Strong Growth in Weakly-developed Networks: Producer–user Interaction and Knowledge Brokers in the Greater Shanghai Chemical Industry

Harald Bathelt & Gang Zeng

Version	Post-print/accepted manuscript
Citation (published version)	Bathelt, H., & Zeng, G. (2012). Strong growth in weakly-developed networks: Producer–user interaction and knowledge brokers in the Greater Shanghai chemical industry. <i>Applied Geography</i> , 32(1), 158-170.
Copyright / License	© 2011. This manuscript version is made available under the CC-BY-NC-ND 4.0 license. http://creativecommons.org/licenses/by-nc-nd/4.0/
Publisher's Statement	The version of record [Bathelt, H., & Zeng, G. (2012). Strong growth in weakly-developed networks: Producer–user interaction and knowledge brokers in the Greater Shanghai chemical industry. <i>Applied Geography</i> , 32(1), 158-170.] is available online at: http://www.sciencedirect.com/science/article/pii/S0143622810001633 [doi:10.1016/j.apgeog.2010.11.015]

How to cite TSpace items

Always cite the published version, so the author(s) will receive recognition through services that track citation counts, e.g. Scopus. If you need to cite the page number of the TSpace version (original manuscript or accepted manuscript) because you cannot access the published version, then cite the TSpace version in addition to the published version using the permanent URI (handle) found on the record page.

October 28, 2010

Word count: ca. 10,000 (main text only)

**Strong growth in weakly-developed networks:
producer–user interaction and knowledge brokers in the
Greater Shanghai chemical industry**

by

Harald Bathelt

University of Toronto, Department of Political Science and Department of Geography & Program
in Planning, Sidney Smith Hall, 100 St. George Street, Toronto ON M5S 3G3, Canada;
E-mail: harald.bathelt@utoronto.ca, URL: <http://www.harald-bathelt.com>

and

Gang Zeng

East China Normal University, Department of Human Geography,
3663 North Zhongshan Road, Shanghai 200062, China;
E-Mail: gzung@re.ecnu.edu.cn

Paper to be re-submitted to

Applied Geography

Special issue on “China in transition: globalization, industrialization, and development”,
edited by Wei Y H D and Liefner I

Strong growth in weakly-developed networks: producer–user interaction and knowledge brokers in the Greater Shanghai chemical industry

Abstract (ca. 190 words). This paper investigates the developing spatial and social division of labor in the Greater Shanghai chemical industry. This industry experienced strong growth after the Asian financial crisis, when policy support was extended beyond “new economy” industries to include traditional manufacturing sectors. Based on a conceptualization that emphasizes the role of producer–user networks and interactive learning as a basis for ongoing innovation and business success, an explorative study was designed to investigate the supplier and customer linkages in different locations of the Greater Shanghai region. The results suggest that inter-firm networks are not extensive and often involve limited producer–user interaction. Important chemical firms in the region concentrate on business with their established international customer basis, use state-controlled distribution channels or rely on intermediaries that act as knowledge brokers. Neither of these practices of market interaction includes intensive information exchange and feedback on products, customer experience and demand changes. As such, these practices do not provide a sound basis for self-sustained growth or innovation in the future. The paper concludes that regional policy needs to support the establishment of combined “bonding” and “bridging” relations between chemical producers and their user industries.

Keywords: Shanghai, chemical industry, producer–user interaction, social networks, knowledge brokers

1. Introduction

Recent studies on the relationships between expanding global value chains and foreign direct investment (FDI) in China, as well as between research and development (R&D) and regional economic growth, have primarily focused on the role of “new economy” industries such as electronics, telecommunications and other information technology (IT) industries (e.g. Fan 2006; Sun and Wen 2007; Wang and Lee 2007; Zhou 2007; Wei et al. 2009). Some studies find evidence of positive spillovers from FDI to domestic firms (Hu and Jefferson 2002), although this evidence is inconclusive (Fan 2006). Other investigations identify a positive influence of wider vertical and horizontal interorganizational networks on firm performance (Lu and Ma 2008). In particular, a significant impact of global production networks and strategic coupling between Chinese firms and foreign multinational partners on business success and innovation has been observed (Sun 2002a; Hong 2004; Tan 2006; Wang and Lee 2007; Kim and Zhang 2008; Yeung 2009; Yang et al. 2009).

In terms of the relationship between industrial agglomeration (or regional clustering), interfirm linkages and innovation, results of empirical studies are somewhat mixed. Zhou (2007), for instance, finds that there are no close interfirm linkages or networks between high-technology firms clustered in Beijing’s Zhonguancun Park. Similarly, Zeng and Wen (2004) conclude from their study of the horizontal, vertical, external and power linkages in the Pudong IT industry that local linkages and interfirm learning are limited. Along the same line, Sun’s (2002b) investigation of China’s manufacturing sector shows that in-house R&D is often more important for innovation processes of domestic firms than local producer–user relations. A recent study of Wang (2010) suggests that there is no close relation between local networking and innovation in the Chinese ICT industry, suggesting that such linkages have been over-emphasized in the literature (see, also,

Wei et al. 2011). These and other analyses lead some observers to claim that “western” theories drawing a causal relationship between regional clustering, interactive learning and innovation might not be applicable to the Chinese situation (e.g. Yeung and Lin 2003; Wang C C et al. 2010). In contrast, others convincingly argue that technological learning and innovation are also important in the Chinese context (Miao et al. 2007; Wang J et al. 2010). Their studies confirm general conceptual findings on the importance of producer–user interaction for regional innovation and growth (Lundvall 1992; Gertler 2004).

One shortcoming of recent work on China is that traditional industries are somewhat underrepresented, with few exceptions such as Hu and Jefferson (2002), Hong (2004) and Depner and Bathelt (2005). The chemical industry, in particular, has been almost completely neglected despite its tremendous growth in recent years and its increasing importance in the Yangtze Delta region consisting of the three provinces of Shanghai, Jiangsu and Zhejiang (Xu 2006; Cheng and Bennett 2007; Bathelt and Zeng 2009; Zeng and Bathelt 2010).

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. Relatively late in the early 1990s, a radical shift took place in Shanghai’s regional economic policy orientation (Giese and Zeng 1993; 1997), opening up the regional economy to FDI as a basis for subsequent economic growth. Through this, the city expanded rapidly toward Pudong, originally a less industrialized suburb located between the Pacific coast and the Huangpu River (e.g. Olds 1997; Wu 2000). The strategy of attracting FDI to accomplish technology transfers to domestic businesses became the core of what has been known as the Pudong business model (Wang 1996).

The new political goal was to support an economic shift from traditional manufacturing based on large state-owned firms toward new industries and services of the knowledge economy.

As a part of this, large technology parks were established, such as the Zhangjiang Hi-Tech Park in Pudong (Lin 2007). The new economic core sectors, however, proved to be vulnerable which became clear with the Asian financial crisis after 1997 (Zeng 2000; 2001). As a consequence of this crisis, the goals of economic policies were once again restructured. To decrease the dependence on the “new economy”, an economic support policy was introduced which put stronger emphasis on “old economy” industries. As a result, investments were also supported in the chemical industry, and new suburban industrial parks, such as the Shanghai Chemical Industry Park (SCIP), were established. This paper will take this shift as a starting point to investigate the newly developing social and spatial division of labor in terms of the supplier and customer linkages of firms in the Greater Shanghai chemical industry and their different spatial expressions. We do this in a qualitative study that investigates two main questions:

- First, our goal is to investigate the different configurations of chemical production that have developed in the Greater Shanghai region. As part of this, we aim to identify the spatiality of supplier–producer–customer linkages that has resulted.
- Second, we aim to analyze the practices of producer–user interaction that have developed as a basis for interactive learning and innovation. We hypothesize that such relationships in both local as well as trans-local contexts are important to enable long-term self-sustained growth.

To explore these questions, we analyze the practices of supplier–producer–user linkages and associated information and knowledge flows in the Greater Shanghai chemical industry based on semi-structured interviews with foreign and Chinese chemical firms. Our research follows a firm-based perspective by analyzing the production, linkage and investment structures of major players in the industry, rather than focusing on the role of government (Yeung 2009).

This paper is organized as follows: In the next section, we introduce the conceptual basis building upon the literature about interactive learning, social networks and structural holes to

argue that close producer–user linkages are key to secure innovation and self-sustained growth in the future. The methodology is discussed in section 3. Section 4 describes the context of the growing chemical industry in the Greater Shanghai region, while section 5 identifies the developing production and linkage patterns in different locations, presenting evidence of a changing social and spatial division of labor. Section 6 presents a typology of firms regarding investment patterns and practices of producer–user interaction to explore the lack of interactive learning and the role of knowledge brokers in the industry. This is followed by conclusions in section 7.

2. Conception: economic growth, producer–user networks and knowledge brokers

From the existing literature on producer–user interaction, we can conclude that close, regular, intensive interaction and knowledge exchange between suppliers, producers and customers is an important basis to stimulate learning processes, which, in turn, lead to incremental innovation and continuous changes in products and technologies (von Hippel 1976; Lundvall 1992; Gertler 2004). In the context of our analysis of the chemical industry, we thus expect that access to national and local markets and to the specific needs and practices of user industries is an important reason driving FDI in China. Through ongoing producer–user interaction, wholly foreign-owned firms (WFOEs) and foreign joint ventures (JVs) can learn how to adjust their technologies to local needs, customize production and develop new niche markets. This process is similar to that described in Dunning’s (1988) eclectic paradigm of decision-making in the context of FDI, according to which firms may expand their market reach and/or reduce production and transaction costs.

Given the specific production structure in the chemical industry, however, we generally cannot expect that producer–user networks develop that are as intensive as those in other industries. This is due to the “closed” nature and relatively high degree of standardization in production. The nature of interaction in agglomerations of this industry is unlikely to stimulate the development of fully-fledged industry clusters (Zeng and Bathelt 2010). Yet, at the same time, prior work has shown that ongoing interaction between suppliers, producers and customers still provides an important basis for customization and market success in the industry (Bathelt 1997).

But to conclude from this that “western-based theory”, developed in the context of highly-industrialized economies, would not apply to the Chinese context (e.g. Yeung and Lin 2003; Wang C C et al. 2010) is not fully convincing. Miao et al. (2007), for instance, suggest that technological upgrading in China is closely associated with interactive learning processes and innovation, and, in terms of the role of social networks in production, some interesting parallels have been found between China and the western hemisphere. Studies have confirmed that both wide, diversified interorganizational and interpersonal networks contribute to increased business success in China (Lu and Ma 2008; Ma et al. 2009). This suggests that firms, which extend their linkages with customers, suppliers, competitors and the state – and whose executives widen their personal networks with other executives, will likely be able to improve their business performance.

In response to this, we follow a relational approach to the study of economic action and interaction in space, which suggests that those theories applied have to be contextualized to the specific national, regional or cultural–institutional conditions at hand (Bathelt 2006; Wang J et al. 2010). Even though our understanding of the importance of close producer–user interaction is based on studies in developed countries (Lundvall 1992; Gertler 2004), we assume that this generally also applies to the situation of chemical firms operating in China. Close ongoing

producer–user interaction provides an important basis for these firms to customize products, conduct incremental innovation, increase customer commitment and identify new demand.

The emphasis on producer-user interaction is much in line with empirical studies in the social sciences on the role of social capital in economic context. In his seminal work, Coleman (1988) suggests that social capital can be realized through ongoing economic interaction within social networks¹, leading to increased competitiveness. This is related to information advantages and the development of reliable commitments, expectations and joint norms and values. In spatial perspective, this view is reflected in studies about regional innovation systems and clusters which emphasize the benefits of close local networks between producers, suppliers and customers within a coherent regional institutional context (Cooke and Morgan 1998; Malmberg and Maskell 2002; Martin and Sunley 2003). While embedded (or closely-interwoven) industry networks have the potential to enable fine-grained information transfer, interactive learning and flexible adjustments to market changes (Granovetter 1985; Uzzi 1997), such effects do not always occur in real-world contexts.

The reason behind this is that closed social networks (that are rigidly inward-directed) can sometimes have a negative impact and lead to stagnation, lock-in and over-reliance on old technologies and solutions – due to ossification, over-embeddedness or blind confidence (Uzzi 1996; Kern 1996; Burt 2002). The recognition that “weak bridging ties”², which draw

¹ When using the term “social network”, we do not only refer to friendship or other non-economic linkages but relate to economic ties that involve ongoing interaction and adjustments, which cannot be reduced to price-based exchanges. Such networks may, for instance, be associated with mutual commitment, reciprocity and professional trust (Ettlinger 2003).

² As opposed to “weak ties” which are based on arms-length relationships, “strong ties” involve close ongoing relationships based on mutual or contractual commitment.

connections between different social networks, are key in providing access to different knowledge pools – thus establishing a competitive advantage (Granovetter 1973) – has led Burt (1992; 1997) to develop his theory of “structural holes”. The argument is that structural holes establish bridges across different social networks and enable agents to overcome limited views and conceptions which might exist within a closed framework.³ This conception emphasizes the importance of bridges between social networks (or brokerage) as opposed to bonds (or closure) within individual networks (Glückler 2004; Oliver et al. 2007).

These insights into the nature of social networks are also important in the context of the Chinese economy. While we can assume that Chinese firms, being familiar with the political-institutional system, might have few problems to operate in the domestic market, due to their experience in establishing wider social networks, this cannot be assumed for foreign investors and their local branches. This is an important issue in the case of Shanghai as economic development in this region has followed the Pudong business model (Wang 1996; Zeng and Bathelt 2010). This model differs from other business models, such as the Sunan and Wenzhou models that build on strong government linkages or local entrepreneurial networks, respectively (Wei et al. 2007; 2009), and, instead, focuses on FDI and associated technology transfer to stimulate locally-based innovation processes. In light of the above discussion, the long-term success of the Pudong model requires that wider business networks develop, at least at three levels:

³ In economic context, such bridges can be created by intermediaries, traders or distributors, who connect otherwise unconnected producers and users.

- First, business networks have to be established between domestic firms and foreign partners (Yeung 2009; Yang et al. 2009) to enable knowledge and technology transfers to regional/national economies.
- Second, Chinese partner firms have to engage in wider regional and cross-regional networks with other domestic firms through transactional relations and knowledge flows to maximize the effects of the technology transfers.
- Third, both foreign and Chinese firms have to engage in systematic producer–user interaction with a wide set of customers to acquire information about market changes, customization needs and ideas for innovation. To achieve broad market access, however, is not a routine task, as the Chinese market is characterized by a large size, rapid changes in its composition and a lack of both transparency and effective institutions to provide information about reliable transaction partners.

In the case of the Pudong model, wider business networks would benefit from entailing both between-group “bridging” and within-group “bonding” relations, which – according to Burt (2002; 2005) – are not opposing elements of social capital. They have their greatest effects when being combined with one another. Manifold redundant “bonding” relations in a social network produce reliable ongoing information and knowledge flows for production and innovation processes within a foreseeable range (bandwidth hypothesis) (Burt 2005). In spatial perspective, this conception has similarities with the information and communication ecology, or “local buzz”, which exists in ideal-type industry agglomerations or clusters, generating almost automatically knowledge flows and constant updates thereof. This enables firms to reduce uncertainties, make sense of new technological developments and distinguish more from less valuable knowledge (Storper and Venables 2004; Bathelt et al. 2004).

Without “bridging” relations, the economic effects of “bonding” relations are limited. Burt (2002; 2005) suggests that firms in closed networks may suffer from selective information transfer due to dominant institutional arrangements. Ongoing interaction patterns produce consistency, thus favoring complementary, rather than contradictory, information and knowledge flows (Granovetter 1973). This strengthens existing patterns of social relations and creates “friends networks”. To overcome these limitations, access to other social networks is needed (echo hypothesis). From a spatial perspective, the need for bridging relations finds its equivalent in the role of networks and knowledge flows with partners from other regions and nations, or “trans-local pipelines” (Owen-Smith and Powell 2004; Bathelt et al. 2004). These linkages provide access to knowledge about markets and technologies that exist or develop outside a given industry agglomeration. They are an important source of revenues and ideas for innovation; however, to develop and maintain them is a timely and costly process that involves risks and non-routine decisions.

From a regional policy perspective, a combination of Burt’s social network perspective and the buzz-and-pipeline perspective might be an interesting starting point to investigate the regional effects of economic growth and their potential to trigger new developments (e.g. Glückler 2004; Zhou 2007; Kim and Zhang 2008). In the case of the Greater Shanghai chemical industry, this implies that if wider social networks can be established within the region and beyond, the outcomes of “bridging” and “bonding” relations could materialize and stimulate further agglomeration. But before drawing further conclusions about potentialities, it is necessary

to investigate the actual spatial and social division of labor in the Greater Shanghai chemical industry.⁴

Before proceeding with this analysis, we next provide an overview of the empirical basis and methodology of this study.

3. Methodology

The research in this paper presents a qualitative interpretation and exploration of important trends and structures in the Greater Shanghai chemical industry. It is based on a variety of information sources, including statistical data, academic literature, business/news reports and government publications. It relies on more than 50 interviews with industry experts, managers and technical specialists of chemical firms in the Yangtze Delta region. The analysis presented in this paper specifically draws from 22 in-depth semi-structured interviews with representatives of German, other foreign and Chinese chemical firms in the Greater Shanghai region, as well as 9 interviews with industry observers, retired executives, park managers and industry representatives. These interviews were conducted between September 2001 and June 2007. The firms interviewed were not chosen randomly. In order to gain an overview of dominant trends, Chinese and foreign market leaders, trend setters and innovative firms were identified. The selection of firms was based on prior knowledge about the industry structure, firm and industrial park directories, news about FDI ventures in Asia and advice from industry observers. Overall, we selected firms that

⁴ Our analysis is not focused on Granovetter's (1973) distinction of strong vs. weak ties; we differentiate between dense networks with many (weak and strong) linkages and less dense networks that are weakly-developed with few strong or weak ties, arguing that the latter networks offer few possibilities for ongoing interactive learning and related innovation.

included some of the world's leading chemical corporations (for an overview of firm profiles, see Table 1).

Prior to our interviews, the corresponding general managers, founders or chief technology officers were contacted by telephone and e-mail. More than 80% of the firms were willing to participate in our interviews. Although the overall number of interviews appears too small to provide a representative picture of the entire industry, our data allows us to identify main trends in local and non-local transaction linkages and important practices of producer–user interaction.⁵

Interviews were conducted jointly by both authors, either in English, German or Chinese. While interviews with foreign managers were typically recorded on tape, this was not always feasible during interviews with Chinese firms due to initial skepticism regarding our research. In these cases, we simply did not want to risk the reliability and quality of the information provided. These interviews were recorded in the form of detailed protocols. The transcriptions and interview reports were systematically organized and intensively discussed between both researchers. Answers for the key questions were condensed and classified to provide an overview of the bandwidth of responses. This provided the basis for our typology of firms according to investment patterns and interaction practices which is explored in more detail in section 5. Interview results were also compared with other information sources to avoid misinterpretations and provide consistent results (Miles and Huberman 1984; Eisenhardt 1989; Silverman 2001).

⁵ Although we primarily interviewed German and Chinese firms (Table 1), we do not expect that our findings regarding weakly-developed producer–user networks would differ substantially if we included, for instance, more US firms. The latter originate from a liberal-market-economy background (Hall and Soskice 2001) and would be even less likely to develop intensive inter-firm relations.

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. 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. Interviews with Chinese firms were structured in a similar way. The analysis presented here focuses on questions about the linkages with suppliers and especially customers. It draws on questions about the nature, frequency and intensity of interaction with partners. These included questions about the type of the products distributed, the specifics of users and their locations, the reasons why local users were chosen or not, the frequency of interaction with users and the nature of information exchange and potential learning processes.

The results of this research are presented in the following sections.

4. Context: the growth of the Yangtze Delta chemical industry

Since the 1990s, the cities located in the Yangtze Delta region in the provinces Shanghai, Jiangsu and Zhejiang have developed into major economic centers, witnessing tremendous growth in the chemical industry, as well as other industries. This growth was largely due to continued industrialization which began in the 1980s and accelerated during the 1990s based on globalization processes, and particularly the inflow of FDI (for effects in Europe, see Chapman and Edmond 2000). Although this has not been greatly discussed in academic work, the chemical industry played an important role in supporting this process (Mu 2006; Xu 2006). Even though the region was already an important site for chemical production before the economic reforms

began, its development has become more dynamic since the late 1990s (Cheng and Bennett 2007; Hui 2007), as many multinational chemical firms, especially from Europe, extended their production base to China (Mueller 2005; Perlitz 2005).

As a consequence of the Asian financial crisis in 1997/1998, which abruptly halted the hype surrounding the “new economy”, the Chinese central government began to rethink its economic focus on knowledge-intensive services and high-technology industries. New political goals were formulated to further open up the Chinese economy and redirect growth to “old economy” industries (Zeng 2000; 2001). These new priorities also had a substantial impact on the chemical industry at different administrative levels. They affected the goals of economic support policies and led to a redirection of resources to specific sectors. This, in turn, led to the generation of specific policy programs. First, two chemical industry parks of strategic national importance were identified and designated (Zeng and Bathelt 2010): the Shanghai and Nanjing Chemical Industry Parks. They received highest priority in funding programs and heavy support from central, provincial and local funding sources to support the fast development and the attraction of tenants. Second, large chemical industry parks were also established in other cities, such as Wuxi and Ningbo. Third, programs were developed to improve existing and invest into new infrastructure for the chemical industry. Some locations received improved access to deep sea harbors, while others benefited from the possibility of conducting bulk shipments on the Yangtze River. As a consequence, this provided better conditions for supplies of raw materials from overseas, or access to an oil pipeline (Bathelt and Zeng 2009).

Table 2 about here

Overall, this development had a strong effect on production levels of the chemical industry. While the gross production value of the Yangtze Delta chemical industry increased from 46.7 billion Yuan (5.8 billion US-\$) to 333.2 billion Yuan (41.6 billion US-\$) between 1987 and 1998, its growth accelerated in the period thereafter to 1,304.9 billion Yuan (163.1 billion US-\$) in 2005 (Table 2). In relative terms, the region's share in employment in the industry increased slightly from 15.5 % to 17.6 % between 1997 and 2006 (Table 3), whereas the share of the Chinese gross production value jumped from 24.1 % in 1987 to 30.7 % in 2005 (Wu 2005; Table 2). Depending on the chemical branch, between 16.7% (petroleum processing, coke products and processing of nuclear fuels) and 71.4% (chemical fibers) of the Chinese production value were produced in the Yangtze Delta region in 2006 (Table 4).

Tables 3 and 4 about here

Since 2007, the central government has – again – revised its support policy for the chemical industry, in light of global warming and environmental protection. Even though some provincial and city governments still actively support its development, the central government has reduced incentives for the expansion of chemical production (Wu 2005; China Petroleum and Chemical Industry Association 2006). In terms of the spatial distribution of the industry, the central government also began to favor relocations or shifts of primary growth areas from the heavily populated Yangtze Delta city-regions to China's southwestern regions. The main objective was to stimulate economic development in less developed regions while, at the same time, reducing financial incentives for foreign direct investment in the coastal areas.

Due to the continued growth of consumer manufacturing industries, such as IT and automobiles, whose production value grew by 536.5 % between 1995 and 2004 (National Bureau

of Statistics of China 2006), the demand for chemical products in China will likely continue to grow substantially in the future (Sun and Gu 2004). This will support further development of the chemical industry in the Yangtze Delta region, and especially in Greater Shanghai. At the same time, China's chemical industry is still characterized by structural problems, such as a low degree of integration within value chains, limited competition, a lack of fine/specialty chemicals and low technological standards (e.g. Zhu 2003; Perlitz 2005; Scott and Ramesh 2007).

5. Results: the changing spatial and social division of labor in the Greater Shanghai chemical industry

Although production values in the chemical industry have steadily grown, employment has actually decreased in most parts of China. Employment in the Yangtze Delta region's chemical industry decreased from 1.22 million to 880,000 people between 1997 and 2006, and in Shanghai from 290,000 to 180,000 (Table 3). This was related to the strong role of large state-owned firms in the region. In realizing that these firms were not competitive internationally and were characterized by low efficiency levels, over-employment and ongoing losses, strong moves were made to improve the profit situation of these firms. In the 1980s and 1990s, many state-owned firms were privatized and transformed into publicly-traded firms, albeit still with strong or even dominant state involvement (Cao et al. 1999; Cheng and Bennett 2007). This went along with major restructuring, modernization and massive job losses. In addition, a substantial number of small and medium-sized private and collective chemical firms were closed down due to environmental problems. Again others were relocated from their former downtown locations to

the periphery.⁶ Although we did not investigate in detail the exact localized effects of these restructuring activities, they clearly had the strongest effect in inner-city locations and industrial areas developed prior to and in the early phases of the establishment of the People's Republic.

In the following subsections, we investigate the dynamics of production and linkage structures across different locations in the Greater Shanghai chemical industry (Figure 1).

Figure 1 about here

5.1 Older plants in urban locations before the 1970s

Traditionally, Shanghai had a strong presence in heavy manufacturing industries consisting mainly of large hierarchical, vertically-integrated state-owned firms. As part of this, the region developed a chemical industry related to the production of basic chemicals. The locations of the firms remained relatively stable until the 1990s when the city began to expand rapidly. Large-scale plants for the production of inorganic chemicals/petrochemicals had grown 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 are the operations of a petrochemical firm which belongs to one of China's largest chemical/petrochemical groups. The facilities were originally established as a US investment in the 1930s where, at the time, a large amount of land was

⁶ One example was the relocation of an older Chinese chemical producer to the SCIP. Several of our interviewees were not very happy with this relocation since the firm still used old technologies and remained to be a

available for industrial development. After the foundation of the People's Republic in 1949, the firm was transformed into a large-scale state-owned corporation. A leading executive and the research head explained that the distribution of products from this location was largely organized through a state-controlled system of intermediaries. Products, in particular basic chemicals, would be shipped by pipeline to these intermediaries and customer contact was managed through them. Direct customer interaction was not very common due to the standardized nature of the products, and the firm's operations were not regionally embedded through close supplier relations. Most supplies were purchased from international locations. Other older Chinese firms seemingly had a similar structure with a focus on standardized raw materials and little direct customer contact.

The original advantage of such locations of being relatively remote from the city's core turned into a disadvantage as Shanghai expanded rapidly later on. Residential neighborhoods developed in the vicinity, leading to conflicts concerning pollution levels. As a consequence, the pressure increased to relocate to locations in the periphery, especially since the city aimed to increase the recreational value of areas along the Huangpu River.

Land-use conflicts were even more drastic in other parts of the city where older Chinese companies, originally located outside of Shanghai, were now surrounded by urban developments. 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 environmental and safety standards. Consequences were conflicts with other land uses, high risks for residential neighborhoods and increasing environmental hazards inside the urban core.

heavy polluter.

As a consequence of the Asian financial crisis, existing relocation plans for some of these industries, aiming at replanting the firms from central locations toward the periphery, were postponed (Zeng 2000). It seemed clear though that these chemical firms could not remain at urban locations for long.

Overall, we did not find evidence that these older chemical operations engaged in local networking, or bonding in the sense of Burt (1992), or benefited from interactive learning processes similar to those described by Lundvall (1992).

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

Since the 1980s, new chemical plants were established by Chinese firms in locations further away from the city core in areas such as Baoshan, Waigaoqiao or Jinshan, close to today's SCIP (Figure 1). These chemical facilities were often medium-sized operations with older production technologies. Because of capital shortages, they had difficulties to modernize their operations in recent years. Their market shares, however, appeared stable due to the overall growth in the economy.

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 later established in Pudong. In contrast to the investments in Pudong, the firms were characterized by production processes with a larger scale of emissions and stronger focus on standardized chemical products. Since the foreign firms interviewed were mostly engaged in long-term customer relations with other multinational firms, new producers already had a customer base in the region when they moved here.

According to our interviews, the firms in these areas usually purchased basic chemicals and raw material supplies from within China, while specialty chemicals were acquired through corporate networks, often from overseas. A good example of the latter is a producer of specialty

chemicals from Switzerland that started operations in 1996. The firm decided to start as a WFOE because it already had a customer base in the region. The local manager suggested that almost all of the final customers were branches of foreign firms in the Yangtze Delta region, so the firm was able to build upon long-term delivery commitments. As the operations relied on regular interaction with customers including almost monthly visits, this firm was a clear exception in our sample. The manager explained that the main customers were acquired through the global corporate operations. The need for close customer contact led to investments that were similar to “piggy-backing” (Glückler 2006). The plant manager said: “Basically we followed our customers [to China].” Over time, the firm also acquired an increasing proportion of standard supplies from within the region.

An observer confirmed our observation that customer linkages of other firms in these peripheral areas were less intensive, often relying on intermediaries. In contrast to the literature on producer–user interaction, this did not provide many opportunities for interactive learning and product modifications.

5.3 FDI in specialty chemicals and pharmaceuticals since the late 1990s in Pudong

During the 1990s, Pudong became an important focus of FDI in low-emission, technology-based industries (e.g. Old 1997; Lin 2007). This was related to its excellent infrastructure, such as the new Shanghai-Pudong international airport and proximity to Shanghai’s city core (Figure 1). While the growth of the chemical industry in other parts of the Yangtze Delta region was more limited to basic chemicals and related products, Pudong specialized in segments such as pharmaceuticals, biotechnology, cosmetics and specialty chemicals.

Our interviews showed that local production activities were often limited, focusing on relatively simple production stages. Many supplies and intermediate products were purchased

through corporate networks from international sources. Foreign subsidiaries of multinational chemical firms were mostly established as WFOEs, and did not have access to an existing customer network of a domestic partner. Direct sales contacts were therefore limited to long-term multinational customers with whom transactional relations had already existed before. Otherwise, the distribution of products was handled through intermediary firms that had excellent knowledge of the Chinese market. Interestingly, a number of these intermediaries or traders were located in Hong Kong or the adjacent Guangdong province. They were in control of the information and knowledge flows between chemical producers and their users and thus operated as knowledge brokers in the sense of Burt (1992; 1997), linking production and consumption that were otherwise unconnected. These agents had the local market knowledge necessary to access user industries.

This is exemplified by a German firm that established a small branch plant in Pudong in 2003. After more than a year in operation, the firm still purchased about 60% of its supplies from Germany. Local supply-side linkages seemed to grow though, as more foreign suppliers established operations in the region. Strong corporate ties to Germany were maintained to exercise control in the assessment of potential future suppliers. The local manager of the firm indicated that specialists from the headquarters were routinely involved in decision-making processes and would regularly travel to Shanghai. The firm's main customers were primarily operations of European and North American chemical firms in the Yangtze River and Pearl River Delta regions. Although some of these firms were dealt with directly, many – especially smaller customers – did not have personal contact with the producer. The local manager explained this as follows: “For us, it is more the question of market access, and until now, we could cover that via this quite loose bond to these distributors. Of course, [you] also have a lot of agreements ... but it is not as tight as a marriage in a joint venture.” This response mirrors the attitude of some of the

foreign managers we encountered. Knowing that it would be difficult to access the large number of small and medium-sized Chinese firms in an intransparent market on their own, and knowing about the “cultural–institutional barriers” (Depner and Bathelt 2005) associated with this, the firms felt that they had to choose between two alternatives: selecting a Chinese JV partner, which was perceived to be a high risk, or serving customers via distributors at a much lower risk. In both cases, actual opportunities for learning from customer experience were limited, and the knowledge brokers – although connecting both groups of firms (Burt 2005) – seemed to hinder rather than support direct feedback loops.

A different trend that was visible in Pudong was related to the increasing customization of products to the domestic market.⁷ This was associated with the need to develop local R&D capabilities. Sometimes, necessary product adjustments were made through a local development facility. This is exemplified by a new technical center established in 2005 by a leading European chemical firm. Originally established as a 50/50 JV with a Chinese partner, the firm was transformed into a WFOE before the investment materialized. This decision was related to concerns surrounding the potential for unintended knowledge spillovers through “*guanxi*” networks⁸ – a process that was even pointed out by some Chinese interviewees.

⁷ An interesting question is why foreign firms increased their R&D investment in Shanghai to customize products while relying on intermediaries to serve the local markets. First of all, these firms apparently had at least some contact with Chinese customers from which they benefited. Second, customization appeared to depend strongly on regular contact with established foreign customers in China. Third, as one interviewee mentioned, development centers were sometimes primarily set up to satisfy government expectations, rather than to actually innovate or develop new products.

⁸ The term “*guanxi*” refers to personal relationships and commitments in the Chinese context that are reciprocal in character. They are both instrumental and emotional based on observed or constructed common grounds.

In addition to foreign R&D facilities, the number of small Chinese development and engineering firms in Pudong also increased quickly. Start-up processes of pharmaceutical R&D facilities in the Zhangjiang Hi-Tech Park in Pudong were, for instance, strongly subsidized by the city government. Wang (2005) highlights the positive role of return migrants, i.e. Chinese engineers and scientists returning from North America and other countries, in the process of establishing new high-tech ventures in Pudong. These entrepreneurs kept close contact with those foreign research institutes where they had previously worked or studied. These contacts helped acquire contracts at an international level and establish global market linkages, similar to what has been described by Saxenian (2006). In sum, however, the overall research potential of these facilities appeared limited, as observers noted (Zeng and Hu 2004; Lin 2007). Some start-ups primarily conducted low-cost laboratory work and standardized test runs for foreign customers. A study of these facilities found that many were characterized by low sales and 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 related to capital shortages in developing new technologies and problems in acquiring new customers. Potential Chinese customers often did not have sufficient capital to externalize their development activities, and foreign subsidiaries did not recognize the capabilities of these firms, as one founder emphasized.

According to our study, local linkages were rare despite the potential for such contacts. The firms interviewed were not interested in having closer contact with other local firms or competitors because of the threat of unintended knowledge spillovers; linkages with universities were also not important. One firm in the park, which was a spin-off from a pharmaceutical research laboratory jointly established by a state-owned firm and a local university, was located in close vicinity to its incubator. This indicated that former contacts were still important. The founder mentioned that there were few potential customers in the region and therefore few

opportunities to develop local customer linkages. Close linkages with customers in other regions, which were key to success, had to be established without help from state agencies. Generally, since the firm would be small, such networks were established based on personal or *guanxi* networks. These were based on former joint work relationships with different employers in different locations. As in several other cases, the resulting producer–user relations did not systematically provide feedback from a wider market segment but were concentrated on few already established customers with limited capacities to expand.

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

Since its foundation in 2004, the SCIP developed into a modern, world-scale industrial site for chemical production (Tan 2003; Festel and Geng 2005; Krumberger 2005; Shanghai Chemical Industry Park Development Co. 2007). The industry park is located in Caojing south of Shanghai's core at Hangzhou Bay (Figure 1). It is a fully developed industrial area equipped with infrastructure, such as jetties, pipelines, public utilities and environmental protection facilities; all of which are provided by the Shanghai Chemical Industry Park Development Corporation. Once fully developed, the SCIP will be connected with an older petrochemical park that is located in the west. The latter consists of older facilities of large Chinese chemical/petrochemical groups that presently operate relatively isolated drawing on close government relations. According to our interviews, producer–user linkages between these older firms and the new developments in the SCIP did not yet exist.

The goal of the SCIP Development Corporation was to develop the area into an integrated site of petrochemical/organic chemical production. Following the FDI-based Pudong model as a development paradigm, it was aimed to transform the park into a hub for the entire chemical industry in Southeast Asia (Zeng and Bathelt 2010). An ethylene cracker formed the heart of the

SCIP producing basic organic chemicals. In selecting new investment projects, the Development Corporation announced to prioritize operations that establish long-term material linkages with other facilities in the park to further process basic chemicals. At the same time, the park pursued an environmental protection strategy to avoid conflict with neighboring communities (Shanghai Chemical Industry Park Development Co. 2007). One of the means used to establish initial trust with new tenants was to engage some of the long-term service providers and suppliers of these new firms in ongoing infrastructure projects.

In 2004, there was only one older Chinese chemical firm in full operation while many JV projects of foreign–Chinese co-leadership were underway, including investments by Air Liquide, BASF, Bayer and BP (Stachels 2005). The structure of the SCIP has changed rapidly, however, since the mid 2000s. In 2006, the park already hosted 14 chemical firms with a combined labor force of 3,250 employees and sales of 29.0 billion Yuan (3.6 billion US-\$) (Shanghai Economic Commission, Shanghai Municipal Statistics Bureau and Shanghai Development Park Association 2007). One of the industry observers suggested that the new investments will result in a chemical labor force of 20,000 people (Bathelt and Zeng 2009).

According to our research, most industrial operations in the SCIP were not closely interlinked with each other or with other regional firms – not generating interactive learning processes similar to those described by Lundvall (1992). The interviews conducted indicated that the firms were still heavily dependent on international corporate networks for supplies of specialty chemicals, know-how and other high-end services. Neither an abundance of local bonding nor intensive trans-local bridging relations were found. Direct linkages of foreign-owned chemical firms with customers in China were limited. Firms that were established as WFOEs tended to ship their products to specialized intermediaries that distributed the products to their user industries. These intermediaries were located in the city cores of Hong Kong or Shanghai.

We can expect that the reliance on such knowledge brokers (Burt 1992) will, at least, slow down the development of localized learning processes due to little direct producer–user interaction. As one manager explained, the decision to invest into a WFOE project was based on former experience in other Chinese regions and the desire to avoid knowledge spillovers to domestic competitors.

The leading engineer of a specialty chemicals producer emphasized that the local operations primarily relied on business with other foreign investors in China: “We have a similar customer structure than we have globally. We have global key accounts ... they stand for forty percent of our, or fifty percent of our turnover. So we have important customers [here] and the same in China. So all these international global key accounts ... are for us the most leading companies ... I would say the major spot is ... the Pearly River Delta; second the Shanghai region.” The manager also emphasized that there was little learning or interaction that took place with customers in China: “The international and global key accounts, they are quite familiar with our products ... as far as they use old technologies they can do it without support ...”.

Our interviews indicated that firms were only partially informed about other investment projects in the SCIP or possibilities for local interaction in the future. Local information flows seemed limited. We expect, however, that information flows through informal networks and producer–user relations will become more pronounced 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, especially since some firms are simultaneously involved in projects with different partners. At the time of our interviews, though, we encountered little “local buzz” in the way described by Storper and Venables (2004). Obviously, new information did not travel easily between the different locations in the region.

6. Discussion: strong economic growth in weakly-developed producer–user networks

This study has identified the enormous growth potential that exists in the “old economy” of the Greater Shanghai region, especially related to the chemical industry. Due the new policy priorities that brought new attention to traditional industry sectors, a new spatial and social division of labor has emerged involving both old and new locations. The analysis of the development of different locations of the chemical industry shows that the recent growth has not resulted in close regional supplier and customer linkages and associated learning processes in important segments of the industry. While numerous studies in other industries also find that close regional collaboration and networks are relatively rare in the Chinese context (Sun 2002; Zhou 2008; Wang C C et al. 2010), other important work has shown that interorganizational and/or interpersonal networks have a positive impact on business success (Ma et al. 2009). Overall, interactive technological learning also seems to be important for innovation in the Chinese context (Miao et al. 2007). To provide a better understanding of the growth potential of the chemical industry in the Greater Shanghai region, we investigated the different practices of producer–user interaction in more detail and were able to distinguish four types of firms according to different investment forms and interaction patterns:

(Type 1) Foreign chemical joint venture (JV) firms. A large part of the sales of these firms depended on contracts with other large foreign firms with whom customer linkages already existed prior to the market entry in China. Another part of their sales was managed by their Chinese JV partners based on pre-existing domestic distribution networks and state relations. Knowledge flows through these partner networks were described as hierarchical and information flowing back to the foreign JV firms as irregular and incomplete. It appeared that neither of these distribution channels provided much additional information regarding innovation. Different from

the findings in the network literature, small and medium-sized local firms were often difficult to access or not viewed as being significant.

The local manager of a large Chinese-German producer of basic/standardized chemicals explained that the firm would export almost half of their products and would sell most of the remainder regionally. He said: “For many of our products we have direct customers here. Often, we also have our international customers here. The first group of customers one can reach are not really the local ones. The first customers ... are international customers who we know from other world regions. They know us – we know them” (translated from German). With respect to domestic customers, he acknowledged having difficulties to get in contact with them: “Very often with small local customers – be in it Shanghai or elsewhere – we are often second choice, because these firms negotiate with local – real local – firms and make business with locals based on local rules. And this is the customer group that is most difficult for us to get access to ... otherwise, we aim to use trader networks to get access to many customers ... but it is the large international ones that ... we are in closest contact with” (translated from German). The manager added with respect to small local customers that “we often do not recognize potential customers, which are normally small customers, because we deal with these firms through traders” (translated from German). Clearly, their Chinese partner did not provide much information about such customers. As such, opportunities to learn specifics about the local or national market were limited, and customization was not a priority – different, for instance, from the observations in von Hippel’s (1976) work.

(Type 2) Wholly foreign-owned enterprises (WFOEs) in the chemical industry. Although many foreign operations originally started as JV firms with Chinese partners, an increasing number switched their strategy later to form WFOEs, particularly in the area of fine and specialty chemicals. These firms did not draw from established market knowledge and, instead, relied to a

great extent on intermediaries and traders, or established foreign and Chinese customers, to distribute their products to users. These intermediaries operated as knowledge brokers, connecting different sets of agents that operated in different network configurations (Burt 1997). In line with recent work of Burt (2005), such structural holes were not automatically positive: Some had negative effects, especially, if the knowledge brokers cashed in on their knowledge monopoly while keeping the social worlds they connected separate. In this case, the structural holes stayed “active” (Burt 2005) controlled by bridging relations between the producers and users. As a consequence, closer ties were not established and opportunities for innovation did not emerge (see, also, Wei et al. 2011).

This is exemplified by a German producer of both standardized and specialized chemicals. A leading manager and technical expert who was familiar with the market for several years explained that the firm was strongly dependent on existing international customers, as well as distributors located in the Hong Kong region: “I only know few, usually very large Chinese firms that are present in international markets. This is due to the fact that we have viewed the Chinese market as an import market in the past in which we entered from outside – and not all Chinese producers were able to import directly ... They had to be able to do business on a US dollar basis and needed corresponding import–export permissions by the government. All other customers are served through so-called traders or distributors ... The trace to a large part of the market gets lost very quickly for us. This is because the Chinese market was organized in such a way that we had no opportunity to bring the products directly to our Chinese customers” (translated from German). The firm nonetheless decided against engaging in a JV with a Chinese partner firm because they wanted to avoid unintended knowledge transfers and internal conflict – something they experienced earlier. The manager was aware that “this is probably not a very modern structure in the future in such an explosively growing and booming market” (translated from German).

The general manager of another specialty chemicals producer emphasized that it was difficult to make new contacts in a market where customer relations with local firms would be governed by personal relationships. The manager – who had studied Chinese culture and philosophy – explained the limitations he experienced in the firm’s activities as follows: “But it always stayed anyhow a kind of indirect approach, because as you know there is *guanxi*. The personal relationship in China is quite important, so we need still the distributors and we do not want to invest into 200/300 guys [of our] own sales force ... We would not have this personal relationship and would partly not be able to cover the industry [ourselves] ... [In contrast,] for the multinational companies and also for managing the distributors, we have our own sales force; and for the small companies that are not so huge, we cannot afford to approach them directly.”

Due to insufficient market transparency, high market uncertainty and a lack of being able to stimulate *guanxi* networks, firms of this type did not develop close producer–user linkages. They benefited little from direct customer feedback in their product development. Instead, the firms interviewed relied on intermediaries or knowledge brokers located in Shanghai, Shenzhen or Hong Kong to distribute their products.

(Type 3) Small and medium-sized Chinese chemical firms. The firms of this type operated in specialty chemicals markets in which production did not depend on economies of scale. Although they engaged in close customer relations with selected partners, these were often based on pre-existing personal networks or *guanxi* that developed during their studies or former collaborations. Otherwise, they also drew on contacts with traders that were located in the Shanghai and Guangdong provinces. Similar to their foreign counterparts, several firms did not have regular ongoing contacts with a wide range of customers. According to our interviews, their innovation activities had slowed down after the start-up phase. Their business focus was on adjusting products and technologies to few large customers.

The CEO and founder of a Chinese producer of specialty chemicals – who had returned from studies and former employment in Canada – was skeptical about the reliability of Chinese firms as compared to foreign firms. He said that it would be difficult to commit the local Chinese firms to joint projects. Due to past experience, the firm was hesitant in establishing close customer relations in the region. The interviewee had the impression that there was too much imitation and “idea theft” going on, as firms competed in similar markets. Customer relations were based on private contact networks that were originally non-economic in nature, based on joint work or alumni relations. Other contacts were made through relations with municipal and other state organizations which had proven to be helpful.

Similar to their foreign competitors, technological learning based on close interaction with customers was also underdeveloped in the case of small Chinese chemical firms. This was surprising at first, yet it fit with observations made in other industries in Shanghai (Zeng and Wen 2004). Overall, this left little room for the form of interactive experience-based innovation that Gertler (2004) explores in the machinery industry, be it through bonding or bridging relations.

(Type 4) Large Chinese chemical groups that developed from state-owned conglomerates.

The operations of these firms, of which we interviewed only few, focused on basic chemicals and related products. The firms depended on close industry–state linkages, which had existed for a long time, and distribution channels that were controlled or organized by the state. They had few incentives to engage in close producer–user interaction and related innovation as suggested in the innovation literature. Our impression was that the distribution channels of these firms were similar to strong rigid ties with little outside information entering or explicit learning taking place. In our sample, not even the major Chinese chemical producers engaged in intensive direct exchanges with their user industries or actively looked for new market segments.

In sum, the results of this research left us puzzled. Although the chemical industry in the Yangtze Delta region grew substantially since the late 1980s, this was not driven by the establishment of intensive producer–user networks and associated interactive learning processes (von Hippel 1976; Lundvall 1992). Drawing on conceptions developed by social network theorists we had expected that wide, diversified social networks with suppliers, customers, competitors and/or state agencies would stimulate interactive learning and adjustments in production and result in superior business performance (Granovetter 1973; 1985; Burt 1992; 1997). The results of our explorative study in different sub-regions of the Greater Shanghai region, however, demonstrated that chemical operations were typically not intensively interlinked with one another or with other regional and national firms. Of course, not all firms behaved in such a way or confirmed the typology described above. However, three quarters of our interview firms clearly fit into one of the four types discussed. While we did expect to find such patterns in the case of foreign subsidiaries and branches, we were surprised that even Chinese firms did not systematically establish intensive producer–user networks and, instead, relied on distributors or traders that operated as knowledge brokers.

This seeming paradox of substantial economic growth despite weakly-developed producer–user networks – and its consequences from a policy perspective – require further elaboration in the final section of this paper.

7. Conclusions

While the chemical industry has experienced substantial growth and expansion over the past two decades, an important question is whether this process has generated favorable conditions for long-term economic growth and innovation. Although our study is largely explorative and deals with a limited sample size, it involves some of the most important

international and numerous national chemical corporations and – based on our interviews with experienced managers and industry observers – captures important trends in the industry regarding the developing spatial and social division of labor: First, some foreign chemical firms in Shanghai depend on networks with customers that have existed prior to their market-entry in China. These linkages seemingly provide few additional learning impulses. Second, other firms also rely on state-controlled distribution networks organized through their Chinese JV partners. Such linkages are hierarchical in nature and do not always provide detailed knowledge feedbacks to the foreign partners. Third, foreign WFOEs, at least partially, rely on networks with intermediaries or traders which are located in Shanghai, Hong Kong or Shenzhen. Such distribution networks typically do not involve direct user contact or regular feedback. In most of the cases, the various intermediaries, Chinese JV partners or state organizations operate – be it consciously or unconsciously – as knowledge brokers in the sense of Burt (1992; 2005) connecting otherwise unconnected producers with their users. However, these brokers block interaction between producer and user groups and hinder fine-grained information flows that could provide an important basis for future market access, customization or innovation. This has substantial implications in the context of the Pudong business model (Wang 1996) that depends on FDI to stimulate regional growth. Yet, our study also shows that such linkage patterns are not limited to foreign firms.

Some observers might wonder why this would be a problem as the chemical industry and most of its firms have experienced strong growth since the 1990s. There are two concerns associated with this development that cannot be ignored as they question the self-sustained character of this growth in the future: First, many firms are successful because they benefit from a fast-growing market even if they employ less efficient technologies and routines. The overall growing market over-powers the market selection mechanisms according to which cost-efficient,

customer-responding and innovative firms would be the most successful. Second, the lack of broad producer–user interaction across broader market segments suggests that firms have limited knowledge about the specific needs of their users, do not learn systematically from customer feedback and leave out opportunities to explore new markets niches. Although we expect that ongoing learning and related modification and customization processes will become more important for chemical firms to survive in the future, such processes are presently not well developed.

What are the policy conclusions from this? Overall, our findings have identified a puzzle to be solved by regional policy makers. The above analysis suggests that regional policy initiatives are important and necessary despite the strong economic growth in recent years. The danger of this is that a globally – in corporate structures – embedded, yet locally and/or nationally de-linked industry structure could develop in the region, similar to the situation found in the Suzhou IT sector (Wang and Lee 2007). Through this, broader positive triggers in the regional economy and labor market would be unlikely to unfold. Although the Shanghai chemical industry has some elements of such a “hollow cluster” structure, that is primarily outward-looking with little internal glue (Bathelt, Malmberg and Maskell 2004), it also differs from this in some respects: First, massive efforts are underway in institution-building, for instance in the context of the SCIP, aiming to embed the chemical industry in the region (Zeng and Bathelt 2009). Second, the industry’s development in Shanghai is, to a large extent, driven by the growing Yangtze Delta markets, and the breadth and skill levels in the regional labor market, rather than just by labor costs.

To solve the identified puzzle will require explicit policy attention. To support long-term prospects for economic growth, policy makers should provide incentives for foreign and domestic chemical firms to develop producer–user networks with one another and extend these to their

suppliers and customers in other cities and regions. Furthermore, incentives should be developed to support the establishment of R&D facilities, safeguard the protection of firm-specific knowledge and encourage interorganizational research to trigger long-term innovation and economic growth. In short, regional policy should actively support the establishment of combined “bonding” and “bridging” relations, as well as close local and trans-local linkages between chemical producers and their user industries.

Acknowledgements

In conducting this study, we received superb research support from Heiner Depner, Ulrich Dewald, Nicole Kogler, Fei Li, Pengfei Li, Yuefang Si, Peter Süß, Fei Wang, Qin Xiao and Carolin Zimmer, 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 further indebted to the Editors and Reviewers, particularly Yehua Dennis Wei, for their support and encouragement. This research was, in part, supported by the National Natural Science Foundation of China, East China Normal University and the Canada Research Chair program of the Social Sciences and Humanities Research Council of Canada.

References

- Bathelt H 1997 *German chemical industry: technological change, the division of labor and geographical structure* Edition Sigma, Berlin (in German)
- Bathelt H 2006 Geographies of production: growth regimes in spatial perspective 3 – toward a relational view of economic action and policy *Progress in Human Geography* **38** 223-236
- Bathelt H Malmberg A and 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 and Zeng G 2009 Against the new economy? The changing social and spatial divisions of labor in the larger Shanghai chemical industry *SPACES online* **7** (2009-03) Toronto, Heidelberg, www.spaces-online.com
- Burt R 1992 *Structural holes: the social structure of competition* Harvard University Press, Cambridge MA
- Burt R 1997 The contingent value of social capital *Administrative Science Quarterly* **42** 339-365
- Burt R S 2002 Bridge decay *Social Networks* **24** 333-363
- Burt R S 2005 *Brokerage and closure: an introduction to social capital* Oxford University Press, Oxford
- Chapman K and Edmond H 2000 Mergers/acquisitions and restructuring in the EU chemical industry: patterns and implications *Regional Studies* **34** 753-767
- Cheng J and Bennett D 2007 Success strategies in the Chinese chemical industry: a survey and case study investigations *Journal of Chinese Economic and Business Studies* **5** 91-112
- China Petroleum and Chemical Industry Association 2006 Report on the outline of the eleventh five-year plan for the chemical industry technology in China *Zhongguo Shiyou He Huagong Biaozhun Yu Zhiliang (China Petroleum and Chemical Standard and Quality)* **2** 3-7 (in Chinese)
- Cao Y Qian Y and Weingast B R 1999 From federalism, Chinese style to privatization, Chinese style *Economics of Transition* **7** 103-131
- Coleman J 1988 Social capital in the creation of human capital *American Journal of Sociology* **94** (supplement) S95-S120
- Cooke P and Morgan K 1998 *The associational economy* Oxford University Press, Oxford

- Depner H and Bathelt H 2005 Exporting the German model: the establishment of a new automobile industry cluster in Shanghai *Economic Geography* **81** 53-81
- Dunning J H 1988 The eclectic paradigm of international production: a restatement and some possible extensions *Journal of International Business Studies* **18** 1-31
- Eisenhardt K M 1989 Building theories from case study research *Academy of Management Research* **14** 532-550
- Ettlinger N 2003 Cultural economic geography and a relational and microspace approach to trusts, rationalities, networks, and change in collaborative workplaces *Journal of Economic Geography* **3** 145-172
- Fan P 2006 Catching up through developing innovation capability: evidence from China's telecom-equipment industry *Technovation* **26** 359-368
- Festel G and Geng Y 2005 Chemical industry parks in China in Festel G Kreimeyer A Oels U and von Zedtwitz M eds *The chemical and pharmaceutical industry in China: opportunities and threats to foreign companies* Springer, Heidelberg 53-62
- Gertler M S 2004 *Manufacturing culture: the institutional geography of industrial practice* Oxford University Press, Oxford, New York
- Giese E and Zeng G 1993 Regional aspects of the opening policy in the PR China *Geographische Zeitschrift* **81** 176-195 (in German)
- Giese E and Zeng G 1997 Economic development and international linkages in the PR China *Geographische Rundschau* **49** 708-716 (in German)
- Glückler J 2004 *Reputation networks and the internationalization of the consulting industry: a relational theory* Bielefeld, Transcript (in German)

- Glückler J 2006 A relational assessment of international market entry in management consulting
Journal of Economic Geography **6** 369-393
- Granovetter M 1973 The strength of weak ties *American Journal of Sociology* **78** 1360-1380
- Granovetter M 1985 Economic action and economic structure: the problem of embeddedness
American Journal of Sociology **91** 481-510
- Hall P A and Soskice D 2001 An introduction to varieties of capitalism in Hall P A and Soskice
D eds *Varieties of capitalism: the institutional foundations of comparative advantage*
Oxford University Press, Oxford, New York 1-68.
- Hong L 2004 Chongqing: opportunities and risks *The China Quarterly* **178** 448-466
- Hu A G Z and Jefferson G H 2002 FDI impact and spillover: evidence from China's electronic
and textiles industries *World Economy* **25** 1063-1076
- Hui C S 2007 What's the buzz about Asia? *ICIS Chemical Business Americas* **271** (1) 26-27
- Jiangsu Bureau of Statistics 1988 - 2007 *Jiangsu statistical yearbook* China Statistics Press,
Beijing (in Chinese)
- Kern H 1996 Loss of trust and blind confidence: integration problems in economic action *SOFI-*
Mitteilungen 24/1996 7-14 (in German)
- Kim J Y and Zhang L Y 2008 Formation of foreign direct investment clustering: a new path to
local economic development? *Regional Studies* **42** 265-280
- Krumberger O 2005 Establishing a competitive production network in Asia in Festel G
Kreimeyer A Oels U and von Zedtwitz M eds *The chemical and pharmaceutical industry*
in China: opportunities and threats to foreign companies Springer, Heidelberg 171-179

- Lin L 2007 *Technology transfer and location decisions of high-tech enterprises – the case of the Zhangjiang hi-tech park, Shanghai* PhD thesis Department of Human Geography, East China Normal University, Shanghai (in Chinese)
- Lu J and Ma X 2008 The contingent value of local partners' business group affiliation *The Academy of Management Journal* **51** 295-314
- Lundvall B-Å ed 1992 *National systems of innovation: towards a theory of innovation and interactive learning* Pinter, London
- Ma X Yao X and Xi Y 2009 How do interorganizational and interpersonal networks affect a firm's strategic adaptive capability in a transition economy? *Journal of Business Research* **62** 1087–1095
- Malmberg A and 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
- Miao C-H Wei Y H D and Ma H 2007 Technological learning and innovation in China in the context of globalization *Eurasian Geography and Economics* **48** 1-20
- Miles M B and Huberman A M 1994 *Qualitative data analysis: an expanded sourcebook* 2nd edition Sage, Thousand Oaks CA
- Mu J 2006 *Research on the spatial structure of the petrochemical industry in the Yangtze Delta region* Masters thesis Department of Human Geography, East China Normal University, Shanghai (in Chinese)

Mueller H 2005 Activities of European chemical companies in China in Festel G Kreimeyer A

Oels U and von Zedtwitz M eds *The chemical and pharmaceutical industry in China: opportunities and threats to foreign companies* Springer, Heidelberg 23-46

National Bureau of Statistics of China 1988 - 2005 *China statistical yearbook* China Statistics Press, Beijing (in Chinese)

National Bureau of Statistics of China 1998 *China labour statistical yearbook 1998* China Statistical Publishing House, Beijing (in Chinese).

National Bureau of Statistics of China 2006 *China statistical yearbook 2006* China Statistics Press, Beijing (<http://www.stats.gov.cn/tjsj/ndsj/2006>) Accessed 17 June 2007 (in Chinese)

National Bureau of Statistics of China 2007a *China labour statistical yearbook 2007* China Statistical Publishing House, Beijing (in Chinese)

National Bureau of Statistics of China 2007b *China statistical yearbook 2007* China Statistics Press Beijing (in Chinese)

Olds K 1997 Globalizing Shanghai: the “global intelligence corps” and the building of Pudong *Cities* **14** 109-123

Oliver A L Kalish Y and Yair G 2007 Reflections on ‘Brokerage and Closure’ *Social Networks* **29** 330-339

Owen-Smith J and Powell W W 2004 Knowledge networks as channels and conduits: the effects of spillovers in the Boston biotechnology community *Organization Science* **15** 2-21

Perlitz U 2005 *Chemical industry in China: overtaking internationally* Deutsche Bank Research – Aktuelle Themen 333: China Spezial, Frankfurt/Main (in German)

- Porter M E 1990 *The competitive advantage of nations* The Free Press, New York
- Saxenian A 2006 *The new argonauts: regional advantage in a global economy* Harvard University Press, Cambridge MA
- Scott A and Ramesh D 2007 Fine chemicals in China *Chemical Week* **169** (35) 17-19
- Shanghai Bureau of Statistics 1988 - 2007 *Shanghai statistical yearbook* China Statistics Press, Beijing (in Chinese)
- Shanghai Chemical Industry Park Development Co. 2007 *Shanghai Chemical Industry Park* Shanghai (<http://www.scip.com.cn>) Accessed 29 May 2007
- Shanghai Economic Commission Shanghai Municipal Statistics Bureau and Shanghai Development Park Association 2007 *Shanghai development park statistical manual 2007* Shanghai (in Chinese)
- Silverman D 2001 *Interpreting qualitative data: methods for analysing talk, text and interaction* 2nd edition Sage, London
- Stachels E 2005 Bayer – a multinational committed to China in Festel G Kreimeyer A Oels U and von Zedtwitz M eds *The chemical and pharmaceutical industry in China: opportunities and threats to foreign companies* Springer, Heidelberg 181-188
- Storper M and Venables A J 2004 Buzz: face-to-face contact and the urban economy *Journal of Economic Geography* **4** 351-370
- Sun J and Gu C 2004 Development of the area along the Yangtze River in Jiangsu *Resources and Environment in the Yangtze Basin* **13** (5) 403-407
- Sun Y 2002a China's national innovation system in transition *Eurasian Geography and Economics* **43** 476-492

- Sun Y 2002b Sources of innovation in China's manufacturing sector: imported or developed in-house? *Environment and Planning A* **34** 1059-1072
- Sun Y and Wen K 2007 Uncertainties, imitating behaviors and foreign R&D locations: explaining the over-concentration of foreign R&D in Beijing and Shanghai within China *Asia Pacific Business Review* **13** 405-424
- Tan C 2003 In the park ACN: *Asian Chemical Network* July 15-16
- Tan J 2006 Growth of industry clusters and innovation: lessons from Beijing Zhongguancun Science Park *Journal of Business Venturing* **21** 827-850
- Uzzi B 1996 The sources and consequences of embeddedness for the economic performance of organizations: the network effect *American Sociological Review* **61** 674-698
- Uzzi B 1997 Social structure and competition in interfirm networks: the paradox of embeddedness *Administrative Science Quarterly* **42** 35-67
- von Hippel E 1976 The dominant role of users in the scientific instrument innovation process *Research Policy* **5** (3) 212-239
- Wang C C 2010 *Understanding China's ICT industry: state-firm strategic coordination and the geography of technological innovation* PhD thesis Department of Geography, University of Hong Kong, Hong Kong
- Wang C C Lin G C S and Li G 2010 Industrial clustering and technological innovation in China: new evidence from the ICT industry in Shenzhen *Environment and Planning A* **42** 1987-2010
- Wang J et al. (2010) *Beyond clusters: theoretical exploration of industrial clusters in China* Science Press, Beijing (in Chinese)

- Wang J H and Lee C K 2007 Global production networks and local institution building: the development of the information-technology industry in Suzhou, China *Environment and Planning A* **39** 1873-1888
- Wang L 2005 *Analysis of cluster firms started up with overseas Chinese and other foreign capital* PhD thesis Department of Human Geography, East China Normal University, Shanghai (in Chinese)
- Wang X 1996 The basis of the Pudong model of development: from land to tax reference *Explorations and Free Views* 1996 (1) 45-46 (in Chinese)
- Wei Y H D Li W and Wang C 2007 Restructuring industrial districts, scaling up regional development: a study of the Wenzhou model, China *Economic Geography* **83** 421-444
- Wei Y H D Lu Y and Chen W 2009 Globalizing regional development in Sunan, China: does Suzhou industrial park fit a neo-Marshallian district model? *Regional Studies* **43** 409-427
- Wei Y H D, Zhou Y, Sun Y, Lin G 2011 Production and R&D networks of foreign ventures in China: Implications for technological dynamism and regional development. *Applied Geography* **31** in press
- 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 Reflection and response: choosing the way to Chinese industrialization *Academic Monthly* 2005(12) 38-45 (in Chinese)
- Xu Q 2006 Structure and trends in the petrochemical industry in the Yangtze Delta region *Shanghai Chemical Industry* **31**(7) 1-3 (in Chinese)

- Yang D Y-r Hsu J-y and Chin C-h 2009 Revisiting the silicon island? The geographically varied 'strategic coupling' in the development of high-technology parks in Taiwan *Regional Studies* **43** 369-384
- Yeung H W-c 2009 Regional development and the competitive dynamics of global production networks: an East Asian perspective *Regional Studies* **43** 325-351
- Yeung H W-c and Lin G C-s 2003 Theorizing economic geographies of Asia *Economic Geography* **79** 107-128
- Zeng G 2000 The financial crisis in Asia and the modification of economic structure in Shanghai *Asian Geographer* **19** 37-48 (in Chinese)
- Zeng G 2001 Research on the modification of industrial spatial distribution in Shanghai *Geographical Research* **20** (3) 330-337 (in Chinese)
- Zeng G and Bathelt H 2010 Divergent growth trajectories in China's chemical industry: the case of the newly developed industrial parks in Shanghai, Nanjing and Ningbo *GeoJournal* **60** forthcoming
- Zeng G and Wen H 2004 A study on the IT industrial cluster in Pudong area, Shanghai *Acta Geographica Sinica* **59** (supplement) 59-66 (in Chinese)
- Zhejiang Bureau of Statistics 1988 - 2007 *Zhejiang statistical yearbook* China Statistics Press, Beijing (in Chinese)
- Zhou Y 2007 *The inside story of China's high-tech industry: making Silicon Valley in Beijing* Rowman & Littlefield, Lanham MD
- Zhu Y-f 2003 Discussion on structure adjustments of China's chemical industry in the 21st century *Hebei Journal of Industrial Science & Technology* **20** (5) 1-5 (in Chinese)

Table 1: Profiles of the chemical firms interviewed in Greater Shanghai, 2001 - 2007

Interview number	Year when interview was conducted	Year when firm was established in Shanghai	Chemical branch	Ownership	Employees at time of interview
1	2001	Early 1990s	Chemical fibers	Chinese-German	150
2	2001	1997	Chemicals/pharmaceuticals	German	50
3	2001	Early 1990s	Chemical fibers	Chinese-German	150
4	2003	Early 1990s	Specialty chemicals	German	500
5	2003	N/A	Organic chemicals	Chinese-German	N/A
6	2004	Early 1990s	Specialty chemicals	German	500
7	2004	1949	Basic chemicals	Chinese	10,000
8	2004	1949	Petrochemicals	Chinese	10,000
9	2004	2003	Specialty chemicals	German	100
10	2005	2001	Carbon chemical	Chinese	70
11	2005	2002	Chemicals/pharmaceuticals	Chinese	15
12	2005	2004	Specialty chemicals	Chinese	50
13	2005	2000	Specialty chemicals/coatings	German	400
14	2005	Early 1990s	Specialty chemicals	German	500
15	2005	1997	Specialty chemicals/coatings	Swiss	70
16	2005	1994	Organic chemicals/coatings	German	850
17	2006	Late 1990s	Organic chemicals	US	N/A
18	2005	Mid 1990s	Specialty chemicals	German	150
19	2005	1996	Specialty chemicals	South African	150
20	2005	N/A	Organic/specialty chemicals	Chinese	1,000
21	2007	2005	Chemical research	German	50
22	2007	Early 1990s	Specialty chemicals	German	500

Note: N/A = not available

Table 2: Gross production value of the chemical industry in the Yangtze Delta region, 1987 - 2005 (Sources: 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)

Year	Gross production value of the chemical industry (in billion Yuan)				China
	Shanghai province	Jiangsu province	Zhejiang province	Yangtze Delta region	
1987	17.44	20.74	8.50	46.68	193.84
1990	26.88	40.58	16.54	84.00	325.76
1995	70.11	128.53	58.77	257.41	955.67
1998	92.06	155.97	85.15	333.18	1142.02
2000	120.50	210.65	129.84	460.99	1623.31
2005	264.00	593.35	447.55	1304.90	4248.36

Note: 1 US-\$ = 8 Yuan

Table 3: Regional distribution of chemical industry employment in China, 1997 and 2006 (Sources: National Bureau of Statistics of China 1998; 2007a)

Province	Share of national employment (%)		
	1997	2006	Difference 1997-2006
Shandong	7.8	9.9	2.1
Guangdong	5.4	7.7	2.3
Jiangsu	7.9	7.4	-0.5
Zhejiang	3.9	6.6	2.7
Henan	6.0	5.6	-0.4
Liaoning	8.3	5.4	-2.9
Hebei	5.1	4.8	-0.3
Fujian	2.8	4.5	1.7
Hubei	4.6	4.0	-0.6
Sichuan	3.8	3.9	0.1
Shanxi	3.7	3.8	0.1
Heilongjiang	3.8	3.8	0.0
<i>Shanghai</i>	<i>3.7</i>	<i>3.6</i>	<i>-0.1</i>
Hunan	4.3	2.9	-1.4
Beijing	2.2	2.6	0.4
Tianjin	2.6	2.5	-0.1
Anhui	3.5	2.3	-1.2
Shaanxi	1.9	2.3	0.4
Jilin	4.0	2.2	-1.8
Jiangxi	2.4	2.1	-0.3
Gansu	1.8	1.9	0.1
Guangxi	1.8	1.8	0.0
Yunnan	1.7	1.7	0.0
Guizhou	1.1	1.6	0.5
Chongqing	2.2	1.4	-0.8
Xinjiang	1.0	1.3	0.3
Inner Mongolia	1.5	1.1	-0.4
Ningxia	0.6	0.6	0.0
Qinghai	0.3	0.4	0.1
Hainan	0.3	0.3	0.0
Tibet	0.0	0.0	0.0
Chinese total	100.0	100.0	-
(number of employees)	(7,870,000)	(5,002,000)	-

Table 4: Share of gross production value in the Yangtze Delta Region of the Chinese total by chemical branch 2006 (Sources: Jiangsu Bureau of Statistics 2007; National Bureau of Statistics of China 2007b; Shanghai Bureau of Statistics 2007; Zhejiang Bureau of Statistics 2007)

Chemical branch	Share of the Chinese gross production value (%)				China
	Shanghai	Jiangsu	Zhejiang	Yangtze Delta region	
Raw chemical materials and chemical products	6.5	19.3	7.7	33.5	100.0
Medical and pharmaceutical products	4.7	10.5	9.7	24.9	100.0
Chemical fibers	1.5	31.2	38.7	71.4	100.0
Rubber products	5.7	12.8	10.2	28.7	100.0
Plastic products	6.2	12.7	17.6	36.5	100.0
Petroleum processing, coke products and processing of nuclear fuels	6.1	5.1	5.5	16.7	100.0

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