Development of the area along the Yangtze River in Jiangsu). *Changjiang Liuyu Ziyuan Yu Huanjin (Resources and Environment in the Yangtze Basin)* 13(5): 403 - 407.

Tan, C. (2003): In the park. *ACN: Asian Chemical Network* (July): 15 - 16.

Uzzi, B. (1997): Social structure and competition in interfirm networks: the paradox of embeddedness. *Administrative Science Quarterly* 42: 35 - 67.

Wang, L. (2005): *Waizi canyu de chanye jiqun yanjiu (Analysis of Cluster Firms Started up with Overseas Chinese and Other Foreign Capital)*. PhD thesis. Shanghai: Department of Human Geography, East China Normal University.

Wu, F. (2000): The global and local dimensions of place-making: remaking Shanghai as a world city. *Urban Studies* 37: 1359 - 1377.

Wu, J. (2005): Sikao yu huiying: zhongguo gongyehua de jueze (Reflection and response: choosing the way to Chinese industrialization). *Xueshu Yuekan (Academic Monthly)* (12): 38 - 45.

Xu, Q. (2006): Changsanjiao quyu shiyou he huagong xianzhuang yu fazhan fangxiang (Structure and trends in the petrochemical industry in the Yangtze Delta region). *Shanghai Huagong (Shanghai Chemical Industry)*, 31(7): 1 - 3.

Zeng, G. (2000): The financial crisis in Asia and the modification of economic structure in Shanghai (in Chinese). *Asian Geographer* 19: 37 - 48.

Zeng, G. (2001): Shi gongye buju tiaozhen chu tan (Research on the modification of industrial spatial distribution in Shanghai). *Geographical Research* 20(3): 330 - 337.

Zeng, G., Bathelt, H. (2009): Divergent growth trajectories in China's chemical industry: the case of the newly developed industrial parks in Shanghai, Nanjing and Ningbo. *GeoJournal* 59: forthcoming.

Zheijiang Bureau of Statistics (1988 - 2006): *Zhejiang Statistical Yearbook*. Beijing: China Statistics Pres