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Return Migration in Regional Innovation Systems[1)]

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Summary

This study aims to explore and understand the role of return migrants in the regional innovation system of a transition economy (China) by analyzing the activities of returning entrepreneurs in two emerging high-tech industries in Shanghai. The empirical analysis is based on in-depth interviews with founders of high-tech companies and experts in Shanghai.

The results of the analysis reveal that return migrants are a significant factor for the Shanghai innovation system, which is presently in a transition from a former manufacturing site to a metropolitan region comprising a range of industries (including high-tech) and services.

First of all, return migrants are important for the Shanghai RIS in terms of numbers. Second, they engage in activities in the medium range of high-tech which reflects prevailing weaknesses of the framework conditions for innovation in Shanghai. However, due to their international background, returning entrepreneurs are able to overcome these weaknesses, and thus contribute to the development of high-tech industries in Shanghai and to a reduction of the technological lock-in.

Key words: regional innovation system, entrepreneurship, China, return migration, Shanghai

1. Regional Innovation Systems and Other Kinds of Innovation Systems

It is undisputed these days that the configuration of space and characteristics of place have a role to play in the question of who innovates, where, how much and why. In view of the

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crucial role of innovativeness for national and regional competitiveness in all economies (regional economies as well as national or supra-national economies) in industrialised and emerging countries, it is no great surprise that regional attributes receive a great deal of attention, in scientific studies both of the causes of firm growth or regional growth (spatial turn in economics) and of the effects of innovative behaviour. Howells (1999) gives a good overview of the arguments in favour of the significance of the region for innovation processes. The most important factors to be mentioned in this respect are knowledge spillovers, which are most effective over short distances (see Bottazzi and Peri, 2003), the similarly distance-sensitive transfer of tacit knowledge (see Howells, 2002) and continually significant differences in innovation intensity between regions.

It was therefore a logical consequence that, after the propagation of National Innovation Systems (NIS), in particular by the seminal works of Lundvall (1992) and Nelson (1993), the equivalent at the regional level, the Regional Innovation System (RIS, see Cooke, Braczyk and Heidenreich 2004), would be created some time later. Both concepts acknowledge the systemic character of innovation processes, although they are often not defined unambiguously and are restricted to naming the system elements (e.g., actors, organisations) and their interrelationships (Tödtling and Trippl, 2005). In addition, RISs and NISs together represent the rejection of the linear model of innovation (invention-innovation, in the narrower sense, -diffusion), as is/was dominant in the neo-classical innovation theory and growth theory, and the emphasis of the chain-linked model of the innovation process. The knowledge-based approach is confirmed by empirical research and states that space is a significant factor in innovation as - spatially varyingly distributed - innovating firms are not isolated actors (Rutten and Boekema, 2004). Principles of evolutionary economics understandably are also highly significant in both concepts of innovation systems, in particular in the explanation of knowledge creation and innovation behaviour in a spatial system including firms, universities, government agencies in different regions (see Edquist, 2001).

Quite clearly, there are more scales of innovation than merely the national and regional scales (see also Bunnell and Coe, 2001). Alongside RISs and NISs, some authors therefore also mention International Systems of Innovation (Fromhold-Eisebith, forthcoming), and the continental scale (continental innovation system) doubtless should also not be ignored. Oinas and Malecki (2002, 1998) emphasise that the debate on innovation systems should be expanded to include Spatial Innovation Systems (SIS), which are at home in more than one location and which can explain the technology-specific character of innovation development and diffusion better than NISs and RIS alone. In addition to territorial innovation system concepts there are also sectoral innovation systems and technological innovation systems (Malerba, 2002).

In view of the variety of definitions of RISs, the terms used in this paper and their intended

meanings should be explained. An innovation system, after Lundvall (1992, 2), is "constituted by elements and relationships which interact in the production, diffusion and use of new, economically useful, knowledge". After Koschatzky (2001, 177), "regional" refers to spatial units below the macro-level of nations which enjoy sufficient autonomy to formulate and implement policy independently of the national level. This makes it clear that not every region qualifies as a RIS.

Empirical studies of regional innovation systems mostly focus on intraregional linkages, especially on formal R&D. Extra-local networks and linkages have so far been examined only very seldom (Bunnell and Coe, 2001). There are several kinds of deficiencies of RISs in different types of regions (e.g., Cooke, Braczyk and Heidenreich, 2004). The differentiation in old industrial regions, peripheral regions and fragmented metropolitan regions in particular is helpful for the purposes of this paper (see Tödtling and Trippl, 2005). Empirically well-founded barriers within RISs are organisational thinness (lack of relevant local innovative actors), fragmentation (lack of intra-regional co-operation and trust) and lock-in effects (if regional industry is specialized in outdated technologies) (see Isaksen, 2001). Policies to establish or regenerate RISs therefore need to address these problems in particular.

The concept of the RIS has been the target of a wide range of criticism, both from a conceptional-theoretical point of view and on the basis of empirical studies. The core weaknesses of the RIS concept include an excessive fixation on the high-tech sector and / or successful regions, the lack of clear geographical boundaries of a RIS and the mixing with other concepts of spatially differentiated innovations (e.g., industrial districts, embeddedness concept, learning regions, clusters) (see Doloreux, 2002; Oinas and Malecki, 2002). In addition to that, empirical studies on the connections between RIS actors focus to a very large extent on standardised indicators of innovation activities (patent data, R&D employment or expenditures) and - if extra-local connections are taken into account at all - on MNCs. However, individuals play an important role for RIS as well because their personal networks function as connectors between different RIS. The term "individual" includes migrants coming to the RIS and entrepreneurs located within the RIS (see Bunnell and Coe, 2001; Oinas and Malecki, 2002). Beyond their networks, entrepreneurs are a very important factor for RIS - an aspect which has largely been neglected by research so far. Furthermore, the majority of studies concentrates on RISs in industrialized countries in Western Europe or North America (exceptions include Fromhold-Eisebith 2004; Radosevic 2002 and Wong, forthcoming). In particular, there has been very little research to date on Chinese innovation systems (e.g., Wang, 1998 for Zhong' guancun in Beijing; Chang and Shih, 2004).

This paper intends to fill some of these research gaps. To this end, section two will attempt to illuminate the specific role of migrants, and of entrepreneurship by return migrants in particular, for RIS. The empirical section of the paper investigates the role of returning entrepreneurs for the Shanghai RIS, based on an analysis of Chinese return migrants in the biotechnology and in the electronics industry.

2. Why External Connections are Relevant for Regional Innovation Systems - and What are the Potential Functions of Returning Entrepreneurs?

The current phase of economic globalisation does not signify the "death of distance", nor does it signify the irrelevance of intraregional innovation linkages or the dominance of NISs (or continental innovations systems) over RISs (see also Howells, 2002). Rather, globalisation and regionalisation are two sides of the same coin and they are interdependent. For RISs in particular, this means that they are related to other RISs in the same nation - but also to RISs in other countries and to innovation systems of other scales (NIS, continental innovation systems). The Shanghai RIS, for example, is in an interdependent relationship with both the Beijing RIS (the other major Chinese metropolis of worldwide significance) and the China NIS, and with an East Asia (sub)continental innovation system. Unfortunately, inter-scale research on innovation systems is, rather rare, although some work on the relationship between different levels of innovation systems does exist (see Fromhold-Eisebith, forthcoming).

This leads to the question of how knowledge flows beyond the boundaries of innovation systems. Howells (2002) differentiates between three ways: via patent data analysis (e.g., Jaffe 1989), trade with knowledge-intensive products (e.g., Feldman, 1999) and, perhaps most important in our context, the mobility of highly-qualified labour/individuals. The work of Florida (2002) on the geography of talents as well as empirical research on the correlation between high-tech industries and the location of star scientists (e.g., Zucker, Darby and Brewer, 1997) are particularly relevant in this respect. These studies show that personal preferences, such as for a particular regional "climate" or environment (soft locational factors) influence the migration of creative people to an enormous extent. Creative people who migrate may be self-employed or in a dependent employment relationship; the former is more interesting for our topic for two reasons. First, only the self-employed can take innovation-related decisions independently. Second, entrepreneurs are very important for RISs. The neglect of entrepreneurship in the RIS concept is astonishing, since the economic and innovational relevance of this segment of the economy has been the

subject of much research in recent years. This research has shown that entrepreneurial activities (defined as start-up activities) may have significant effects on national growth. Recent inter-country comparisons based on data from the Global Entrepreneurship Monitor (GEM) show that growth-oriented entrepreneurial start-ups in particular (so called "opportunity entrepreneurship") influence the economic development of nations (Wong, Ho and Autio, 2005; van Stel, Carree and Thurik, 2005). There has been less empirical work on growth effects at the subnational level, but the amount of work has increased considerably in recent times (cf. for example the special issue of "Regional Studies", No. 8, 2004, and, in particular, Fritsch and Mueller(2004 therein). They demonstrate that entrepreneurial activities are to a large extent a "regional event" (Feldman, 2001). Local and regional determinants are much more relevant than national or supranational framework conditions. This is true both for determinants that have an impact on an individual's decision to start a new business and for determinants that exercise an influence on a start-up's success (survival, growth).

Entrepreneurship by start-ups is mostly a regional phenomenon, as entrepreneurs generally come from the same region where they establish their start-up. If, however, there is an international background, as in the case of start-ups by return migrants, this can have very strong positive effects for the RIS in which the entrepreneur establishes his start-up.

We intend the term "entrepreneurship by return migrants", the main focus of the empirical part of this paper, to be understood to refer to entrepreneurs who have returned to their country of origin after many years abroad (e.g. for purposes of studying or self-employment). This may be, but need not be, the home region of the entrepreneur. It is more important that the country of origin is behind the target country of the (first) migration in economic and technological terms. In most cases, therefore, this means a migration from a developing or emerging country to an industrialised country.

Return migrants are at home in at least two countries. If they settle in their country of origin, they generally benefit from their experience abroad - to the advantage of their start-up and of the RIS to which they then belong. In business terms, start-up companies benefit in many ways. First, the entrepreneurs have knowledge of the national and the regional market in the former host country and in their home country. Second, they benefit from innovation linkages to individuals, research organisations and innovative firms in the former host region and therefore remain up-to-date as far as research and development is concerned. Their knowledge in this area is certainly greater than in the developing or emerging country to which they have returned. Compared with entrepreneurs (and start-ups) in high-tech regions of industrialised countries, they benefit from being able to use the specific advantages of a developing country in an international context

(low-cost production of goods, but also low-cost applied research). Overall, to speak in the words of Storper and Walker (1989), they use "windows of locational opportunity" to develop their specific competencies, experiences and capabilities as well as networks in a region of a country into marketable products, which they would be less able to do successfully in other countries and regions as they would not have the necessary knowledge of the regional environment. This is particularly true in the case of the Chinese who are traditionally active in other countries. The traditional guanxi (personal) networks still exist, but they are complemented by modern corporate culture.

The RIS benefits from return migrants by staying open for new knowledge coming from outside the RIS. Translated to the concept of knowledge spillovers, it could be argued that return migrants are capable of overcoming the distance-sensitivity of knowledge spillovers. These entrepreneurs skim off knowledge that overflows from high-tech regions in industrialised countries by taking a part of knowledge acquired during their stay abroad with them when returning to their home country. This is a kind of "travel of tacit knowledge" (Oinas and Malecki, 2002, 123), and it contributes to reducing the lock-in dangers of RISs. Entrepreneurs and their interpersonal networks thus connect a RIS with other RISs or NISs.

From the point of view of the RIS where such return migrants establish their firms, it is crucial to find a good combination of domestically and foreign-generated technologies - a requirement which is particularly pertinent for China and the Shanghai RIS (see also Wang, 1998). The ideal mix of extra-local networks and intra-local networks is region-specific.

In conclusion it can be said that the migration of individuals between RISs and between NISs is very important for keeping RISs open and performing. If the return migrants establish a firm, the potential effects on the target (RIS) are even greater. The international dimension of RISs and NISs cannot be ignored, particularly for newly industrialised countries like China. Both local and distant connections of innovative actors have positive impacts for the RIS (and the firms) which manifest themselves in proximity effects and socialisation effects (see Oinas and Malecki, 2002).

The empirical part of this paper examines the role of entrepreneurial Chinese return migrants for the Shanghai innovation system. To this end, the authors aim to answer the following questions: 1) Does Shanghai constitute a regional innovation system? Which deficits can be identified? 2) Are return migrants a significant factor - in terms of numbers - for the Shanghai innovation system? 3) What kind of companies are founded by return migrants? 4) In how far do they make up for the prevailing deficits in the Shanghai RIS?

3. Emergence of the Shanghai Innovation System

3.1. The Shanghai Development Path

Until the founding of the PRC in 1949, Shanghai was the economic hub of China in the areas of trade, finance and light industries.[2] However, after taking power in 1949, the Chinese Communist Party restricted and controlled private commerce and focused on heavy industry. Subsequently, private industry disappeared as entrepreneurs either fled to Hong Kong or were absorbed by collective enterprises. The ratio of light to heavy industry in the city fell from 71: 29 in 1957 to 49: 51 in 1978 (Lin, 1998, p. 50).

Central development plans resulted not only in the loss of Shanghai's comparative advantage in light industry, but also in the loss of economic autonomy. Between 1949 and 1983, about 87 percent of the Shanghai city government's revenue was remitted to the centre. The resource outflow resulted in a chronic underfunding of the local infrastructure. The growth of the state sector and state-owned enterprises (SOEs) did little to increase Shanghai's financial capabilities.

In the course of the reform process that was initiated in 1978, economic power was devolved from the central to regional governments.[3] The result is an informal sharing of competencies between the central and regional levels. While the central government concentrates on monetary and regulatory policy and on the reduction of interprovincial disparities, regional governments enjoy a high level of autonomy concerning a variety of policies to shape their own innovation system, including residential policy, education policy, sectoral and industrial policy (Heilmann, 2002).

However, during the first few years, Shanghai was left out of the reform process. The central government was reluctant to allow experimentation that might threaten its revenues, as failure in Shanghai was seen to affect the entire country. Excluding Shanghai from reforms seriously damaged its economy: In 1978, Shanghai topped the list of all provinces and regions in contributions to national income; by 1986, Shanghai had fallen to number six, in 1990 to number 10 (Segal, 2003).

The recovery of Shanghai is marked by two turning points. First was the development plan of February 1985, which arranged for Shanghai to regain its national lead in commerce, trade,

2) In 1933, Shanghai's contribution to world trade was larger than the contribution by Japan and Hong Kong to world trade together (Schüller and Diep, 2001, p. 1001).

3) Montinola, /Qian and /Weingast (1995) call this phenomenon "Chinese-style federalism", because regional power was not anchored in the constitution.

science and technology. Additionally, local control over fiscal resources increased (Segal, 2003). In the early 1990s, the Pudong Policy was devised to complement the original plan, granting Shanghai a status similar to that of the special economic zones. Shanghai began to enjoy more autonomy in boosting the non-governmental economy. Although market reforms proceeded more slowly in Shanghai than in other Chinese coastal cities during the 1980s, the private sector and foreign investment have grown rapidly since the 1990s, moderating the dominant role of SOEs in the economy (Hong, 2003).

The second major turning point was the urban 10th five-year plan (FYP) (2001-05), which proposes that the future role of Shanghai should be as a high-tech hub and business centre of China. Although the promotion of high-tech industries was a fundamental component of the 8th and 9th urban FYP, the significance of high-tech is emphasised to an unprecedented degree in the 10th FYP. To support such a strategic transformation, the traditional six pillar industries of the 1990s, e.g. automobiles, steel and petrochemicals, are to be replaced by new ones, including high-tech industries such as semiconductors, biotechnology and software (Segal, 2003).

Of the six high-tech parks in Shanghai, ZhangjiangHigh-TechPark in the Pudong New Area is emerging as the locus of new investments in high-tech-industries. The park was established in 1992 by the Ministry of Science and Technology as a national centre for the development of new and high technology. Both the municipal government and the park administration have aggressively pursued investment by offering subsidised loans, generous tax exemptions and a 50 percent discount on land rent in the park. The policies have had several visible results.

Most notably, the semiconductor industry in Shanghai took off following the Chinese government's announcement, in July 2000, of substantial tax reductions for the industry. Later that year, three major manufacturers announced plans to build chip fabrication facilities in ZhangjiangHigh-TechPark.[4] These investments have in turn attracted downstream and upstream producers, making Zhangjiang home to over 100 IC-related firms representing all stages of the IC production chain (Saxenian, 2003).

Biotechnology is the area that is currently receiving the largest amount of funding from the Ministry of Science and Technology, and Zhangjiang is emerging as one of the major biopharmaceutical parks in China. Since 1994, more than 30 R&D institutions have been built in close proximity to each other, and a number of multinational pharmaceutical companies have set up branches in Shanghai. Roche is one of the first multinational companies to set up an

4) Shanghai Belling Microelectronics Co, Shanghai Grace Semiconductor Manufacturing and Semiconductor Manufacturing International.

R&D centre in China.

Apart from promoting high-tech industries in general, Shanghai also started to pay more attention to the role of entrepreneurship for the development of such industries. At the beginning of the reform process, there was doubt about whether Shanghai should rely on small-scale, autonomous enterprises to achieve its economic goals. Unlike Beijing, it did not encourage scientists to found their own companies (spin-off companies). High-tech-parks were established mainly in order to attract foreign direct investment (FDI) and to induce the creation of joint venture firms that would be the vanguard of technological development, but not in order to promote entrepreneurship.

However, because of the success of non-governmental enterprises, notably in Beijing, officials in Shanghai began to realise that the city needed to rely less on SOEs to promote a regional innovation system. The city began to create innovation centres and incubators for private enterprises within the zones and near major universities (Segal, 2003). By the end of 2004, there were 28 incubators in total (interview with Wang Rong). Additionally, Shanghai established several organisations that finance research and development activities of private companies. One of them is Shanghai Venture Capital Ltd. which was founded in 1999 and supports local projects in IT, biotech and new materials.

Policies fostering (high-tech) entrepreneurship focus on two types of entrepreneurs. First, universities in Shanghai have started to formulate incentive policies in order to encourage faculty members to commercialise their R&D achievements. JiaotongUniversity, for instance, allows staff to leave university for up to two years in order to support the creation of spin-off companies. Secondly, the city supports entrepreneurship by Chinese who are returning home after years of study and work abroad. Shanghai is extremely active in recruiting highly-qualified Chinese from abroad. Among other measures, the city has established "Overseas Student Parks" within the high-tech development zones. These parks are reserved exclusively for companies started by returnees. They offer low rent, tax breaks, shared infrastructure and financial benefits like other science parks in China, but they also address the special needs of returnees, such as accelerating the bureaucratic process involved with establishing residency and ensuring access to housing (Saxenian, 2003). Attracting returnees has become an ever more important element of Shanghai's high-tech strategy. As recently as December 2004, the Ministry of Personnel and the Shanghai municipal government opened a state-level business park for returned overseas students. The Shanghai Overseas Talent Service Centre will integrate the existing ten business parks for returned overseas students in Shanghai, thus forming a complete network (China Economic Information Service, 2004).

3.2. Assessment of the Shanghai Innovation System

The previous chapter has shown that it is justified to regard Shanghai as a regional innovation system, as it has largely regained the autonomy to implement its own (innovation) policy. However, Shanghai's innovation system is marked by several deficiencies. A complete assessment of Shanghai's innovation system would require a research project of its own and can therefore not be delivered in the framework of this paper. Instead, we will tentatively classify Shanghai with the help of Tödtling and Trippl's (2005) typology of problem regions, based on a few obvious characteristics.

Shanghai has been developing rapidly, but is still in transition from a site of heavy industry to a metropolitan region comprising a range of industries (including high-tech) and services. Therefore, it exhibits some of the weaknesses typical of old industrial regions, such as the dominance of large firms, the concentration of firms in traditional industries and a political lock-in.

Even though the government has started to officially promote entrepreneurship, SOEs and large business groups remain at the centre of attention. This is exemplified by the fact that the six largest state-owned enterprise groups generated 87 percent of total output value in the IT sector in 2000. Although by the mid 1990s, there were over 7,000 private enterprises in Shanghai, technological development in Shanghai is still not driven by what happens in these enterprises (Segal, 2003).

In order to preserve and foster SOEs, the majority of local resources are channelled into them. Shanghai, for example, concentrates most of its R&D budget within large state-owned industries and not, like Beijing, in R&D institutions. However, as many SOEs are loss-making, funds are used to pay employees rather than to finance R&D activities. Furthermore, the ailing state sector is kept alive with the help of massive loans from the banking system. Thus, SOEs acquire most of the resources but hardly utilise them for innovation activities. This constrains private companies whose lack of capital is one reason for low investment in innovation activities. For high-tech enterprises in particular, the lack of capital is a serious bottleneck for R&D (Hong, 2003).

This situation is partly a result of the fact that Shanghai is caught in a political lock-in. In industrialised countries, this term refers to strong relationships between public and private actors which hamper industrial restructuring. In the case of China, it is more apt to talk of "guanxi" between the government and state-owned enterprises which constrain the development of the private sector.

"Guanxi" can be loosely translated as "connections" or "relationships". In this paper, the term refers in particular to relations with the government. In China, guanxi have traditionally been the prime organising principle of political and economic life, but have become even more important with the beginning of economic transition. Although market mechanisms were introduced 25 years ago, China is still not a market economy with stable regulatory and legal framework conditions. Instead, powerful bureaucrats control access to resources, permits and licences. In such an environment, good relationships with government officials are necessary to operate a company successfully.

Contrary to private entrepreneurs who are hardly supported, SOEs have a strong lobby in the administration and the government. Ministries traditionally sympathetic to the plight of SOEs, such as the planning and economic commissions, dominate bureaucratic politics. Members of the Science and Technology Commission who are more inclined to support private enterprises have only little influence. Local bureaucracies, therefore, tend to intervene on behalf of SOEs, thereby discriminating against private entrepreneurs (Segal, 2003). This finding is supported by the interviews with entrepreneurs in Shanghai who stated that, although Shanghai is supporting private companies on paper, in practice beneficial treatment is difficult to obtain because the local administration is still "thinking big". For example, in order to be registered as a high-tech company and benefit from the relevant policies, the decisive criterion is the company's revenue, which must be larger than € 500,000 (interview with return migrant 5).

To summarise, although Shanghai has undertaken many steps to create an innovation system and has started to recognise the role of entrepreneurship for innovation, deficits prevail. Most notably, SOEs do not innovate. The prominence of SOEs in the economy constrains the development of private entrepreneurs, potentially important innovation actors, thus resulting in a lock-in. High-tech companies started-up by Chinese returning from overseas can therefore be expected to make a significant contribution to the Shanghai innovation system.

4. Research Methodology

For the empirical part of this paper, a qualitative research design was chosen. The main reason is the exploratory nature of the topic. Not much is known about returning Chinese - why and how they start-up a high-tech company in China, if and how they innovate, and to what extent they influence regional innovation processes. The goal is therefore to describe and qualify the phenomenon with respect to its relevance for the Shanghai innovation system rather

than to test hypotheses. Accordingly, systematic instead of random sampling was employed in order to gain a comprehensive understanding of the object under investigation, meaning that persons were asked for an interview if they met the following two criteria: first, if they had founded their own company, as distinct from managing a foreign company's subsidiary, and secondl, if they had founded a high-tech company. Variations of other criteria, e.g. age or size of the company were desired in order to learn about different types of companies founded by returnees. The second and more pragmatic reason for systematic sampling was that a company in China can be registered as a domestic company, as a joint venture or as a foreign company, but not according to the characteristics of the founder. Therefore, in order to identify companies founded by returning Chinese, it was necessary to literally search for them by establishing networks in the study region. The result is a small number of cases compared to the random sampling method.

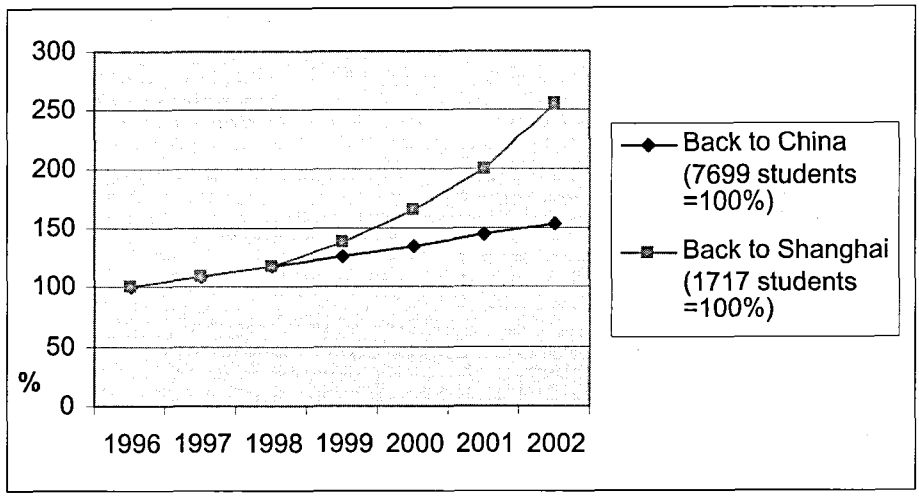
The empirical part of this paper is based on in-depth interviews with 25 returning and with 15 domestic entrepreneurs in the biopharmaceutical and in the semiconductor industry, and with 20 industry and other experts (e.g. managers of high-tech parks, investment managers), conducted in Shanghai between Sept. - Dec. 2003 and between Aug. - Oct. 2004. Interviews with entrepreneurs were based on an interview guideline which included topics such as the biography of the founder, the founding history of the company and the companies' collaboration and innovation activities.

5. Return Migration as an Important Factor of the Shanghai Innovation System

The Chinese brain drain[5] is caused mainly by the flow of students leaving the country in order to pursue their education abroad. The brain drain started following China's policy of opening up in 1978 and has been so great that Mainland Chinese are now the largest and fastest growing group of foreign-born students at U.S. universities. Overall, between 1978 and 2003, 700,000 people left China to study abroad, and the trend has been accelerating in recent years. Moreover, students have not been returning to China in large numbers. In total, about 170,000 have come back, and although more people have been returning in recent years, they do not compensate for the numbers of those leaving. The loss of talent is especially acute in technical fields (Saxenian, 2003). Based on data concerning the migration of Chinese students, we attempt to show in

5) "Brain drain" refers to the migration of highly-qualified people (including students) from developing to developed countries. If people return, this results in a reverse brain drain for the respective source country.

the following paragraphs that regions in China are affected to varying extents by brain drain and reverse brain drain, and that highly-qualified returnees are a factor of particular importance for the Shanghai innovation system.

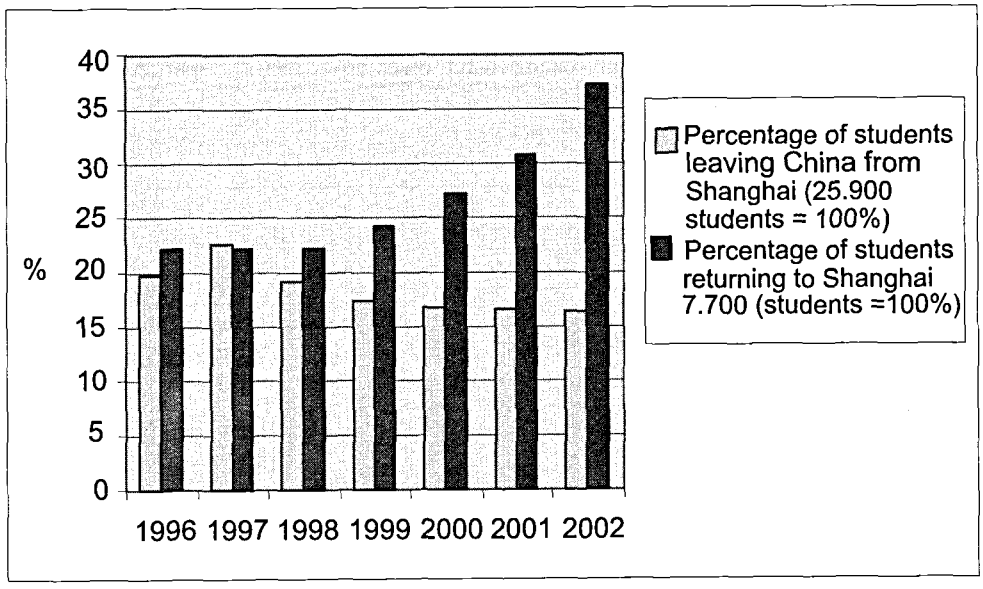


Source: Unpublished data provided by the Shanghai Bureau of Public Security.

Figure 1 : Student Migration to Shanghai and to China (indexed)

First, Shanghai benefits more from reverse brain drain than China as a whole. As figure 1 shows, the numbers of students returning to Shanghai and to China have both increased. However, the number of students returning to Shanghai has been increasing much faster than the number of those returning to China. Second, in recent years, Shanghai has been affected less than other regions by brain drain. While the percentage of students returning to Shanghai from abroad has been increasing, the percentage of students leaving for studies abroad from Shanghai has declined (see figure 2).

Not only the number of students, but also of people returning to China to start-up a high-tech company is rising. According to one source, the number of companies founded by "returnees" in Shanghai has increased at the rate of one per day since 2002, reaching 3,000 and amounting to a total investment of € 330 million by the end of 2004 (China Economic Information Service, 2004). In 2003, in Zhangjiang High-tech Park - the most popular site in Shanghai for entrepreneurs in high-tech sectors - there were approx. 500 companies founded by "returnees", among them 50 biotech companies, 230 software companies and 18 IC chip design companies (see figure 3).[6]



Source: Unpublished data provided by the Shanghai Bureau of Public Security.

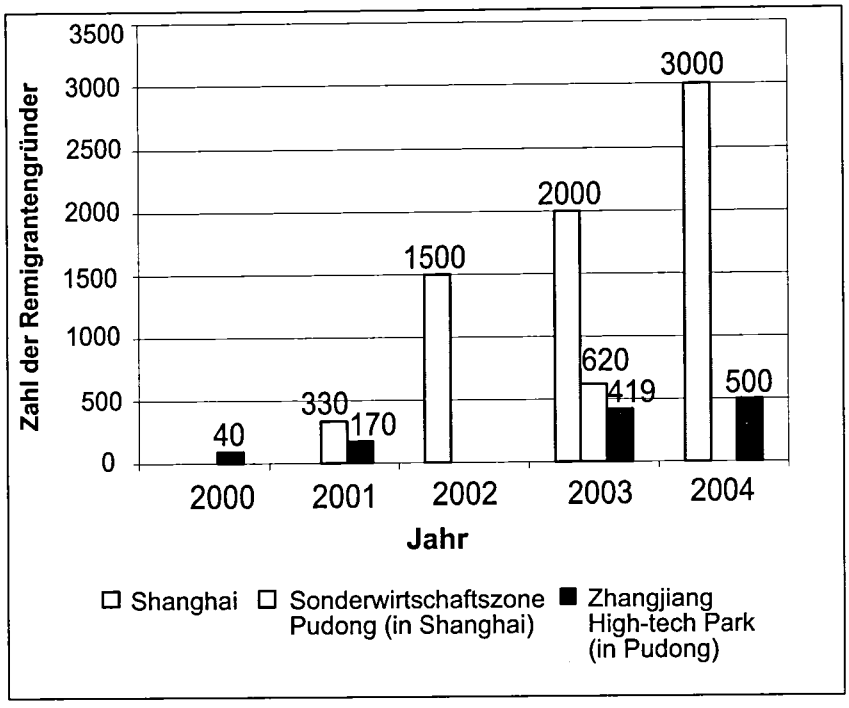
Figure 2 : Percentage of Students Leaving from and Returning to Shanghai

The proposition that Shanghai is more likely to attract returnees than less developed regions in China is further supported by the interview data. Of the 41 entrepreneurial return migrants, 11 people were neither born, nor had worked or studied in Shanghai before starting up a company there. Rather, they decided to settle in Shanghai after comparing several locations within China.

6. High-tech Entrepreneurship in Shanghai

In this section we will first characterize the development status of two industries in China in which returning entrepreneurs start-up a company (biopharmaceutical and semiconductor). Subsequently, the activities of returning entrepreneurs in the respective industries are examined in order to shed light on the following questions: How "high-tech" are the activities of returning entrepreneurs, what is their motive for returning to China and how do entrepreneurs assess the framework conditions for innovation activities in Shanghai? Based on these analyses we

6) If a founder does not declare, or register the company as a domestic corporation, it would not show up in the register. The fact that many of the companies visited registered as a wholly foreign owned or joint venture indicates that the real number of companies founded by returnees in Zhangjiang is higher.



Source: Authors' illustration based on several sources.

Figure 3 : Number of Returning Entrepreneurs in Shanghai, in Pudong and in Zhangjiang High-tech Park

will gauge in how far returning entrepreneurs contribute to the development of the Shanghai IS.

6.1. Entrepreneurs in the Biopharmaceutical Industry[7]

6.1.1. Development Status of the Industry

Modern biotechnology integrates knowledge from various subjects of the natural and engineering sciences. It is capital-intensive and requires complex technological and management know-how. These attributes make biotechnological research in less developed economies very difficult. Biotech

7) 12 of 14 companies are biotech or biopharmaceutical companies and engaged in the development and manufacturing of drugs, diagnostics and other biotechnology-based medical products. Only two companies are developing medical instruments. Therefore, they are subsumed as "biopharmaceutical companies", and the following analysis is limited to the biotechnology and pharmaceutical industry.

firms in industrialised countries either carry out research on new drugs or, based on a proprietary technology platform, they sell products or services that support other biotech or pharmaceutical companies' research. Some companies offer products or services in order to generate funds for their own research. The process of creating a new medicine can be divided into two stages with differing demands on the framework conditions: drug discovery and drug development.

The identification of active substances that have the potential to become a drug ("drug discovery") can be qualified as applied research and is usually followed by a patent application. Drug discovery requires exacting environmental conditions, most critically, the protection of intellectual property, and relies on results from basic research. Drug development primarily consists of testing a patented substance in the course of animal and clinical studies. In terms of technology, it is not as demanding as basic research.

However, it is still high-tech as it requires the expertise of qualified scientists. Due to resource constraints, biotech companies in industrialised countries often specialise in research and license the development and marketing of drugs to pharmaceutical companies.

The modern Chinese biotechnology industry came into existence approximately six years ago. It is so far underdeveloped but has enormous growth potential, due to high growth rates of the economy and a demand for medical products rising with it. Sales of biotechnology-based drugs amounted to six percent of the total revenue of China's pharma industry in 2000, and were over two billion euros in 2001. In 2002, there were about 300 biotech companies in China (Dechema, 2004). However, industry experts estimate the number of innovation-based biotech start-ups to be considerably smaller (interview with expert A; interview with Jiang Jing Fei). The reason is that the majority of their customers in the pharmaceutical industry does not sell new drugs: 97 percent of drugs on the market are copies of western medicines or generics. As biotech companies in China are geared to the needs of pharmaceutical companies, most of them develop technologies aimed at upgrading existing products or products with low development risks.

6.1.2. Typology of Companies Founded by Returned Entrepreneurs

Entrepreneurs started up a company in China either in order to introduce a new product (drug, instrument, diagnostic) to the Chinese market or to offer services to foreign customers. The general motivation for entrepreneurs to come to China seems to be to engage in activities in the medium range of high-tech. Of the ten companies targeting the Chinese market, nine aim to introduce a product that is not only new in China but new to the world as well. They

engage in three different types of activity in China (see table 1). Only one company carries out all the steps from applied research (activity type 1) to product development (activity type 2) and thus the entire process of creating a medicine in China.

Table 1 : Typology of Biopharmaceutical Companies*

Market	Type of activity	Activity and degree of innovation	Motivation for being in China
China	Applied research (1)	• drug discovery: work on a drug that is new to the world (1 case)	• "to prove to myself that I can do it"
	Product development (2)	• development of medical instruments, diagnostics or drugs that are new at world level (9 cases)	• market-driven & cost-driven
	Production (3)	• production of high-level medical instruments (2 cases) • chemical synthesis of substances that were new in China at the time (1 case)	• market-driven
World	Collaborative research (4)	• outsourcing: technology services at world level (4 cases)	• cost- and resource-driven
	Contract research (5)	• outsourcing (labour-intensive, medium-technology): animal studies, chemical synthesis (2 cases)	• cost- and resource-driven

Note: *The total number of companies is 14. However, some of them engage in more than one type of activity.
Source: Interviews with returned entrepreneurs in Shanghai.

The reason for this entrepreneur to come to China was not to access unique technological know-how, but rather to "prove to himself that he can do it", which is an indicator of the difficulties of doing research in China. The statements of two other founders ("…the R&D environment is not mature enough", and "…one cannot do R&D in China, the project has to be finished") reinforce the argument that the framework conditions for research are, so far, inadequate. In particular, insufficient protection of property rights is hampering the development of the biotechnology industry.

Accordingly, more entrepreneurs focus on product development (activity type 2). For this, the framework conditions are considered to be good. Shanghai is well-equipped with modern research facilities, hospitals, qualified scientists as well as plants and animals. In addition to that, development costs are considerably lower than in industrialised countries. For instance,

the cost of animal testing in China is 20 percent and the cost of clinical trials in China is 15 percent of that in the U.S. (interview with return migrant 1), mainly because of the low wage level for qualified scientists. Whereas a PhD scientist working in the biopharmaceutical industry in Germany earns an average annual salary of € 40,000 - 50,000, he earns € 12,000 in China. Furthermore, test persons receive only a fraction of the sum they would receive in developed countries for participating in clinical studies. Interestingly, while biotech firms in industrialised countries often specialise in basic research and hand product development over to pharmaceutical companies, in China, they can afford to develop the product themselves.

But product development companies encounter challenges as well, most notably the lack of capital. Bank loans are hardly available, and the venture capital industry is underdeveloped especially with respect to biotechnology. There are many reasons, including a lack of knowledge of the industry, exit difficulties[8], and, given that R&D takes up to ten years, the high aversion of investors to risk and long-term commitment. Another major issue is that biotech companies cannot license their drugs to domestic pharmaceutical companies, because they might never receive the royalty payments. Therefore, they have to manufacture in their own factories, which requires additional capital.

Despite these constraints, returned entrepreneurs consider their personal situation in China to be much better than if they had founded a company in the U.S. First, despite the general lack of capital, it is relatively easy for them to raise (government) funds. At the same time, they benefit from lower costs in China, from more government support and less fierce competition, compared to the U.S.

As most entrepreneurs are still working on the product development, only three companies are already producing in China (activity type 3); of these, two are producing sophisticated medical instruments, and only one company is engaged in the labour-intensive production of chemical substances, which were, however, new to China at the time of market entry.

Companies catering to foreign customers either engage in collaborative research (activity type 4) or contract research (activity type 5). Collaborative research - that is developing research results and analyses in close collaboration with the foreign customer - is technologically complex and requires a high level of trust and management skills, depending on how much of the customer's work is outsourced. In China, the term "contract research" includes both research that is somewhat

8) Potential investors are only willing to invest if they can retrieve their initial investment with a return, i.e., if they can exit. One exit option is for the invested company to go public. However, in China this is hardly an option as the stock exchange is still heavily regulated.

less complex than collaborative research, but is also euphemistically used for chemical synthesis or animal studies, which are not contract research in that the outsourcing partner does part of the real research. The main motivation for offering either type of service from China is to reduce costs and, less importantly, to access plants which can only be found locally. The required framework conditions are similar to those for product development and thus quite favourable in Shanghai.

6.2. Entrepreneurs in the Semiconductor Industry

6.2.1. Development Status of the Industry

Like biopharmaceutical research, semiconductor manufacturing is a technically complex process that requires sophisticated technological and managerial know-how. Nevertheless, in less than 25 years semiconductor manufacturing and design has shifted from the U.S. and Japan to formerly peripheral regions in the Asia Pacific, notably to Taiwan in the 1980s and 90s, and has started to shift to the east coast of China in recent years. This has been possible because of transformations in the industrial structure.

The dominant competitors in the 1960s and 1970s were vertically integrated corporations. Large sums of investment were needed and limited the number of actors in the semiconductor industry. When Taiwan Semiconductor Manufacturing Co. pioneered the stand-alone foundry in 1985, it triggered a process of vertical fragmentation. Today, independent producers specialise in chip design, fabrication[9], testing, packaging, marketing and distribution as well as in the multiple segments of the semiconductor equipment manufacturing and materials sector.

For individual entrepreneurs, fabless IC chip design is an attractive field. As the manufacturing of chips is outsourced to a foundry, investment amounts to only a few million dollars for the technical infrastructure instead of € 1 billion for a fabrication facility. Success in IC design mainly depends on a team of creative, experienced engineers. Today, increasing numbers of entrepreneurs in IC design contribute to competition and innovation in the industry.

Countries wishing to build a domestic IC industry tend to establish manufacturing capabilities first before building IC design capabilities (e.g. Taiwan, see Saxenian, 2003). Before 2000, China's IC industry was very small. At present, China has seven domestic IC chip plants, and it is alleged to have 400 IC design companies, 130 of them fabless (interview with Wang Ye).

9) A fabrication facility ("fab") is an in-house chip production plant. "Fabless" refers to a company that does not manufacture its own chips, but concentrates on the design and development of chips. A foundry does not design or develop any chips, but manufactures chips for other brands.

However, most conventional domestic IC companies focus on low-tech chips for consumer goods. In 2000, a new type of company, targeting the middle and high-end of chip design, began to emerge, often started by Chinese returning from overseas. Although the technology gap has been narrowing, China is expected to need ten more years to catch up (interview with Xue Zi).

The Chinese IC market is characterised by a huge gap between supply and demand. From 2001 through 2004, Chinese IC demand registered a compound annual growth rate of 46 percent. In 2005, China is forecast to represent 20 percent of the world's IC consumption, up from eight percent in 2001 (IC-Insights 2005). But in 2003, indigenous semiconductor sales satisfied only 24 percent of the domestic demand (China Semiconductor Industry Association 2004).

6.2.2. Typology of Companies Founded by Returned Entrepreneurs

All but two of the entrepreneurs surveyed started up an IC design house. They are in China to develop a product - the chip and the application software - either for the national or for foreign markets (activity type 1). The dominant strategy is to offer a product of world-level quality but for lower than world-level costs (see table 2). Compared to product development in biotech, IC design is more talent-driven, as it requires a high degree of creativity and innovation. Therefore, to find the right people is possibly even more important for the development stage in IC than in biotech. As the Chinese IC industry and chip design in particular are very young, it is difficult to find experienced engineers. At the same time, education and motivation of employees are critical to compete on a global level. One founder stated that he devotes 80 percent of the time to human resources. Benefits of locating in China arise from the fact that salaries for engineers are much lower - at only 20 percent - than they are in the U.S., although the average revenue per head in China is also only 20 percent of that in the U.S. (interview with return migrant 2).

One company offers services for foreign companies in China (activity type 2) and is working on the development of a chip at the same time. The founder's strategy is to design chips at the "low-end of high-tech", because in his view, "high-tech in China does not sell at this point". Only two companies engage in production (activity type 3). One is a material manufacturer, producing silicon wafers for international customers. The founder had imported state-of-the-art technology (equipment) worth several million dollars and applies it in a new manner in order to manufacture high-tech material at low costs. Only one company is in equipment manufacturing, an activity of relatively low technology content.

Table 2 : Typology of IC Companies*

Market	Type of activity	Activity and degree of innovation	Motivation for being in China
China	Product development (1)	• IC chip design: 1) cutting-edge technology (4 cases) 2) not cutting-edge, but innovative: better quality and lower costs than domestic companies (1 case) 3) "at the low end of high-tech" (1 case)	• market-driven & cost-driven
	Technical support (2)	• Customer service: High - end services (1 case)	• market-driven
	Production (3)	• Equipment manufacturer (low technology content)(1 case)	• Market driven
World	Product development (1)	• IC chip design: World class technology for world-class customers (2 cases)	• market & cost-driven
	Production (3)	• Material manufacturer: New application of an existing high-end technology in order to cut the costs of manufacturing excellent quality (1 case)	• cost-driven

Note: *The total number of companies is 11.
Source: Interviews with entrepreneurs in Shanghai.

Of the 11 entrepreneurs, eight returned to China from Silicon Valley. They describe Shanghai's infrastructure as very good, and ZhangjiangHigh-TechPark as similar to Silicon Valley in style. But, according to the founders, Zhangjiang does not have the size, that is a critical mass of companies, yet and it lacks the "creative buzz" of Silicon Valley. As one founder said: "Some of the technology has to be done in Silicon Valley because the environment is still different. There are good guys, they get information from other good guys, and they have lunch together every day. Here, it is still different, it looks like S.V., but it is not yet". (interview with return migrant 3).

Additionally, difficulties exist in terms of the market. Two companies that originally wanted to sell their chips to Chinese customers did not succeed because "the market is not mature", that is the buyers of chips do not understand the technology. The founders now design chips in China for customers worldwide but hope to sell in China in the future.

The challenges seem to be more than offset by the tremendous growth of the Chinese IC market. Therefore, returned entrepreneurs find it relatively easy to raise funds abroad for a venture in China. Also, once they have established themselves in China, they receive more government support than they would in the U.S.

In both the biotec and the semiconductor industry, the returned entrepreneurs are uniquely positioned to utilise location-specific advantages in two parts of the world by locating knowledge production (phase 1) in more advanced innovation systems abroad, and commercialisation (phase 2) in Shanghai. Some entrepreneurs indicated that they could not have founded a high-tech company otherwise, because they could not afford to pay the high wages of employees working in a technology venture in the competitive environment of an advanced (regional) innovation system.

7. Summary and Conclusions

This paper has identified several gaps in the research on regional innovation systems, most notably the neglect of entrepreneurship in the theoretical debate and the lack of empirical studies concerning the role of return migrants, in particular, concerning the role of returning entrepreneurs. We hypothesized that return migrants may contribute significantly to regional innovation systems in their home countries, as they take part of the knowledge from (high-tech regions) abroad with them when they return. This contributes to keeping the target RIS open for new knowledge and helps to reduce existing technological lock-ins.

In the empirical part, we first investigated if Shanghai constitutes (yet) a regional innovation system. We found that it does, although it is still in a transition from a manufacturing site and hampered by a dominance of SOEs. Subsequently, based on data concerning return migration to Shanghai and to China, respectively, return migrants and entrepreneurial return migrants in particular were shown to be an important factor of the Shanghai innovation system, despite their small numbers in absolute terms. Lastly, companies started up by return migrants were examined with respect to their innovation activities.

The analysis of returned migrants' entrepreneurship in the biopharmaceutical and in the semiconductor industry indicates that return migrants starting up firms in Shanghai mainly engage in product development, that is in activities in the medium range of high-tech. Apparently, for activities related to the "D" of R&D, the framework conditions in Shanghai are rather good, as the city offers a combination of first-world infrastructure and third-world labour costs (including

qualified labour). However, weaknesses such as a lack of property rights require that return migrants bring back the core technology or knowledge from abroad. Thus, the framework conditions for conducting the "R" of R&D are not sufficient. This finding corroborates the insight of chapter three, that Shanghai is an *emerging* innovation system but still marked by weaknesses.

The main reason for the entrepreneurs to take the risks as described above and to start-up companies in an immature market environment are the lucrative Chinese market and expected high growth rates. At the same time, starting up companies despite the constraints as described in chapter six, entrepreneurs contribute to the emergence of high-tech industries in Shanghai because they apply their knowledge acquired abroad in the context of a developing and a transition economy. Simultaneously, this reduces the existing technological lock-in which is a result of the dominance of SOE in Shanghai's economy.

To conclude, returned entrepreneurs can be regarded as a factor contributing to the development of the Shanghai innovation system. However, founding a high-tech start-up in China is still a challenge with high risks involved that only experienced returnees can master. To scale up the beneficial effects of return migration it is advisable for regional politics to create a more stable and predictable environment, thus increasing the chance for success of returning entrepreneurs.

Appendix: Interview Partners

The authors thank all interview partners for the information provided. Not all of the respondents' statements have been incorporated directly in this paper. But they have all contributed to an understanding of the situation. All of the return migrants and one expert wish to remain anonymous. Therefore, verbatim statements refer to "Return migrant A", "Return migrant B", "Expert A" etc. instead of referring to names of people or firms.

Experts in Shanghai cited in this paper

Name	**Organisation**
Jiang Jing Fei	Shanghai Venture Capital Corporation
Wang Ye	National IC Design Industrialisation Centre in Shanghai
Xue Zi	Shanghai Semiconductors Association
Expert A	Roche Pharmaceuticals/Shanghai

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