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International Patenting Strategies of Chinese Residents:
an Analysis of Foreign-Oriented Patent Families

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International Patenting Strategies of Chinese Residents: an analysis of foreign-oriented patent families

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Abstract:

In terms of the number of its patent applications, in 2012 China has emerged as the country with the largest IP office in the world. The performance of the Chinese IP system is thus increasingly in the spotlight. While significant economic studies have been devoted to the rise of domestic patenting in China, hardly any study has focused on Chinese patent filings in foreign countries. This paper analyzes Chinese patenting abroad by using WIPO's foreign-oriented patent family dataset and a respective enterprise questionnaire. It finds that by the turn of the century China emerged as major actor in terms of international patenting. While this is changing rapidly, the share of Chinese patents which get filed abroad is still a fraction of total patents filed at home and most patents still also only target one foreign IP office. Chinese foreign-oriented patent families are concentrated in a few technology fields, notably those related to the ICT sector, "Digital communication", followed by "Computer technology", "Nanotechnology", and similar fields. A few Chinese firms are responsible for a large share of total Chinese patents filed abroad. The paper however also highlights that some of these trends are changing rapidly towards more intensive and broad-based filing abroad. Initial results from a selective firm survey also show a shift from the desire to protect technologies abroad to more strategic motives: (i) the desire to build patent portfolios avoiding litigation, (ii) facilitating collaboration with other firms, but also to (iii) license and sell IP abroad, and to (iv) further the firm's reputation as true innovator.

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Thanks also goes to Chinese IP-intensive firms in Shenzhen (China), namely Huawei, Tencent and ZTE who – thanks to the help of the Shenzhen Zhongyi Patent & Trademark Office and SIPO - participated in our structured interview on international IP filing strategies.

The participants in WIPO Experts' Meeting on Intellectual Property and Socio-Economic Development, December 3 and 4, 2013 in Geneva and the SIPO-WIPO Experts' Meeting on Intellectual Property and Socio-Economic Development, March 25, 2013 in Beijing provided feedback on earlier drafts.⁴ In particular, the feedback of Christian Helmers Assistant Professor of Economics, Leavey School of Business, Santa Clara University, USA and Mr. Albert Guangzhou Hu, Associate Professor of Economics, China Europe International Business School and National University of Singapore helped improve previous versions.

Carsten Fink, Chief Economist, WIPO, provided critical input throughout the project.

⁴Full program and speaker details at

http://www.wipo.int/edocs/mdocs/mdocs/en/wipo_exp_ip_bei_14/wipo_exp_ip_bei_14_inf_1.pdf.

Introduction

In terms of the number of its patent applications, in 2012 China has emerged as the country with the largest IP office in the world. The performance of the Chinese IP system is thus increasingly in the spotlight; better understanding the linkages between IP activity and socio-economic development in China is a priority. Also, the rapid development of China's IP system holds important lessons for other low- and middle-income countries.

This working paper presents the findings of a WIPO study on the international patenting strategies of Chinese residents.⁵ Chinese companies have rapidly increased their patent filings abroad. However, there is little systematic study of Chinese foreign-oriented patent families. Evidence on what determines Chinese companies' decisions to seek patent protection in different countries is missing.

The objective of this study is to describe and analyze Chinese patenting abroad by using national IP and other statistical data as well as WIPO's foreign-oriented patent family dataset (see Box 1 for an explanation of patent families versus foreign-oriented patent families). It offers descriptive statistics and econometric evidence on the observed increase in Chinese foreign patenting and its drivers.

Box 1: Patent families explained

Patent family: A set of interrelated patent applications filed in one or more countries/jurisdictions to protect the same invention. Applicants often file patent applications in multiple jurisdictions, thus resulting in some inventions being recorded more than once. In order to take this factor into account, WIPO has developed indicators related to so-called patent families, which are defined as a set of patent applications interlinked by – or by a combination of – priority claim, PCT national phase entry, continuation, continuation-in-part, internal priority, addition or division. In this publication, patent families include both families associated with

⁵ In 2011, the Chinese Government expressed interest for WIPO to conduct a joint study on IP, innovation, and economic development under this umbrella. Joint study work has been initiated to this effect. This paper responds to one out of three work streams determined as part of the joint SIPO-WIPO project. The other two research streams focus on two other questions 1) What is behind China's rapid increase in patenting? and 2) What role does patent protection play in the business strategies of Chinese companies?, see SIPO (2014).

patent applications for inventions and patent families associated with utility model applications.

Foreign-oriented patent families: This is a special subset of patent families having at least one filing office that is different from the applicant's origin. Some foreign-related patent families include only one filing office, as applicants may choose to file directly with a foreign office. For example, if a Chinese applicant files a patent application directly with the USPTO (without previously filing with the SIPO), that application, and applications filed subsequently with the USPTO, form a foreign-oriented patent family. By contrast, domestic patent families are patent families that have only one filing office that is the same as the first-named applicant's country of origin.

Source: WIPO (2013). For further terminological details also see the Glossary in the original study CDIP/13/INF/9, http://www.wipo.int/edocs/mdocs/mdocs/en/cdip_13/cdip_13_inf_9.pdf.

The international patenting behavior in China is analyzed by the construction and use of a dataset of foreign-oriented patent families by Chinese residents based on the WIPO IP Statistics Database and the PATSTAT database (April 2013 edition).⁶ Unpublished patent applications, *e.g.*, patent applications withdrawn before publication, and provisional applications are not included in the patent family count. The dataset includes only "foreign-oriented" patent families with at least one patent application outside of SIPO within a family.

In addition the database has the following features: (1) each "first-filed" patent application forms a patent family; all subsequent patent filings are added to that family, and (2) one patent application may belong to more than one patent family due to the existence of multiple priority claims. Moreover, PCT international filings are excluded, as they represent merely an interim step to secure protection abroad. Names of the first applicants are cleaned and harmonized to be able to group patent families under a specific name. Unique patent applicants are identified among companies, universities and research institutes, but not among individuals due to the prevalence of identical names among individual applicants. Finally, applications are grouped by WIPO's

⁶ For statistical purposes, a "resident" application refers to an application filed with the IP office of or acting for the state/jurisdiction in which the first-named applicant in the application has residence.

International Patent Classification (IPC)-technology concordance.⁷

The final dataset covers the period of 1970-2012. Yet, given that there is a minimum delay of 18 months between the application and the publication date, and the maximum of 30 months delay before applicants file abroad through the PCT system, 2009 is the latest available year for which complete foreign-oriented patent family data exist. To calculate aggregate statistics we opt to include the years of 2010-2012 (approximately 10,000 patent families and about 1/6 of the dataset) together with the rest of the data on patent families because there is no reason to believe that a certain applicant or a group of applicants is more incomplete compared to others. However, when calculating annual statistics, data until 2009 is presented.

This study has been prepared by the WIPO Secretariat in close coordination with SIPO. The study has been discussed by experts at two workshops. First, the participants in the WIPO “Experts’ Meeting on Intellectual Property and Socio-Economic Development”, December 3 and 4, 2013 provided feedback on a previous draft of the study. Second, an “Experts’ Meeting on Intellectual Property and Socio-Economic Development” jointly organized by WIPO and SIPO has been organized in Beijing on March 25, 2014 to present the findings of this study in China to the relevant stakeholders and to obtain further feedback on the study’s preliminary findings.⁸

In addition, in the context of this mission to China, meetings with Chinese IP-intensive firms in Shenzhen (China) took place to further deepen the analysis proposed in this study. By the help of a structured interview guide on international IP filing strategies (see Appendix 1), useful data and information could be garnered to validate and further deepen the analysis proposed in the WIPO study. The structured interview template can be fine-tuned in the future for more systematic survey use in studying international patenting strategies in other countries.

The Working Paper is structured in three parts. The first part discusses the rise of national and international patenting in China. The second part reviews the economic

⁷ The IPC provides for a hierarchical system of language-independent symbols for the classification of patents and utility models according to the different areas of technology to which they pertain. The symbols contain information relating to sections, classes, subclasses and groups.

⁸ Presentations at http://www.wipo.int/meetings/en/details.jsp?meeting_id=32662.

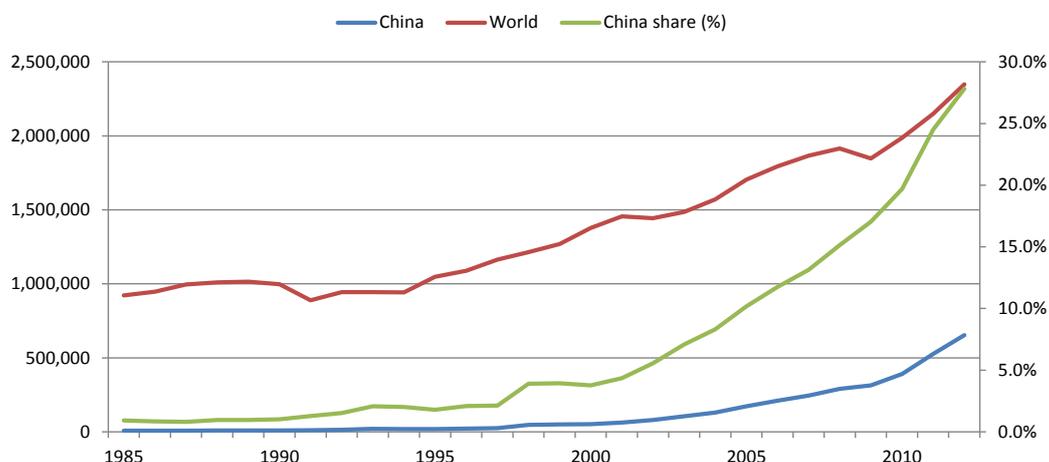
literature on the subject. The third part conducts the analysis of foreign-oriented Chinese patenting. It uncovers the main trends of Chinese patent filings abroad, studying which foreign countries are mostly targeted, which applicants are most active, in which technology fields, and the role of the Patent Cooperation Treaty (PCT) in these patent filings abroad.

1. The rise of Patenting in China

The People's Republic of China enacted its first patent law in 1985. SIPO, the patent office in China, received 8,558 patent applications that year – more than half of them were from abroad. Compared to almost one million applications filed worldwide in the same year, this number was small – just about one percent of the world total. China revised its patent law in 1992, 2000 and 2008 respectively, further bringing it in line with its economic development stage, international standards and its WTO accession.

Patent filings in China grew smoothly in the first 15 years following 1985 (see Figure 1). By 1999, China's volume of patent filings reached 50,000 per year, and its share of the world total climbed to about 4 percent (see Figure 1). In 1998, the Chinese patent office became the sixth biggest patent office in the world, behind Japan, the United States of America (US), the Republic of Korea, the European Patent Office (EPO) and Germany. During this period, the number of resident and non-resident patent filings were about even, except for the period from 1990 to 1994. In 1995, China became a member of the PCT system. As the result, the non-resident patent filings surged in 1998 and 1999.

Figure 1: Patenting at the Chinese IP Office compared to patents worldwide, 1985-2012



Source: WIPO IP Statistics Database, June 2014.

Starting from the new millennium, China’s patent filings took a sharp upturn leading it to become one of the main drivers of global IP growth. In 12 years following the year 2000, patent filings at the patent office of China saw a tenfold increase. In 2010 and 2011, China overtook Japan and the US respectively to become the biggest filing office in the world. In 2012, more than a quarter of world’s patent applications were filed in China. Between 2010 and 2012, the number of grants worldwide increased by 224,600. SIPO accounted for 36.5% of the total growth, followed by the JPO (23.2%), KIPO (19.9%) and the USPTO (14.9%). In 2012, for the first time, residents of China (560,681) accounted for the largest number of patents filed throughout the world, i.e. domestic and international filings combined (WIPO, 2013).

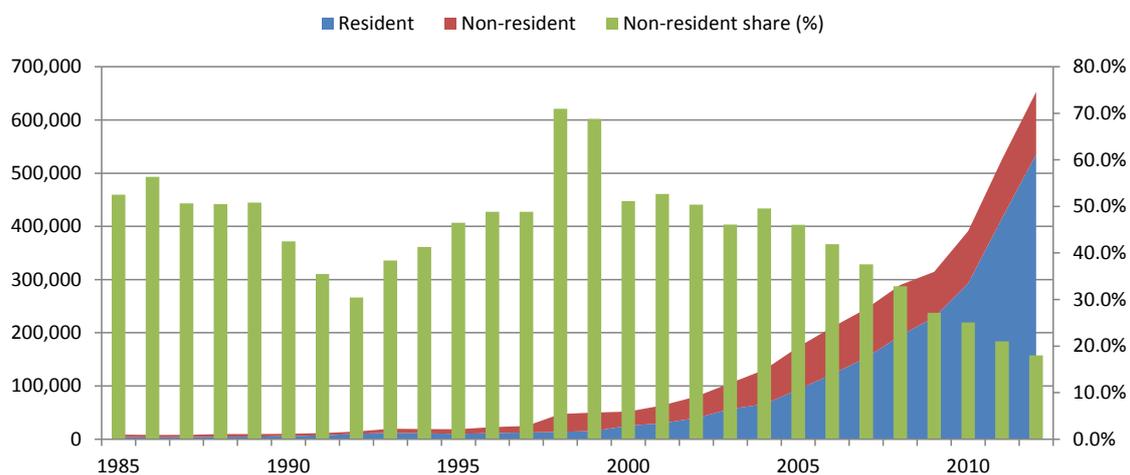
There has also been a shift in the share of world patents filed held among the top five IP offices. SIPO’s share increased from 3.8% in 2000 to 27.8% in 2012, while over the same period that of the Japanese Patent Office halved from 30.5% to 14.6% and as the respective shares of the European Patent Office (EPO), the Korean IP Office (KIPO) and the United States Patent and Trademark Office (USPTO) have remained more or less constant (WIPO, 2013).

China still receives large volumes of filings for utility model patents each year. In 1985, only 2% of world utility model filings are in China. This percentage grew to 89% in

2012. Still in the more recent years there has a significant shift in the use of Chinese residents from using utility model patents only to also filing for invention patents.

Meanwhile, in the more recent decade resident patent filings – those filed by Chinese companies/individuals – were primary driving factor behind the surge of patent filings. In the past few years, the share of filings by foreign applicants steadily dropped (see Figure 2). By 2012, only 20 percent of the patent filings in China are from abroad. This marked an important turning point as non-resident patent filings are usually dominant in most low- and middle-income countries.

Figure 2: Resident versus non-resident patent filings at the Chinese IP Office, 1985-2012



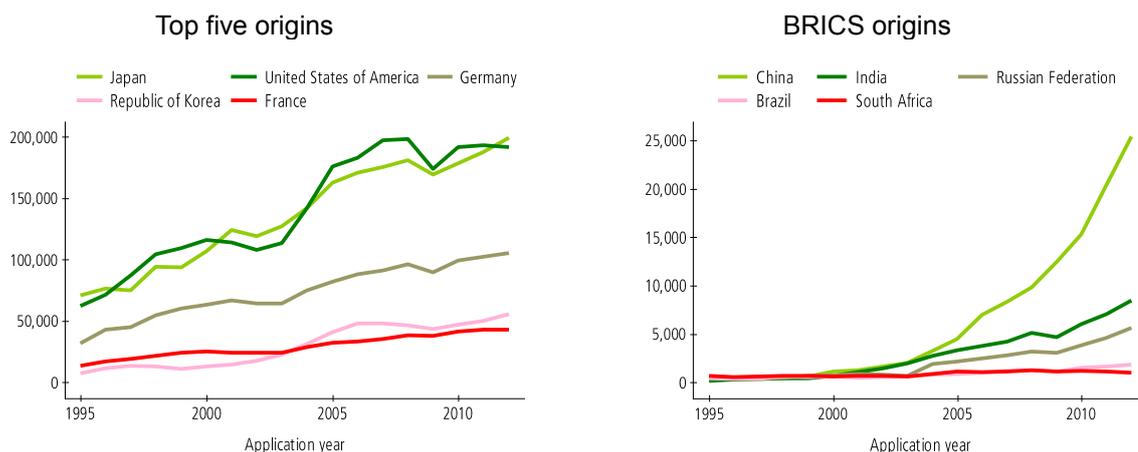
Source: WIPO IP Statistics Database, June 2014.

Chinese patent applicants rarely filed abroad during the earlier years of the Chinese patenting use. Specifically, before 2000, Chinese companies merely filed a few hundreds of patent applications in foreign countries. By 2000, China’s patent filings abroad broke the one thousand marks. By contrast, in the same year, US and Japanese companies filed more than 100,000 patents abroad, and German companies over 60,000.

Yet, the number of patents filed abroad by Chinese residents has increased considerably since as explained in section 3 of this paper. Figure 3 shows the trends in applications filed abroad for the top five origins and China. The bulk of all applications

filed abroad by residents of China, i.e. slightly more than half, were destined for the USPTO.

Figure 3: Trends in applications filed abroad for the top five origins and BRICS origins



Note: As some offices do not provide data broken down by origin, the numbers of applications by origin reported here are likely to be lower than their actual numbers. BRICS = Brazil, the Russian Federation, India, China and South Africa.

Source: WIPO (2013), based on WIPO Statistics Database, October 2013

China has also increased its share of its PCT filings world total since the mid-2000s. The US, with 51,643 applications, was the largest user of the PCT system in 2012, followed by Japan (43,660), Germany (18,764) and China (18,617).

The next section reviews how this exponential use of domestic and foreign patenting systems has been treated so far in the economic literature.

2. Overview of the economic literature on Chinese' domestic and foreign patenting

Mirroring the above trends, a growing economic literature has been concerned with the study of the Chinese use of the patent system. As stated earlier, nearly all the existing papers of economists however focus on the extent and driving factors of the patenting surge at the Chinese IP Office, rather than Chinese filing broad.

Economic literature studying the domestic Chinese patenting surge

The focus of the existing economic literature is on the study of the domestic Chinese patenting increase and assessment of its main drivers. These studies mostly use patent statistics from SIPO at the level of a country or an industry (e.g., Hu, 2010) and occasionally at the level of a province (e.g., Sun, 2000, Li, 2012). At times data from the European Patent Office' (EPO) PATSTAT for domestic Chinese patents is used. So far, only a few academic papers provide analysis at the level of an applicant due to limited data.

The literature on domestic patenting surge concludes the following (see Table 1 for an overview of these papers):

- As indicated by the earlier data analysis, the literature confirms a sharp increase in patent applications can be seen for both domestic and foreign applications at SIPO from 2000; the share of resident patent applicants has been gradually increasing to make up for the majority of patent filings at SIPO.
- Overall, both firms and universities have been gaining share in total patent applications, while the share of individual applicants and public research institutes (PRIs) has been decreasing.⁹ The literature confirms that the patenting increase in China is mainly driven by a greater activity and propensity of Chinese firms – as opposed to foreign firms or Chinese universities and public research institutions – to use the domestic patent system. The accelerated exit of state-owned enterprises (SOEs) and the orientation of remaining SOEs to more efficient and innovation-driven economic activities are also considered drivers of

⁹ Motohashi (2008).

patenting.¹⁰

- Patenting by Chinese residents remains concentrated. Patent filings and subsequent ownership are highly concentrated among a few Chinese firms and in a few sectors only. The concentration of patenting also applies in spatial terms. A few regions are at the source of the majority of Chinese filings at WIPO.¹¹

When it comes to the drivers of the Chinese patenting surge, various factors are analyzed.¹² One key question is whether the increasing use of patents via Chinese residents indeed reflects increased innovation capacity or whether other, more institutional factors or policies, are at play.

Existing studies focusing on the initial rise of Chinese patenting and the years before the turn of the millennium confirm the importance of institutional changes and pro-IP policies (e.g. financial incentives to use IP) in encouraging the surge. During the past three decades China has seen considerable changes in the patent regime, which included reforms in its national laws and signature of international treaties, and in particular the accession to the WTO.¹³

In particular, Motohashi (2008) emphasizes pro-patent legislation as well as government subsidies are the factors behind the patenting surge in China. Hu and Jefferson (2009) study self-reported patent counts for China's large and medium size companies to analyze patenting with SIPO during 1995-2001. They also conclude that pro-patent legislation is the biggest driving factor. The intensification of R&D in the Chinese economy, the inflow of foreign direct investment (FDI), the shift to patent-intensive industries with more complex technologies are also found to be more minor but increasingly important driving factors. Lei, Zhen and Wright (2012) provide further evidence that some of the domestic patent filings are policy-driven, rather than a

¹⁰ Jefferson et al. (2003), Hu and Jefferson (2004) and Sun and Du (2010).

¹¹ Sun (2000) finds that distribution of patents among Chinese provinces in 1985-1995 was highly clustered, where fast growing coastal provinces and inland provinces with large population received most of the patents. For the period 1995-2007, Li (2012) finds that variation in patenting across Chinese provinces is strong and increasing.

¹² In this context see also the presentations of the UNU-MERIT "Workshop on Patenting in China" Maastricht, the Netherlands, 10 December 2010.

¹³ Straus (2008), Awokuse and Yin (2010), Zhang (2011) and Sun (2003).

reflection of innovation and commercial activity. In a similar vein, authors of other papers have studied the influence of particular financial incentive schemes and concluded that their impact on the patenting increase was significant and large.¹⁴

The above papers focus on the early stages of the Chinese patenting increase. Studies on more recent years emphasize that technological and innovation capacity have become a more important driving factor for patenting over time.¹⁵

Chinese firms are shown to conduct and more on internal research and development (R&D) to achieve technological innovation and better economic performance.¹⁶ Technology transfer from foreign firms, domestic R&D efforts, and industry-university science and innovation collaboration is clearly on the increase furthering domestic patent applications. An increase of the returns to patenting can be observed.¹⁷

It has also been suggested that the increasing competition with local and foreign firms and the increased threat of imitation have raised the domestic awareness of the strategic value of patents.¹⁸ Chinese companies increasingly focus on patent implementation and industrialization in their business strategies.¹⁹ SIPO (2014) finds that the majority of companies in China now apply for patents with the goals of: (i) “occupying and expanding market” (60%), and “protecting new technologies from imitations” (62%). In addition, there is an emerging trend that together with implementation and industrialization of patents, Chinese companies have begun to develop other more strategic patenting motives such as occupying a technological space, averting litigation, increasing bargaining power in IP negotiations, improving their corporate image and deriving revenues from royalty and license fee income.

¹⁴ Li (2012), for instance, suggests that the subsidies that have been implemented in Chinese provinces since 1998 had a major impact on the propensity of Chinese residents to patent.

¹⁵ Sun and Du (2010) and Hu, Jefferson, and Jinchang (2011).

¹⁶ OECD (2008).

¹⁷ Kroll (2011), Hu and Jefferson (2009) and Zhang (2010).

¹⁸ Hu and Jefferson (2009), Zhang (2010), Hu (2010) and Huang and Jacob (2014).

¹⁹ SIPO (2014), the other study produced as part of this SIPO-WIPO project, and Huang and Jacob (2014).

Foreign patenting surge

In turn, only a handful of studies have taken interest at patent filings by Chinese residents abroad while focusing on the major foreign patent offices.

Most find that the level of foreign patenting is still low and in line with economic development and lower innovative capacity.²⁰ Limited technological potential is often put forward as the reason for lower foreign patent applications.²¹ The few existing studies often do not resort to detailed analysis of patent data however and are limited to earlier years.

In addition, two studies focused on foreign patenting by Chinese residents have been completed. Using more detailed patent datasets to conduct the analysis, they are focused on the analysis of filings of Chinese residents at one foreign patent office, more specifically as the USPTO.

Hu and Mathews (2008) examine patenting activity at USPTO in 1991-2005 by different groups of patent applicants from China, i.e. universities, public research institutes (PRIs), state-owned enterprises, private enterprises, FDI ventures and individuals. In general before the year 2000 they find very limited Chinese patenting activity at the USPTO. And, before this year, PRIs were the most active Chinese patentee at the USPTO. Mirroring domestic patenting trends, however, since China joined WTO, the patenting of Chinese firms at the USPTO has been on the increase.

In a more recent paper Eberhardt, Helmers and Yu (2013) match USPTO and SIPO patents with manufacturing census data for about 20,000 firms registered in China in 1985-2006. To our knowledge, this is the most ambitious data-driven analysis of Chinese patenting abroad. Given the matched dataset it also nicely allows to compare relative patenting behavior at home and at the USPTO of the same commercial entity. Given the complexity of the matching procedure a subset of Chinese firms is used in the analysis. The analysis also stops in the year 2006. Nonetheless, interesting findings are generated in this paper based on this original data work. In sum, the study finds that at the USPTO it is mainly a handful of very large, relatively young, R&D-

²⁰ Schaaper (2009) and Kroll (2011).

²¹ Sun (2003).

intensive and strongly export-oriented Chinese companies in the ICT sector account for the overwhelming share of patents.

In the following section, this paper aims to complement and extend the above analysis on Chinese patenting abroad while moving the focus on filings at the USPTO alone and while treating a more complete and recent set of Chinese patents abroad by using the approach of patent families.²²

²² One paper, Huang (2014) presented at the Experts' Meeting on Intellectual Property and Socio-Economic Development" jointly organized by WIPO and SIPO has been organized in Beijing on March 25, 2014 also focused on identifying the determinants of "quadric patenting", defined as a patent family that consists of patent applications at the EPO, the JPO, the USPTO, and the national patent office of a fourth country.

Table 1: An overview of the selected economic literature on Chinese' domestic and foreign patenting

Author(s)	Year of publication	Citation	Main findings
Domestic patenting			
Sun	2000	"Spatial distribution of patents in China", <i>Regional Studies</i> , Vol. 34.5 pp. 441-454, 2000	Distribution of patents among Chinese provinces in 1985-1995 is highly clustered, but spatial concentration of patents in China has been declining.
Sun	2003	"Determinants of foreign patents in China", <i>World Patent Information</i> 25 (2003) 27–37	Within the period of 1985 -1999 (i) foreign patents in China primarily fall within the category of inventions, whereas Chinese domestic patents mainly consist of utility models and industrial designs; (ii) foreign patents in China are largely awarded to organizations, while individuals consist of the majority of Chinese domestic patentees.
Jefferson, Hu, Guan and Yu	2003	"Ownership, performance, and innovation in China's large- and medium-size industrial enterprise sector", <i>China Economic Review</i> 14 (2003) 89–113	Based on a panel of large- and medium-size enterprises (LMEs) data for 1994–1999, patent application intensity nearly doubled over the period and eight high-performing patent producers emerged. The data also showed rapidly diversifying ownership structure in which the role of the state was steadily retreating.
Motohashi	2008	"Assessment of technological capability in science industry linkage in China by patent database", <i>World Patent Information</i> 30 (2008) 225–232.	Based on SIPO patent applications in 1985-2005, a sharp increase in patent applications can be seen from 2000, for both domestic and foreign applications at SIPO. The share of Japan among SIPO applications is the highest among non-Chinese countries. The share of ICT and electronics patents has been increasing since the mid-1990s, however substantial portion of these patents are applied from overseas, particularly from Japan. Most of overseas applications are from firms. University-industry co-patenting become important, while the role of PRIs decreases since 2000.
Hu and Jefferson	2009	"A great wall of patents: What is behind China's recent patent explosion?", <i>Journal of Development Economics</i> 90 (2009) 57–68.	R&D, FDI, and pro-patent legislation are all the drivers behind the patenting surge. Pro-patent legislation appears to be the largest contributing factor.
Sun and Du	2010	"Determinants of industrial	As of 2004, in-house R&D plays a more critical role in China's industrial

		innovation in China: Evidence from its recent economic census”, Technovation 30 (2010) 540–550	innovation as measured by patents and new products.
Hu	2010	“Propensity to patent, competition, and China’s foreign patenting surge”, Research Policy 39 (2010) 985–993.	Foreign applications for Chinese patents have been growing by over 30% a year. The ability of Chinese firms to imitate foreign technology and competition between foreign firms, are found to be the drivers of patenting of foreign firms in China.
Zhang	2010	“What is behind the Recent Surge in Patenting in China?”, International Journal of Business and Management, Vol. 5, No.10; October 2010	The main factors accounting for the recent patent boom in China can be attributed to the second revision of Chinese patent law in 2000, the intensification of R&D expenditure both in China and the rest of the world, and the increasing FDI flowing into China.
Kroll	2011	“Exploring the validity of patent applications as an indicator of Chinese competitiveness and market structure”, World Patent Information 33 (2011) 23–33.	The share of Chinese applicants at SIPO has been increasing since the mid to late 1990s and more sharply since 2004. Global filings of Chinese applicants are biased towards the few major firms.
Li	2012	“Behind the recent surge of Chinese patenting: An institutional view”, Research Policy 41 (2012) 236– 249.	Patent subsidy programs implemented by each provincial region have played an important role in the growth of Chinese patenting.
Lei, Sun and Wright	2012	“Are Chinese Patent Applications Politically Driven?”, working paper, 2012, presented at the Patent Statistics for decision makers conference, 2012.	Based on monthly patent application by domestic and foreign applicants at China’s State Intellectual Property Office during 1985-2007, the growth rate of domestic patent applications has increased greatly in recent years despite a slowdown in foreign applications. There is a much stronger peak in December for domestic filings after 2001. The surge in December filings seems to begin after 2001, when China started to encourage innovation and patenting via subsidies.
SIPO	2014	“Patents Role in Business Strategies: Research on Chinese Companies”, CDIP/13/INF/8, prepared by SIPO, WIPO Committee for Development and	Chinese companies continue to focus on patent implementation and industrialization in their business strategies, but have begun to develop other strategic motives such as a technological space, averting litigation, increasing bargaining power in IP negotiations, improving their corporate image and deriving revenues from royalty and license fee income

		Intellectual Property, May 2014	
International patenting			
Hu and Mathews	2008	“China’s national innovative capacity”, Research Policy 37 (2008) 1465–1479.	PRIs are the main patenting group from China at USPTO until the year of 2000 when private sector and foreign firms took off in patenting.
Eberhardt, Helmers, and Yu	2014	“Is the dragon learning to fly? The Chinese Patent Explosion at Home and Abroad”, 2014, Working Paper.	A handful of companies in the ICT sector account for the overwhelming share of patents both in the US and China. The firms that patent both in the US and China tend to be younger, larger and more export-oriented than firms patenting exclusively in China.
Huang and Jacob	2014	“Determinants of Quadric Patenting: Market Access, Imitative Threat, Competition and Strength of Intellectual Property Rights”, Technological Forecasting and Social Change, Volume 85, June 2014, Pages 4–16.	Based on the industry-level analysis for China and country-level analysis for the sample of 38 countries within 1985-2004, “quadric” patenting (a patent family that consists of patent applications filed at the EPO, JPO, USPTO and a home country’s patent office) is driven by the need to access markets, respond to imitative threats, and compete in product markets.

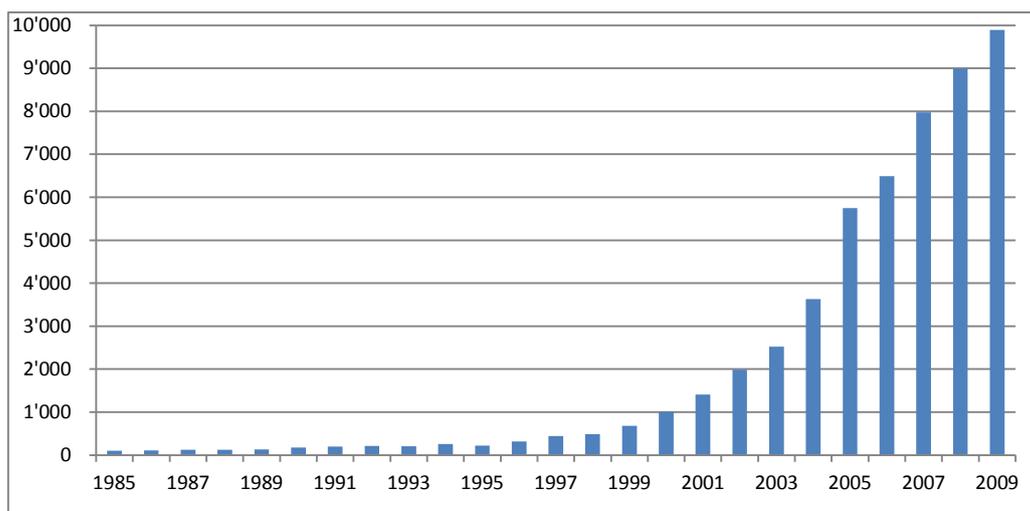
3. Analysis of Chinese patenting abroad

This section conducts the analysis of patents filed abroad by Chinese residents on the basis of WIPO's foreign-oriented patent family dataset.

3.1 The surge of Chinese foreign-oriented patent families as of 2004

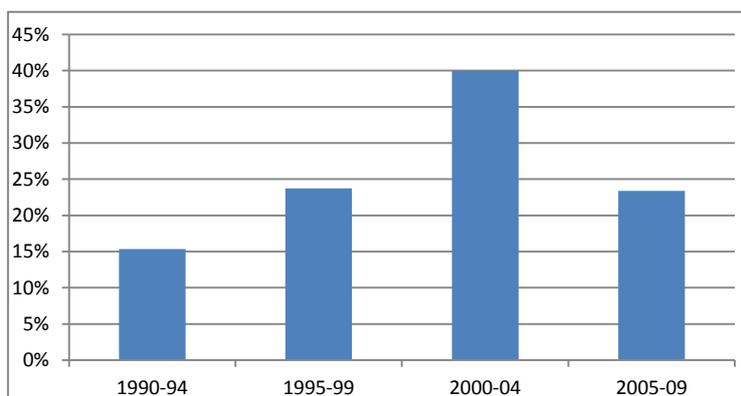
The growth of Chinese patent filings abroad increased significantly after the year 2000 (see Figures 4 and 5). At that point the five-year average annual growth rate increased to almost 40% between 2000 and 2005, up from 24% between 1995 and 1999. Having reached significant levels, the five-year average growth rate of foreign-oriented patent families decreased to 23% since 2005. In absolute terms this still translates to an increase of these patent families by approximately 1,000 every year.

Figure 4: Chinese foreign-oriented patent families, 1985-2009



Source: WIPO IP Statistics Database.

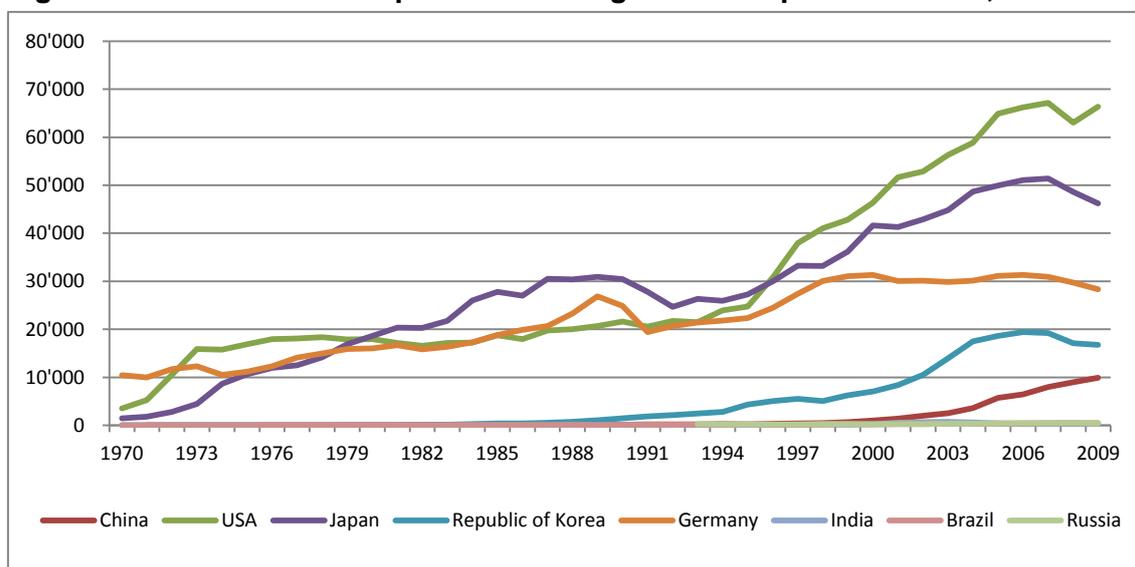
Figure 5: Growth rates of Chinese foreign-oriented patent families, 1990-2009



Source: WIPO IP Statistics Database.

While in the beginning of the 1990s the total number of Chinese foreign-oriented patent families was on par with the number of those of residents of other fast-growing middle-income economies, by the end of the 1990s China decoupled and started to emerge as major player in terms of international patenting as compared to, for instance, Brazil, Russia, India, South Africa and others (see Figure 6).

Figure 6: International comparison of foreign-oriented patent families, 1970-2009

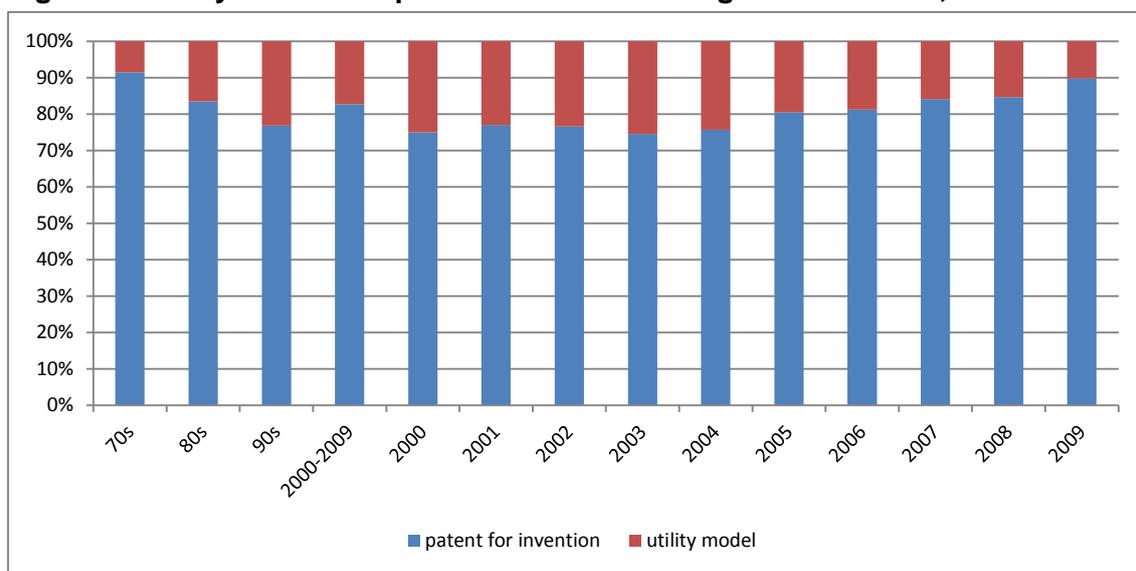


Source: WIPO IP Statistics Database.

Today more than 80% of foreign-oriented patent families by Chinese residents are associated with invention patent applications (see Figure 7). The share of families associated with utility model (UM) applications had grown from less than 9% on

average in 1970s to more than 23% on average in the 1990s. But from 2003 onwards the share of invention patent applications has grown, reaching almost 90% of total foreign-oriented patent family applications in 2009. This compares to 97% in the US, to 98% in the Republic of Korea, to 99% in Japan and to 94% in Germany. This also compares to the fact that the share of domestic patent families by Chinese residents associated with invention patents is only 40%, with the remainder being domestic patent families started through a UM application.

Figure 7: Utility model and patent for invention originated families, 1970-2009

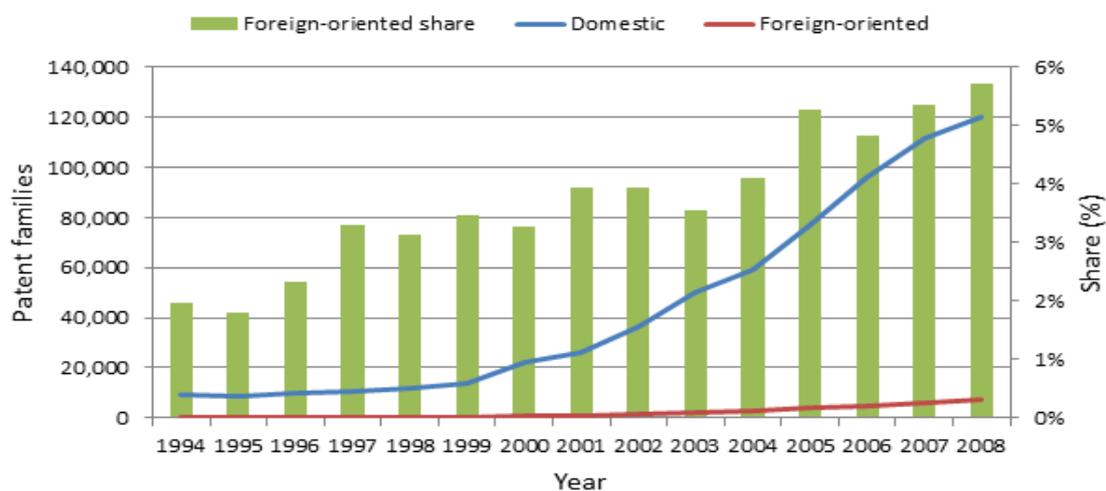


Source: WIPO IP Statistics Database.

That said, the share of Chinese patents which get filed abroad is still a fraction of total patents filed at home. According to the assembled data the total number of Chinese foreign-oriented patent families within the period of 1985-2012 equals 64,969. Within the same period there have been 2,604,707 domestic patent families applied by Chinese residents. In both cases, this includes UM-based applications.

One can narrow this comparison down further to invention patents to have more comparable figures. As shown in Figure 8, roughly speaking, for every 16 domestic families starting with an invention patent, there is one foreign-oriented patent family – of which each might contain several patents in multiple jurisdictions. In other word, the share of foreign-oriented in all patent families by Chinese residents is between 5 and 6%. Relative to the growth of domestic patent families, the growth of foreign-oriented families has been much faster on average, admittedly from a lower level.

Figure 8: Growth rates of Chinese domestic patent families, 1994-2008



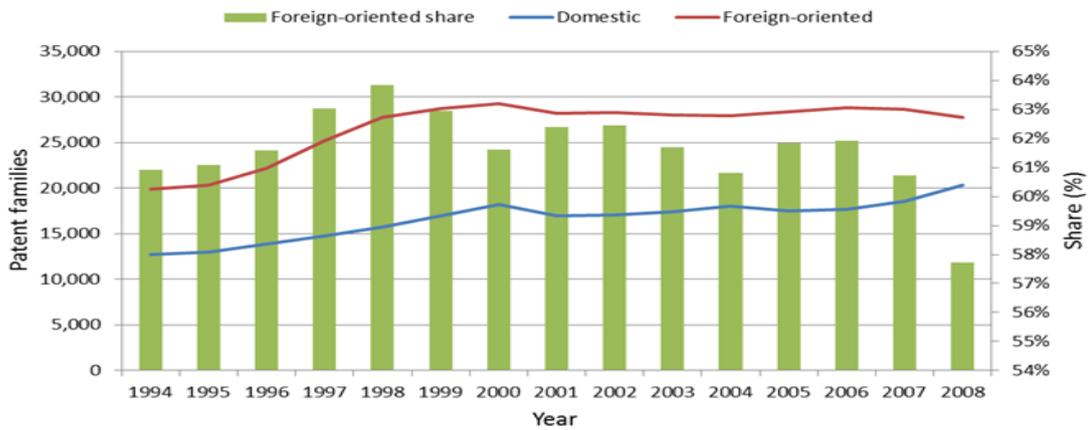
Source: WIPO IP Statistics Database.

When comparing to high-income countries such as Germany, Japan or the US it becomes apparent that these countries have significantly higher shares of foreign-oriented to total patent families (see Figures 9-11). In the case of Germany with around 60%, and the US with around 50% – but less so Japan with less than 20% - the wedge between domestic and foreign-oriented patent families in terms of volume and growth is also significantly smaller in these high-income economies.

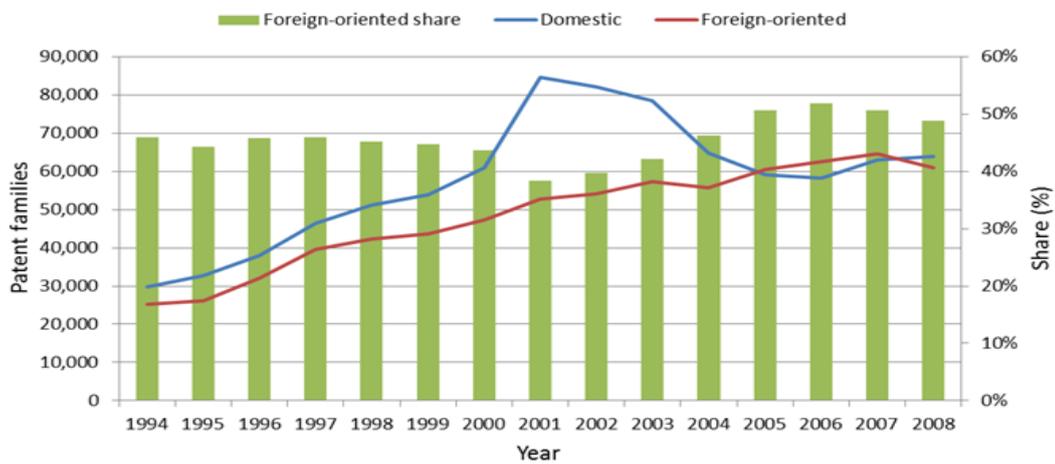
Figures 9, 10 and 11: Domestic and foreign-oriented patent families compared, selected high-income countries, 1994-2008

Left axis is the number of domestic and foreign-oriented patent families (blue and red line), right axis is the share of foreign-oriented in total families (green bars).

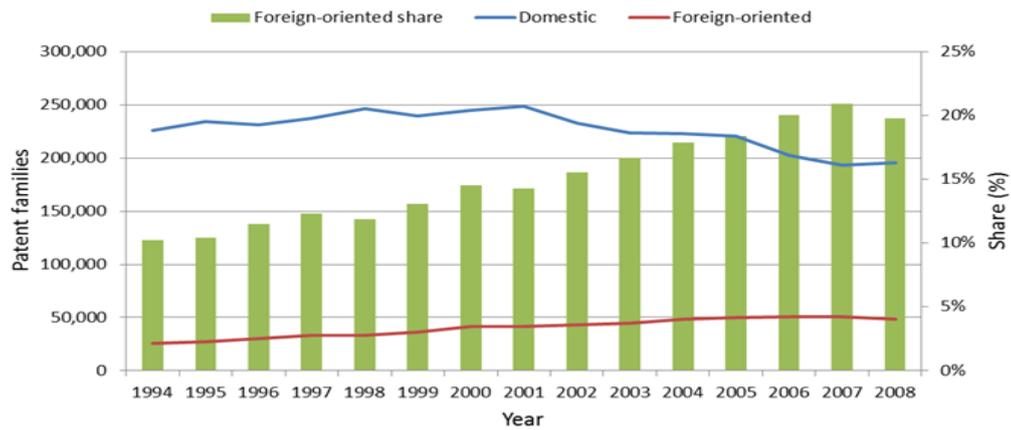
Germany



United States of America



Japan



Source: WIPO IP Statistics Database.

The next section describes the main destinations of Chinese patents abroad.

3.2 Destinations of foreign-oriented patent families by Chinese residents

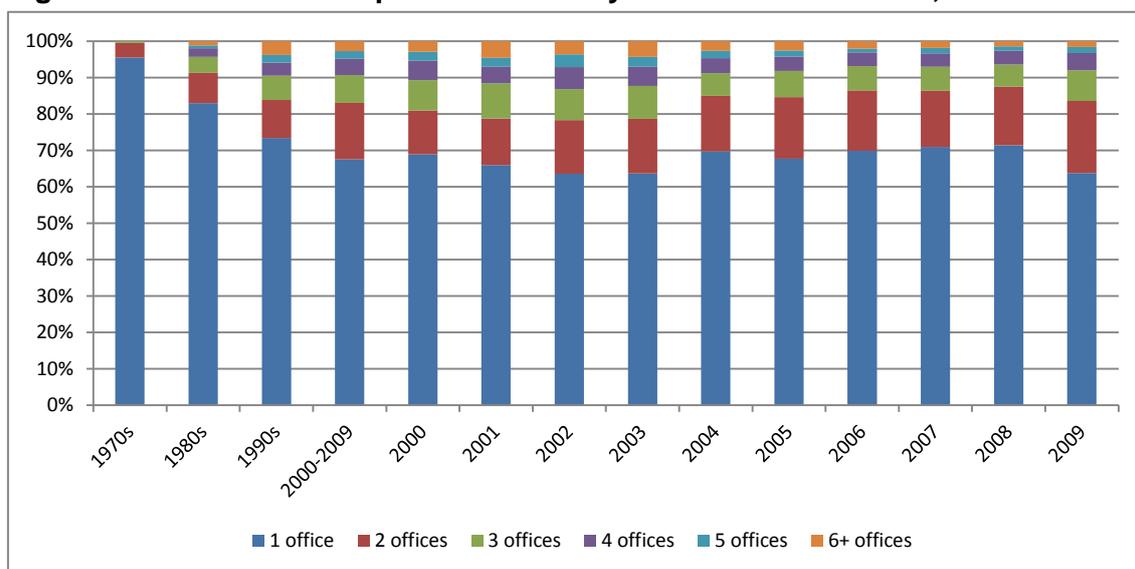
Foreign-oriented patent families can target one or several jurisdictions worldwide. The amount and location of foreign jurisdictions in which a firm or an inventor will file for patent protection depends on many factors, most notably on (i) where an inventor's main markets are, (ii) where an inventor's competitors and potential imitators are, (iii) where an inventor might decide to assemble his or her products, and other business and strategic considerations. Clearly, the industry sector or the technology field for which the patents are applicable matter greatly as well.

Despite the important rise of foreign-oriented patent families by Chinese residents, still the majority of foreign-oriented patent families by Chinese residents, and thus about 70%, target just one foreign IP office (see Figure 12).²³ This is in contrast to Japan and the Republic of Korea where foreign-oriented families with two foreign offices have the largest shares among total foreign-oriented patent families, while the shares of patent families with just one foreign office are small (17% in Japan and 15% in the Republic of Korea). Foreign-oriented patent families emanating from the US or Germany with only one foreign office as target are also of lesser relative importance than in China with respectively 39% and 38% of total foreign-oriented patent families.

That said, over time, the share of Chinese foreign-oriented patent families with more than one foreign office has increased – from about 5% in the 1970s to 36% in 2009. While among these families, the majority is still with two patent offices (about 55%, or 1848 patent families), and not more, a considerable share also targets three (23%, or 782 patent families) and four offices (13%, or 441 patent families).

²³ This figure excludes patents also filed in Hong Kong (China) and Taiwan (Province of China).

Figure 12: Distribution of patent families by the number of offices, 1970-2009



Source: WIPO IP Statistics Database.

More than 80% of Chinese foreign-oriented patent families in 1970-2012 include at least one patent application with USPTO, EPO, or JPO. The share of triadic patent families (USPTO, EPO, and JPO) is approximately 7% and the share of families that include applications at five patent offices (USPTO, EPO, JPO, KIPO, and SIPO) is around 3% (see Table 2.1 for details). Interestingly, more recently and for the time span 2005 to 2009, the above shares have rather dropped rather than increased. The share of patents offices with at least one application with USPTO, EPO or JPO has for instance dropped from about 81% to 72% (see Table 1). The same is true for the other IP office combinations seen in this table.

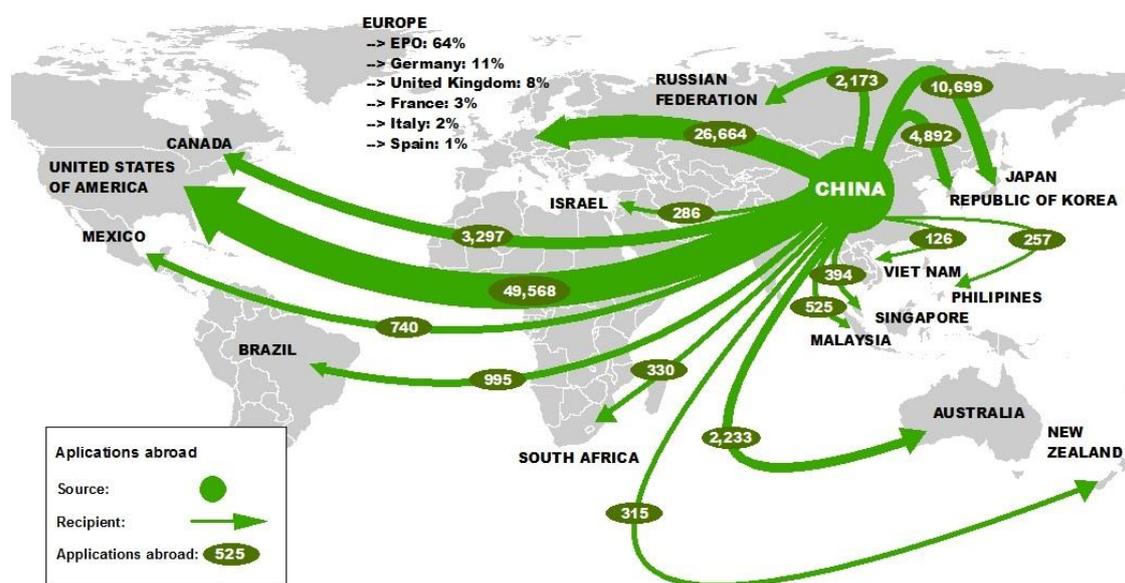
Table 1: Foreign-oriented Chinese patent families with a minimum of foreign IP offices, 1970 to 2012 and 2005-2009

Patent offices within a family	Number 1970-2012	Percentage share 1970-2012	Number 2005-2009	Percentage share 2005-2009
Triadic (USPTO, EPO, and JPO)	4,561	7.0%	1,770	4.5%
5-offices (USPTO, EPO, JPO, KIPO, and SIPO)	1,952	2.99%	584	1.5%
At least one application with USPTO, or EPO or JPO	52,828	80.9%	28,006	71.6%
Total	65,340	100.0%	39,098	100.0%

Source: WIPO IP Statistics Database.

In terms of absolute numbers, the majority of patent applications from China that form the foreign-oriented patent families in our dataset target the US with close to 50,000 patent applications based on available data between 1970 and 2012, followed by Europe, Japan, the Republic of Korea, and Canada (see Figure 13). A significant number of patent applications also target Australia, and the Russian Federation. In comparison fewer applications target Brazil or other Asian economies.

Figure 13: Chinese patent filings abroad, cumulated to top IP offices, 1970-2012



Source: WIPO IP Statistics Database.

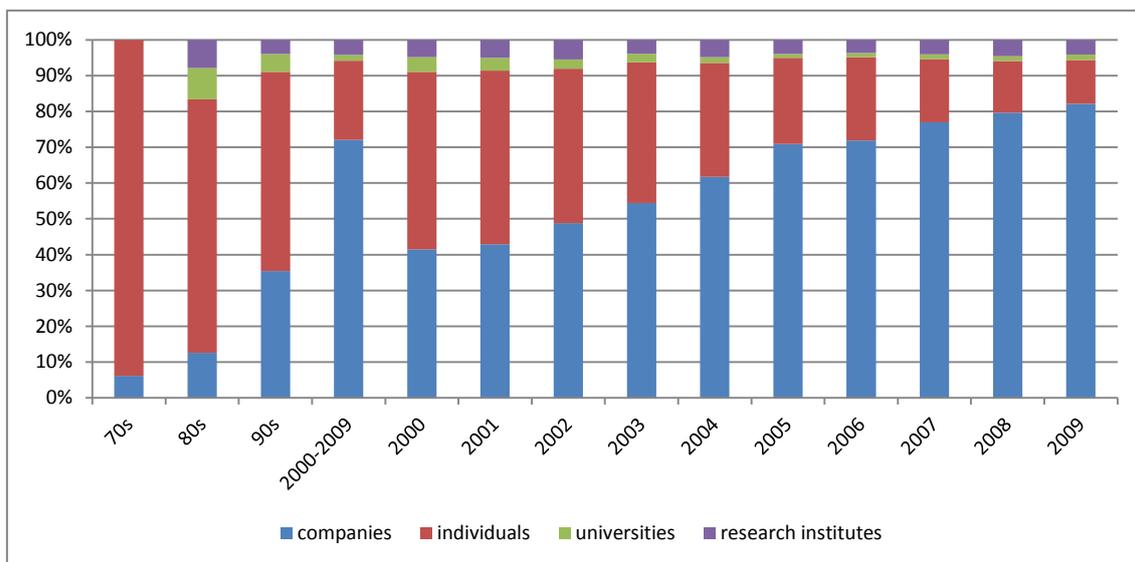
To determine whether a certain group of patent applicants is responsible for the growth in foreign patenting from China, the next section divides the patent families by the type of applicants (i.e., company, individual, and university or research institute) and by field of technology.

3.3. Applicant types: Actors, Technology fields and Sectors

Almost 70% of foreign-oriented patent families by Chinese residents are owned by companies. As Figure 14 shows the share of companies in total foreign-oriented patent families has been rapidly growing between 1970 and 2009; indeed more than doubling every decade. At the same time, the share of individuals has been declining. The share of universities and research institutes in total foreign-oriented patent families

is about 6%, which is similar to Republic of Korea (about 6%), and somewhat bigger if compared to the US (about 2%), Japan (less than 1%), and Germany (about 1%).

Figure 14: Distribution of Chinese foreign-oriented patent families by applicant type, 1970-2009



Source: WIPO IP Statistics Database.

In the next sections the foreign-oriented patent families by Chinese residents are analyzed as to their field of technology. The WIPO IPC-technology concordance table can be used to convert IPC symbols into corresponding fields of technology and sector.²⁴ This concordance table helps determine which technology fields are the most represented in Chinese patent filings abroad. The 35 possible technology fields are grouped into the broad five technology classes: *Electrical engineering*, *Instruments*, *Mechanical Engineering*, *Chemistry*, and *Other fields*. One patent family can belong to more than one technology field.²⁵ Also, there are 1,616 patent families in this dataset with missing information on their technology fields.

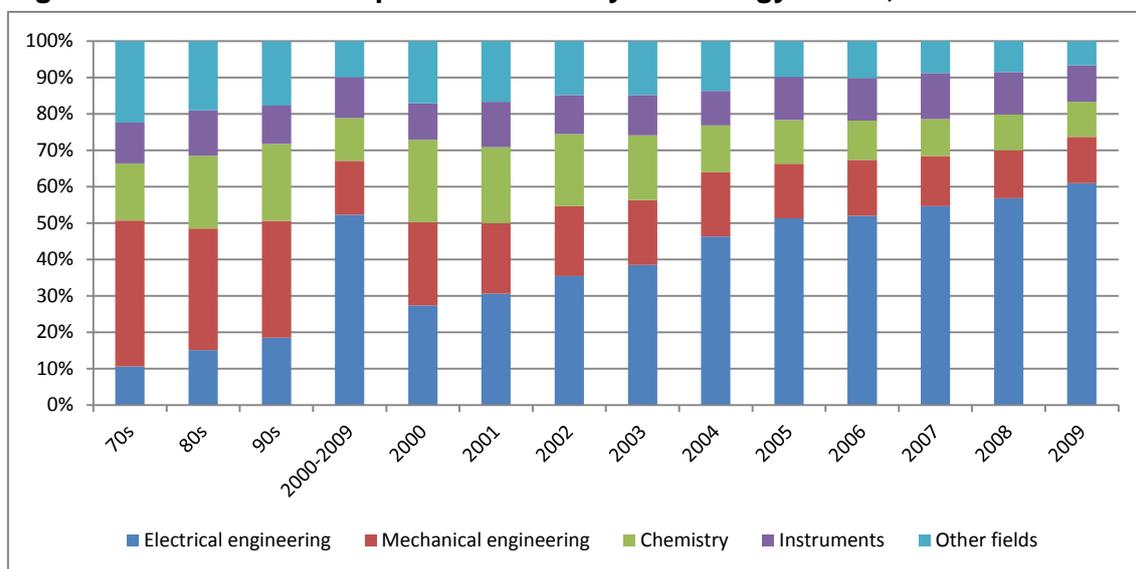
²⁴ See the concordance table at

http://www.wipo.int/ipstats/en/statistics/technology_concordance.html and Schmoch (2008).

²⁵ Fractional counting of technology fields is used for such families, where the percentage share of every field in a family is known.

Based on this methodology it is found that more than 50% of foreign-oriented patent families by Chinese residents belong to the “Electrical Engineering”-class. Figure 15 shows that the “Electrical Engineering”-class had one of the smallest shares in earlier years. Nonetheless, it has since been growing steadily, making up for the biggest share of foreign-oriented patent families in 2000-2009. The shares of other technology classes have rather been declining over the last 10 years. This is valid except for the “Instruments”-class. And while “Mechanical engineering” and “Chemistry” have declined they still make up for a considerable share, almost 23% taken together in 2009 to be precise.

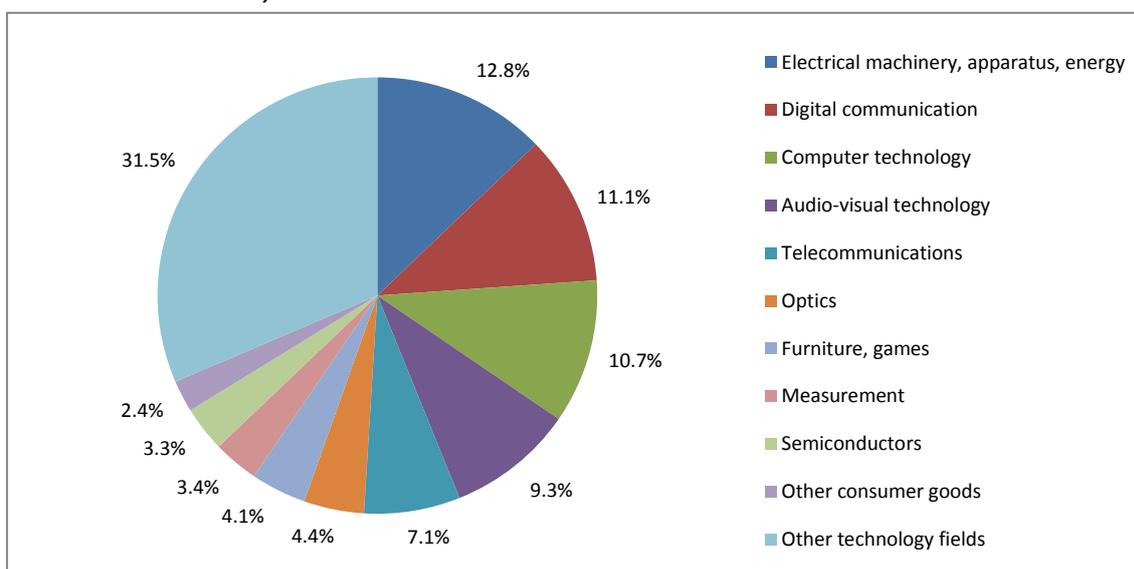
Figure 15: Distribution of patent families by technology sector, 1970-2009



Source: WIPO IP Statistics Database.

Going deeper, it is found that the ICT sector has the largest number of foreign-oriented patent families, with roughly one fourth of all patent families from China (25% within the whole period of 1970-2012, and 29% in 2005-2009). Figure 16 shows the top ten technology fields among foreign-oriented patent families by Chinese residents. The top five technology fields belong to the fastest growing “Electrical engineering”-class of patent families with “Electrical machinery, apparatus, energy” having the biggest share in total families (13%), followed by “Digital communication” (11%) and “Computer technology” (11%).

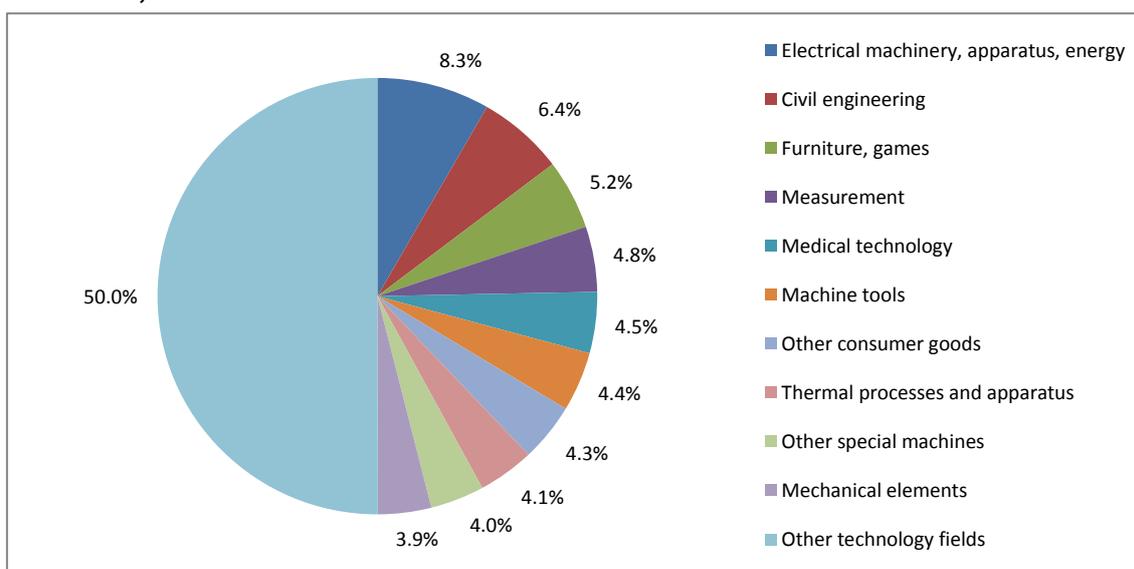
Figure 16: Top ten technology fields among foreign-oriented patent families by Chinese residents, 2005-2009



Source: WIPO IP Statistics Database.

The top technology fields among foreign-oriented patent families and domestic patent families overlap only partially. Specifically, only four out of the top ten technology fields are the same among foreign-oriented and domestic patent families groups (i.e., “Electrical machinery, apparatus, energy”, Furniture, games,” “Measurement”, and “Other consumer goods”) (compare Figures 16 and 17).

Figure 17: Top ten technology fields among domestic patent families by Chinese residents, 2005-2009

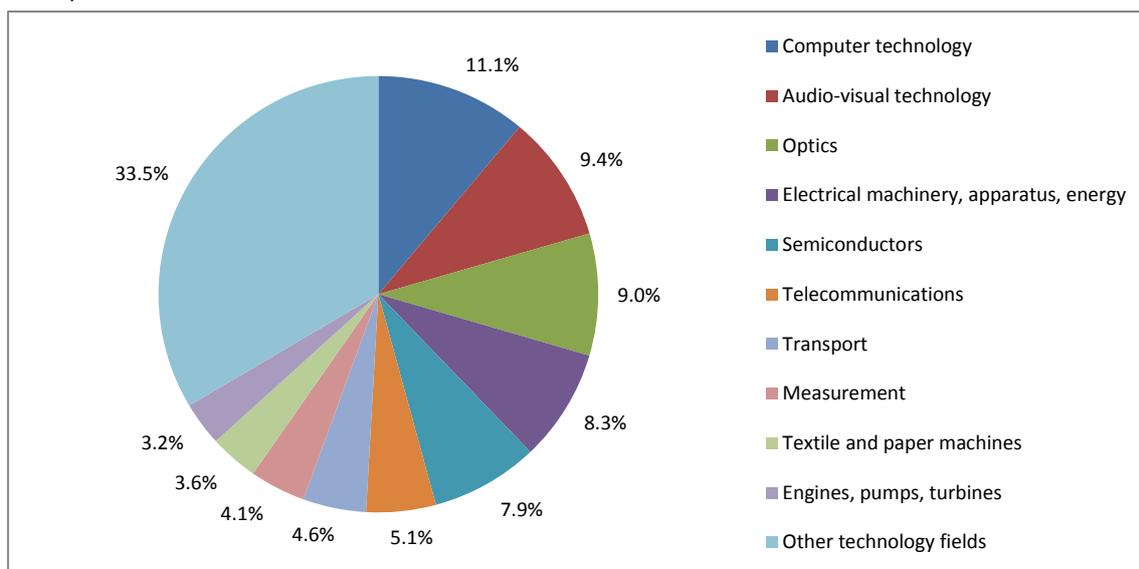


Source: WIPO IP Statistics Database.

Comparing to other countries again, China has a very similar “portfolio” of foreign-oriented patent families to those of the Republic of Korea and Japan, but quite a different from those of Western high-income economies such as the US and Germany (see Figures 18-21).

Seven out of top ten technology fields for Chinese foreign-oriented patent families are also among top ten technology fields for Japanese foreign-oriented patent families (see Figure 18). The “Transport”, “Textile and paper machines”, and “Engines, pumps, turbines”-technology fields are among the top ten for Japan, but not for China.

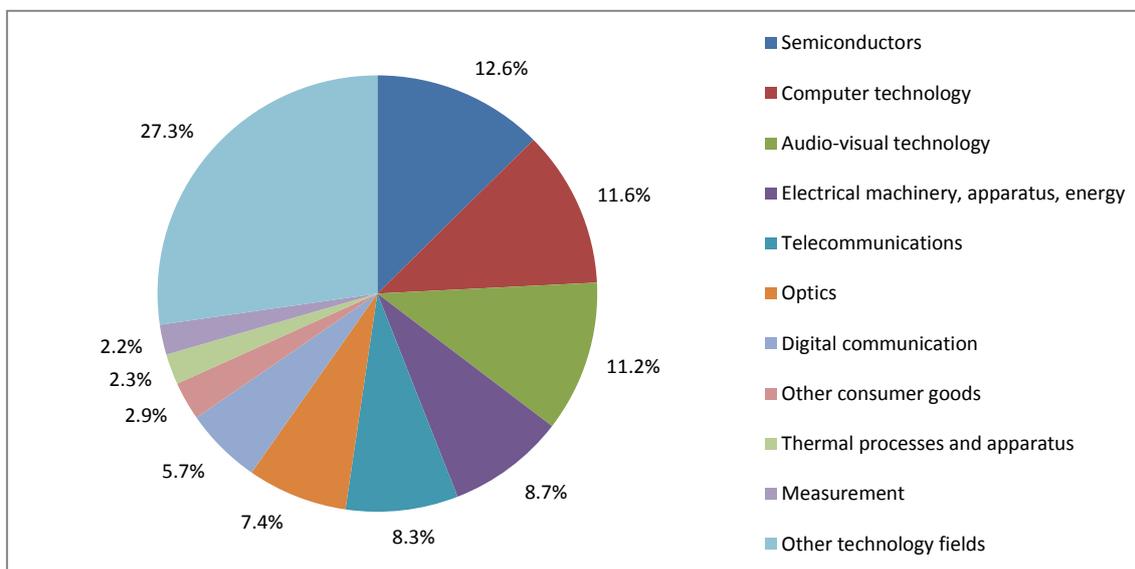
Figure 18: Shares of Japanese foreign-oriented patent families by technology field, 2005-2009



Source: WIPO IP Statistics Database.

Nine out of top ten technology fields for Chinese foreign-oriented patent families are also among top ten technology fields for foreign-oriented patent families of residents of the Republic of Korea (see Figure 19). Only the “Thermal processes and apparatus”-technology field is among the top ten for Republic of Korea, but not for China.

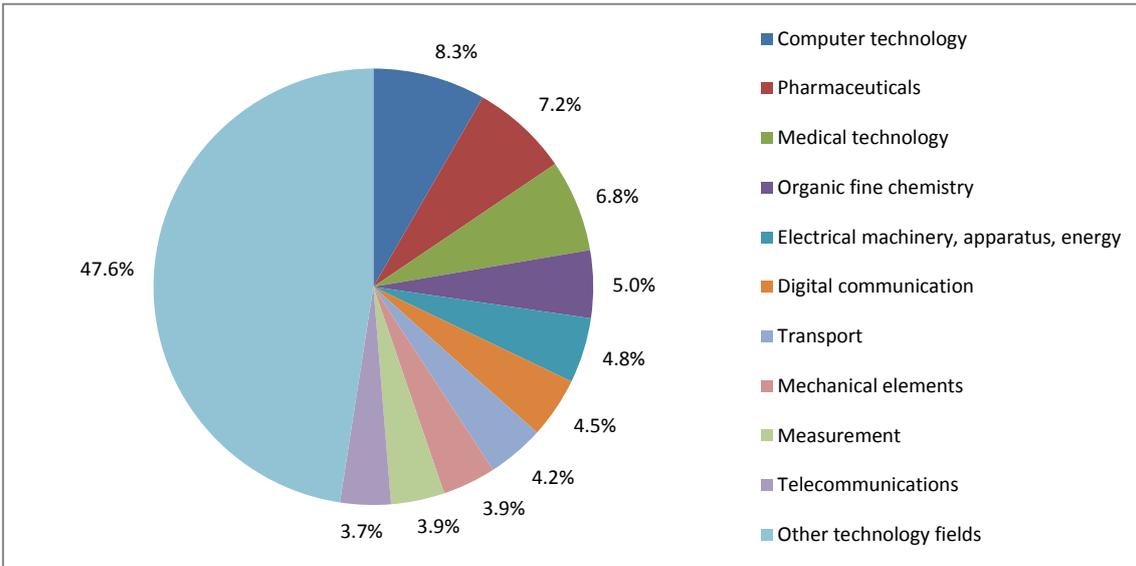
Figure 19: Share of Korean foreign-oriented patent families by technology field, 2005-2009



Source: WIPO IP Statistics Database.

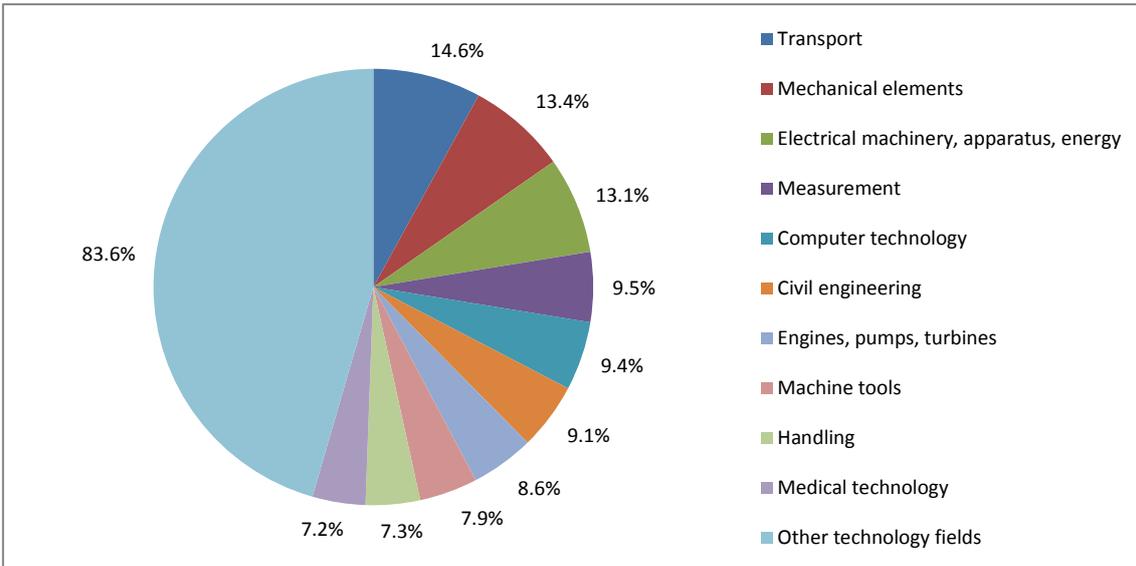
Only five out of top ten technology fields for Chinese foreign-oriented patent families are also among top ten technology fields for the US, namely “Computer technology”, “Electrical machinery, apparatus, energy”, “Digital communication”, “Measurement”, and “Telecommunications” (see Figure 20). Only three technology fields among top ten technology fields are the same for Germany and China (i.e., “Electrical machinery, apparatus, energy”, “Measurement”, and “Computer technology” fields) (see Figure 21).

Figure 20: Top 10 technology fields among foreign-oriented patent families by the residents of the US, 2005-2009



Source: WIPO IP Statistics Database.

Figure 21: Share of German foreign-oriented patent families by technology field, 2005-2009

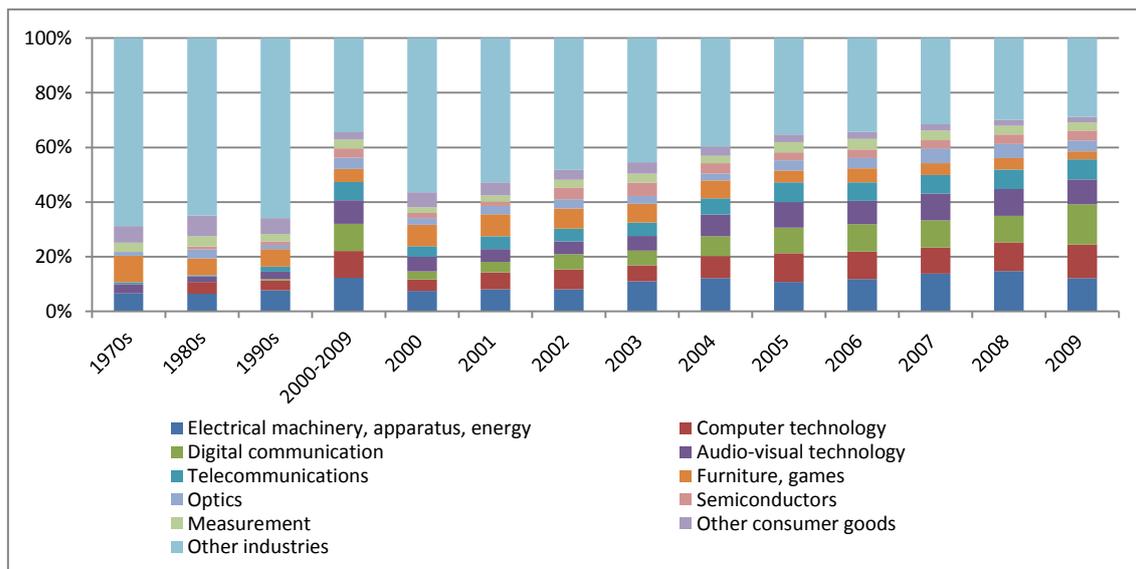


Source: WIPO IP Statistics Database.

In the case of Chinese patents filed abroad, the share of the top ten technology fields among total patent families almost doubled in the last decade (from 34% in the 1990s to 66% in the decade following) with “Electrical machinery, apparatus, energy”, “Digital communication”, “Telecommunications”, “Audio-visual technology” and “Computer technology” having the highest annual growth in 2000-2009. In other words, Chinese foreign-oriented patent families are ever more concentrated in a small number of

technologies fields, and this despite the considerably more important volume of total Chinese patents filed abroad in recent years (see Figure 22 and Table 2 for the growth rates of technology fields among foreign-oriented patent families).

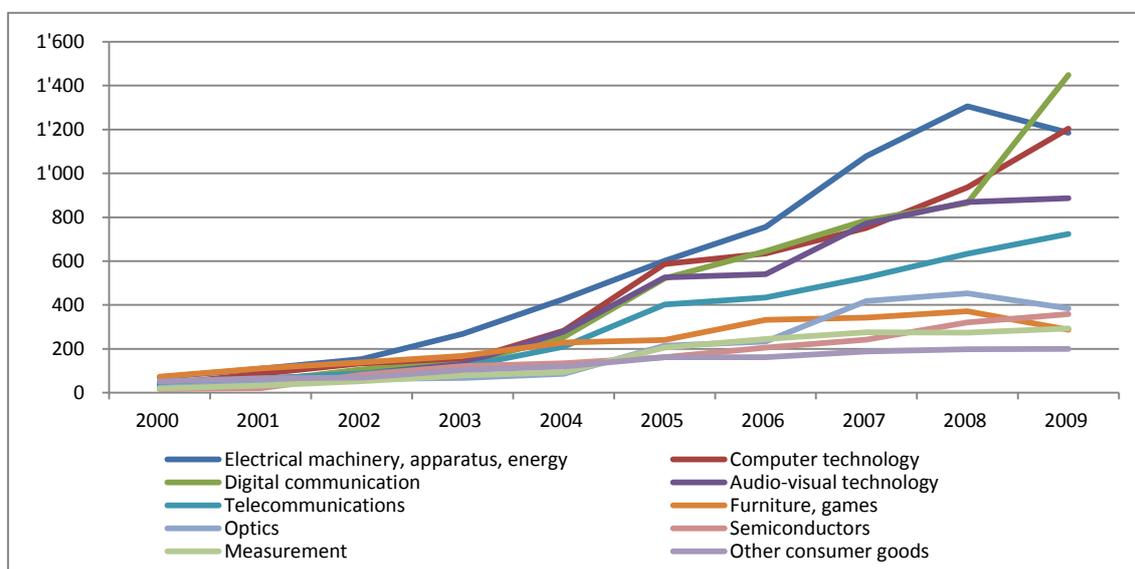
Figure 22: Top 10 technology fields among foreign-oriented patent families by Chinese residents, 1970-2009



Source: WIPO IP Statistics Database.

In terms of growth, “Digital communication” is the fastest growing technology field among Chinese foreign-oriented patent families between 2000-2009, followed by computer technology, nanotechnology, semiconductors and telecommunications (see Figure 23 and Table 2). That said, some of the fastest-growing fields such as nanotechnology or semiconductors are growing fast only from very low initial levels.

Figure 23: Annual number of patent families for the top ten technology fields, 2000-2009



Source: WIPO IP Statistics Database.

Table 2: Compound annual growth rate (CAGR), technology fields of foreign-oriented patent families of Chinese residents, 2000-2009

technology field	Number of families in 2000	Number of families in 2009	CAGR (2000-2009)
Digital communication	27	1449	55.4%
Computer technology	39	1204	46.5%
Micro-structural and nano-technology	1	19	44.0%
Semiconductors	17	358	40.3%
Telecommunications	37	724	39.2%
Audio-visual technology	50	887	37.6%
Electrical machinery, apparatus, energy	70	1186	36.9%
Optics	23	385	36.8%
Surface technology, coating	10	157	35.8%
Basic communication processes	8	121	35.2%
Measurement	20	293	35.0%
Control	10	151	34.7%
Materials, metallurgy	8	94	30.9%
Textile and paper machines	5	57	30.2%
Mechanical elements	27	222	26.4%
Handling	27	168	22.7%
Chemical engineering	25	152	22.2%
Machine tools	36	214	21.7%
Thermal processes and apparatus	33	189	21.4%
Engines, pumps, turbines	21	110	20.2%
Other special machines	31	159	19.9%

IT methods for management	7	35	19.1%
Analysis of biological materials	4	18	19.0%
Civil engineering	36	166	18.6%
Organic fine chemistry	23	107	18.5%
Basic materials chemistry	23	90	16.6%
Transport	35	135	16.4%
Furniture, games	74	287	16.3%
Other consumer goods	52	199	16.2%
Medical technology	37	134	15.4%
Food chemistry	6	21	15.0%
Pharmaceuticals	40	135	14.3%
Environmental technology	13	40	13.5%
Macromolecular chemistry, polymers	28	58	8.4%
Biotechnology	34	69	8.2%

Source: WIPO IP Statistics Database.

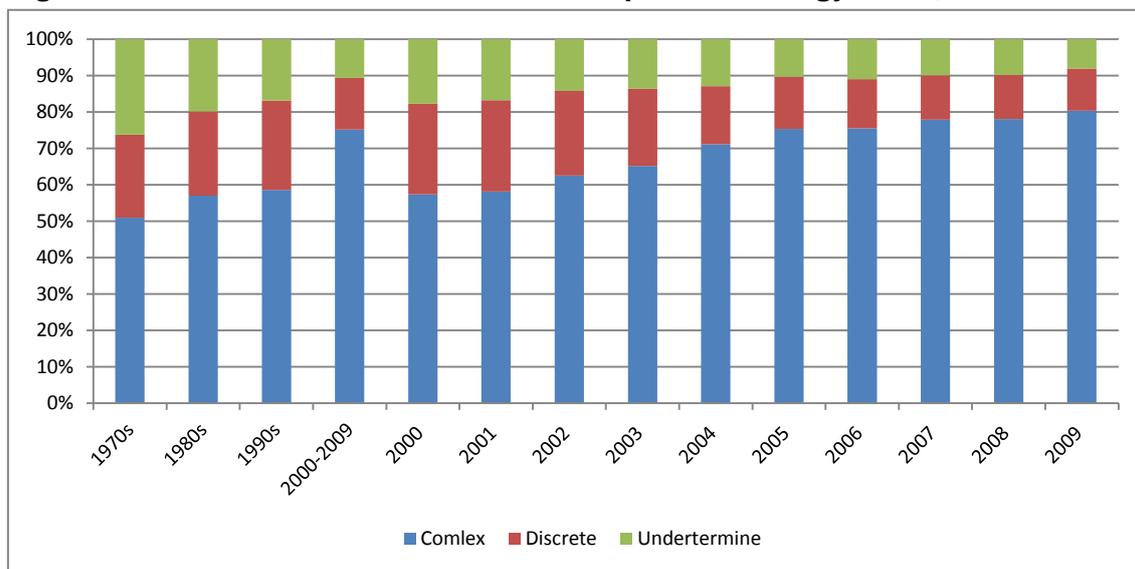
Patent data can be broadly categorized as complex or discrete technologies.²⁶

Complex technologies are usually defined as those for which the resulting products or processes consist of numerous separately patentable elements and for which patent ownership is typically widespread. Discrete technologies, in turn, describe products or processes that consist of a single or relatively few patentable elements and for which patent ownership is more concentrated. For example, smartphones fall into the category of complex technologies, whereas pharmaceuticals are considered a discrete technology.

The share of “complex” technology fields among all foreign-oriented patent families by Chinese residents has been growing between 1970-2009 making up a 75%-share of total patents abroad on average per annum since 2000 (see Figure 24). To the contrary, the share of “discrete” technologies has been shrinking.

²⁶ For a definition of complex and discrete technologies, refer to Annex A of the World Intellectual Property Indicators Report 2011, see WIPO (2011a), available at: www.wipo.int/ipstats/en/wipi/.

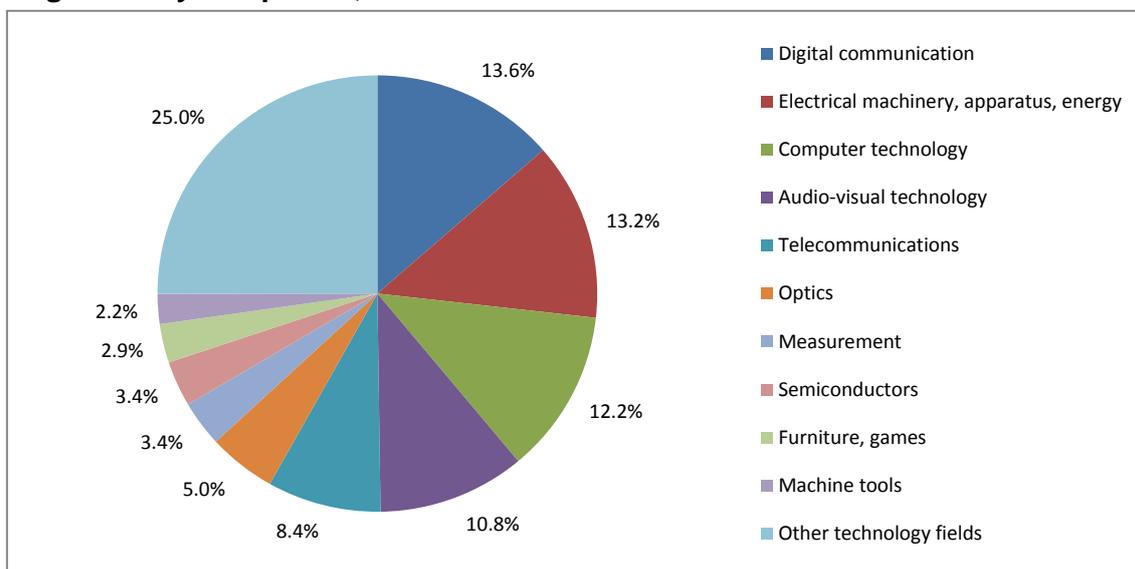
Figure 24: Distribution discrete versus complex technology fields, 1970-2009



Source: WIPO IP Statistics Database.

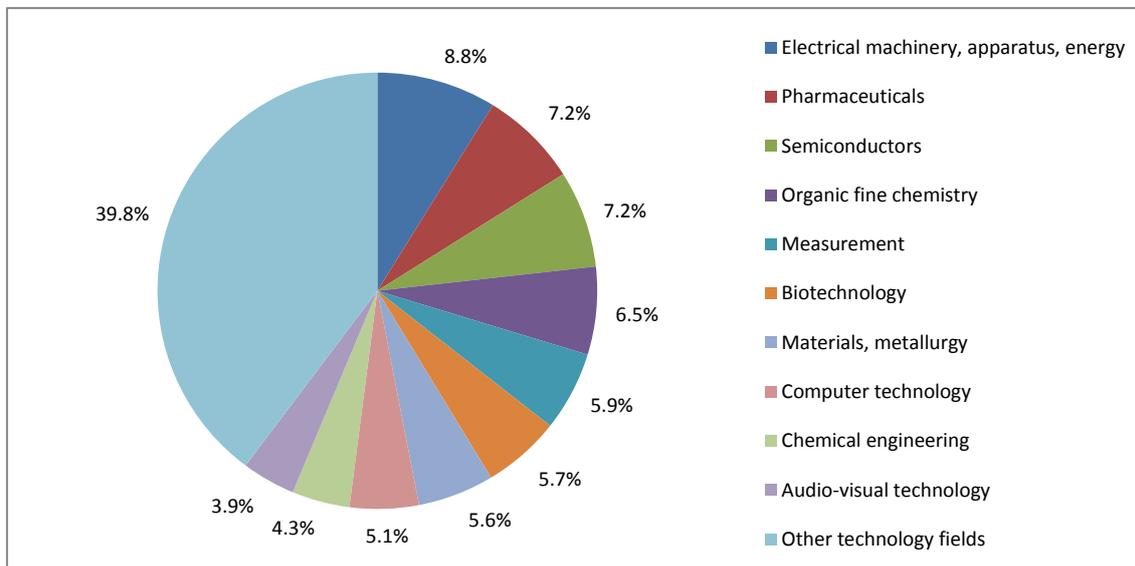
The top ten technology fields of patents filed abroad vary according to the type of Chinese applicants (see Figures 25-27). For companies, “Digital communication”, “Electrical machinery, apparatus, energy”, and “Computer technology” are the most important technology fields in terms of volumes between 2005 and 2009 (see Figure 25). This is not surprising given that these are now the fastest-growing technology fields with Chinese companies competing with foreign companies (see Section 4 for the discussion on top patent applicants of Chinese origin). In terms of volume, and with a 25% cumulative share between 2005 and 2009, universities and research institutes in turn have their most important technology fields in “Pharmaceuticals”, “Organic fine chemistry”, “Biotechnology”, “Materials, metallurgy” and “Chemical engineering”, all of which belong to the “Chemistry” class (see Figure 26). Remarkably, none of these technology fields makes the top ten technology fields for companies or individuals. As for individuals, while they accumulated large shares in fastest-growing technology fields as well. However, they majority of their foreign-oriented patent families focused on “Other fields” of technology, with “Furniture, games”, “Other consumer goods” and “Civil engineering” all being in the top ten technologies for individual applicants (see Figure 27).

Figure 25: Top ten technology fields among foreign-oriented patent families originated by companies, 2005-2009



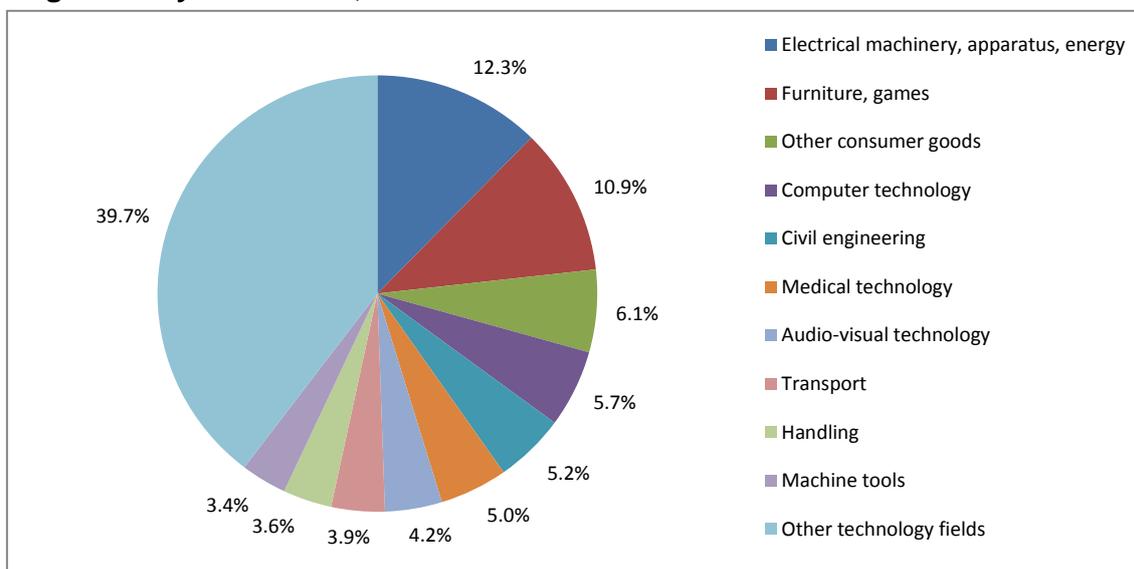
Source: WIPO IP Statistics Database.

Figure 26: Top 10 technology fields among foreign-oriented patent families originated by universities and research institutes, 2005-2009



Source: WIPO IP Statistics Database.

Figure 27: Top 10 technology fields among foreign-oriented patent families originated by individuals, 2005-2009



Source: WIPO IP Statistics Database.

3.4 Top applicants of Chinese origin

Few Chinese applicants are responsible for a large share of all foreign-oriented Chinese patent families. Specifically, the patents filed abroad of the top 10 applicants make up for 35% of the total volume of foreign-oriented patent families by Chinese residents between 1970 and 2012 (see Table 3). If one adds the next 40 top applicants, this percentage increases to close to 45% only, showing the relative importance of these top 10 applicants. If one adds another 50 top applicants, reaching the top 100, this figure only increases to 49%. Moreover, the more recent the years under consideration the more concentrated foreign-patent families are with a few top applicants.

Table 3: Concentration ratios for top applicants of foreign-oriented patent families by Chinese residents, 1970-2012 and 2005-2009

Top applicants	Number of families, 1970-2012	Percentage share, 1970-2012	Number of families, 2005-2009	Percentage share, 2005-2009
top 10 applicants	22,925	35.1%	16,925	43.3%
top 20 applicants	25,468	39.0%	18,620	47.6%
top 50 applicants	29,098	44.5%	20,994	53.7%
top 100 applicants	31,688	48.5%	22,597	57.8%
top 500 applicants	37,758	57.8%	26,440	67.6%
total number of families	65,340	100.0%	39,098	100.0%

Source: WIPO IP Statistics Database.

Table 4 shows the top 10 applicants by the total number of foreign-oriented patent families. It can be noted that this top 10 list exclusively contains companies, except one university namely Tsinghua University, one of the top research universities of China located in Beijing. Aside from ICT and electronics companies, the top 10 list includes BYD Co Ltd which is a Chinese manufacturer of automobiles and rechargeable batteries based in Shenzhen and China Petroleum & Chemical Corporation, or Sinopec Limited, a Chinese oil and gas company based in Beijing.

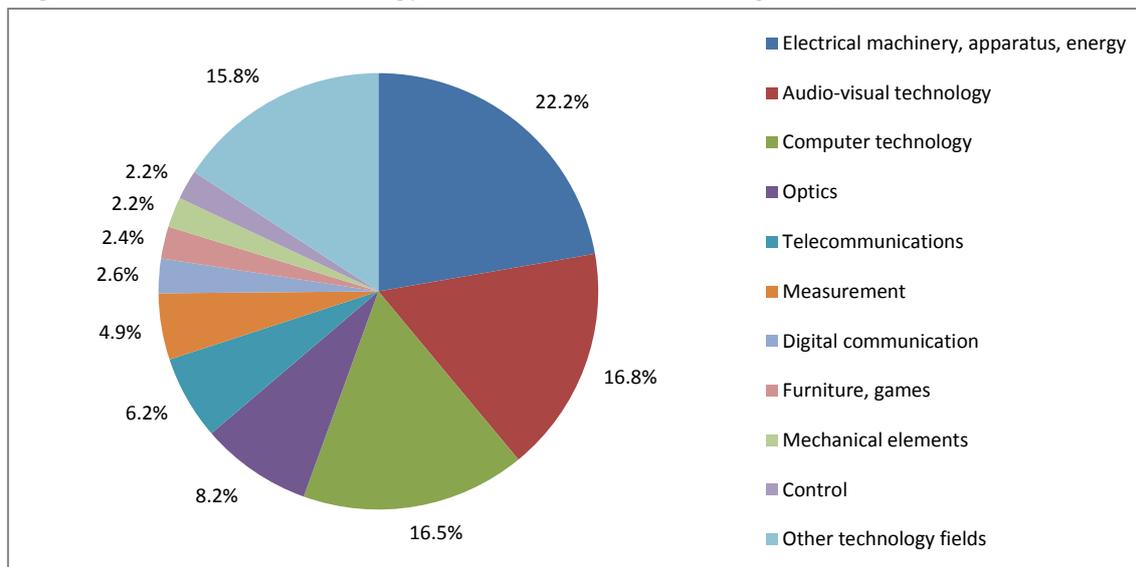
Table 4: Top 10 patent applicants by the total number of foreign-oriented patent families, 1970-2012

Rank	Applicant	Category	Number of families
1	HONGFUJIN PRECISION INDUSTRY (SHENZHEN) CO., LTD.	Company	9,076
2	HUAWEI TECHNOLOGIES CO., LTD.	Company	4,729
3	ZTE CORPORATION	Company	2,480
4	SHENZHEN FUTAIHONG PRECISION INDUSTRY CO., LTD.	Company	1,574
5	FOXCONN (KUNSHAN) COMPUTER INTERFACES CO., LTD.	Company	1,529
6	FUZHUN PRECISION INDUSTRY (SHENZHEN) CO., LTD.	Company	1,296
7	TSINGHUA UNIVERSITY	University	955
8	CHINA PETROLEUM & CHEMICAL CORPORATION	Company	543
9	BYD CO., LTD.	Company	387
10	SILITEK ELECTRONIC (GUANGZHOU) CO., LTD.	Company	356

Source: WIPO IP Statistics Database.

Among the first five top applicants, “Hongfujin Precision Industry (Shenzhen) Co., Ltd”²⁷, “Shenzhen Futaihong Precision Industrial Co., Ltd”²⁸ and Foxconn (Kunshan) Computer Interfaces Co., Ltd” are the entities of “Foxconn International Holdings Limited”.²⁹ Foxconn is one of the world’s largest electronics contract manufacturer. Only within 2005-2009 this holding company accumulated 6,611 patent families in a wide spectrum of technology fields, with more than 50% of its patents in “Electrical machinery, Apparatus, Energy”, “Computer technology” and “Audio-video technology”. Figure 28 shows the top 10 technology fields for the largest holder of foreign-oriented patent families, the Foxconn group; “Hongfujin Precision Industry (Shenzhen) Co., Ltd”, “Shenzhen Futaihong Precision Industrial Co., Ltd” and Foxconn (Kunshan) Computer Interfaces Co. are grouped in this graph.³⁰

Figure 28: Top 10 technology fields for the Foxconn group, 2005-2009



Source: WIPO IP Statistics Database.

²⁷ Hongfujin Precision Industry Co., a subsidiary of Foxconn, is a company which manufactures Apple's iPhone 5, iPod as well as other products for multinational corporations.

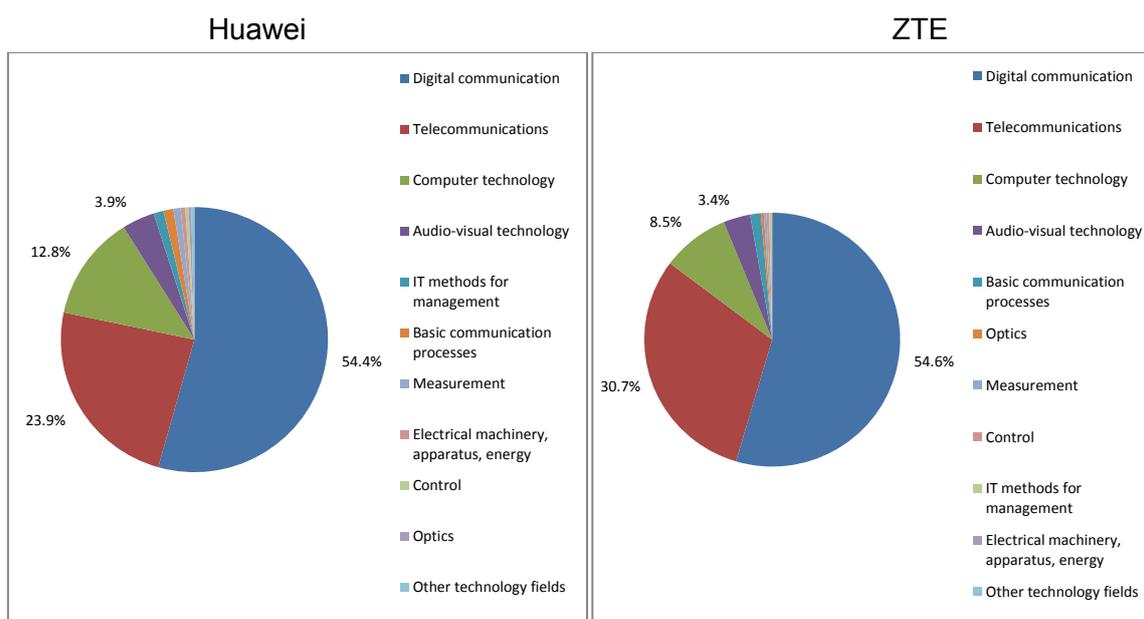
²⁸ Shenzhen Futaihong Precision Industrial Co., Ltd. manufactures communication and consumer electrical products.

²⁹ It must be noted here that this analysis might miss additional internationally-oriented patent families by the Foxconn conglomerate, as the organizational and financial structure, and the ensuing names of all subsidiaries, is not easily available to fully assign all patents back to his holding company. The entities of Foxconn group are marked in grey in the Table 4.2.

³⁰ *Ibid.*

Huawei Technologies Co., Ltd. and ZTE Corporation, both leading Chinese telecommunication equipment providers and major users of the patent system, have similar international patenting strategies (see Figure 29). Nevertheless, the number of accumulated patent families differs substantially between the two companies, with as many as 3,526 patent families for Huawei Technologies Co., Ltd. in 2005-09 and 1,687 patent families for ZTE Corporation within the same period. The number of foreign-oriented patent families with at least one PCT filing is 4,373 for Huawei and 2,422 for ZTE within the whole period 1970-2012. It is 3,285 for Huawei and 1,658 for ZTE between 2005 and 2009. As noted before however, this difference in overall total stocks of PCT filings is decreasing, with ZTE filings more PCT patents than Huawei in recent years. In 2012, ZTE was the top PCT applicant with 3,906 published applications, the highest ever yearly number of PCT applications for one single firm.

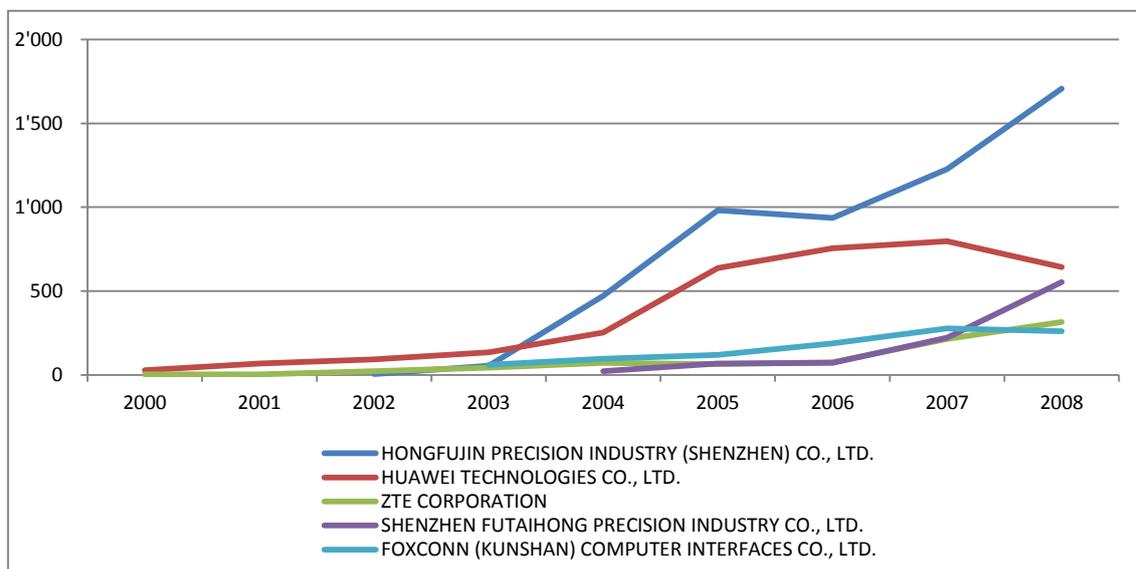
Figure 29: Top 10 technology fields for Huawei Technologies Co. and ZTE Corporation, Ltd., 2005-2009



Source: WIPO IP Statistics Database.

When plotting foreign-oriented patent families of the top filers over time, one sees that the five most active filers increased their filing abroad considerably only after 2004 (see Figure 30).

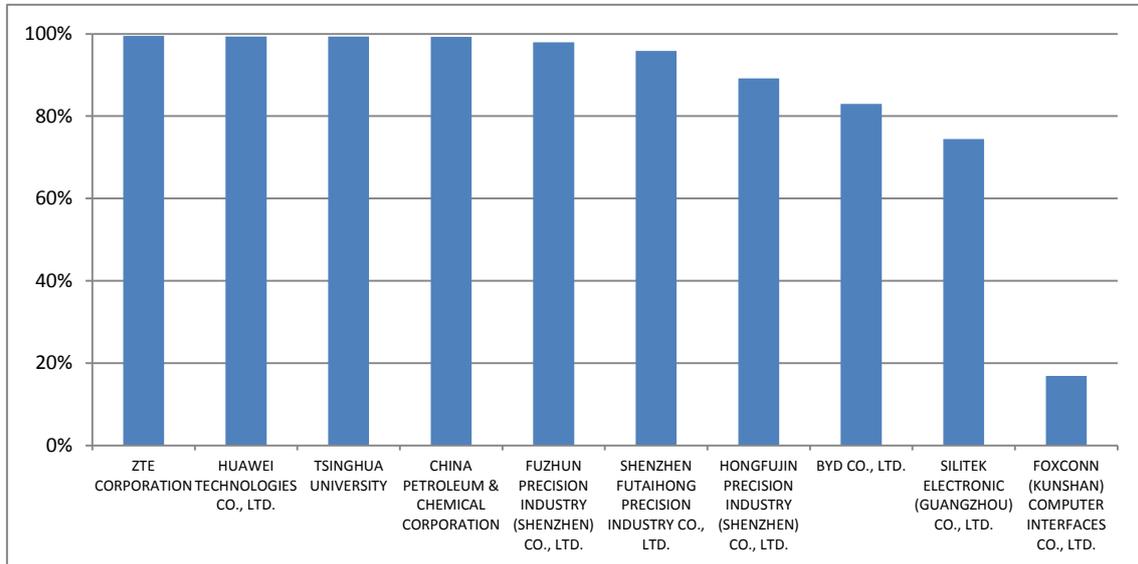
Figure 30: Top 5 foreign-oriented family holders among Chinese residents, 2000-2009



Source: WIPO IP Statistics Database.

One can also show that the largest foreign-oriented patent family holders have almost exclusively patent for invention-originated families (Figure 31), rather than those families originated by UM. Interestingly the percentage is much smaller for one Foxconn subsidiary listed here (Foxconn Kunshan) which uses the UM system more. BYD, the only automotive manufacturer in the top 10 list also seems to rely more on the UM system as entry point for foreign-oriented patent families.

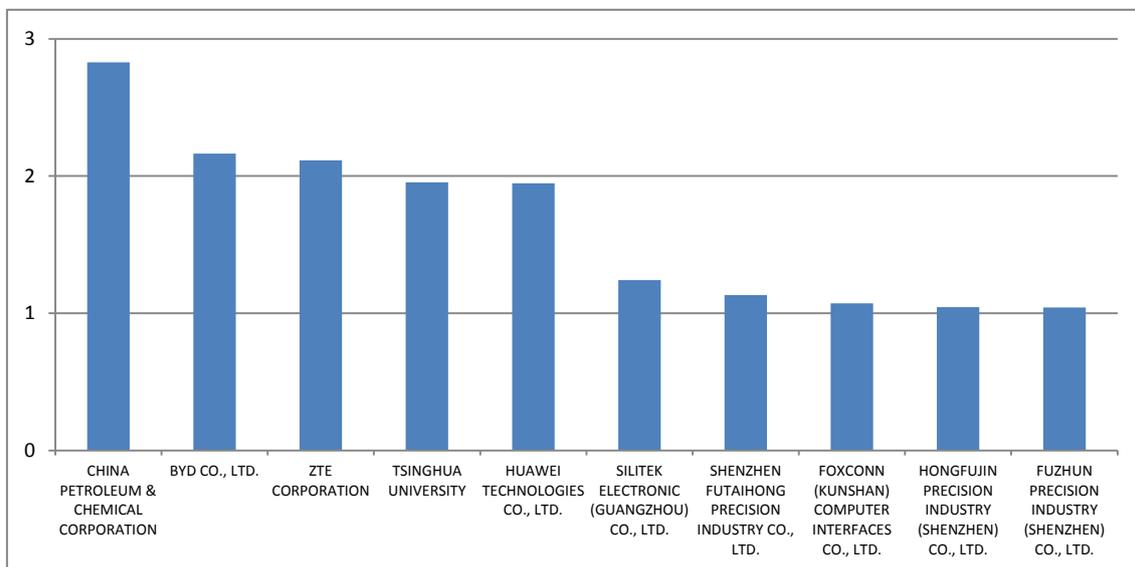
Figure 31: Share of patent for invention families among top 10 applicants, 1970-2012



Source: WIPO IP Statistics Database.

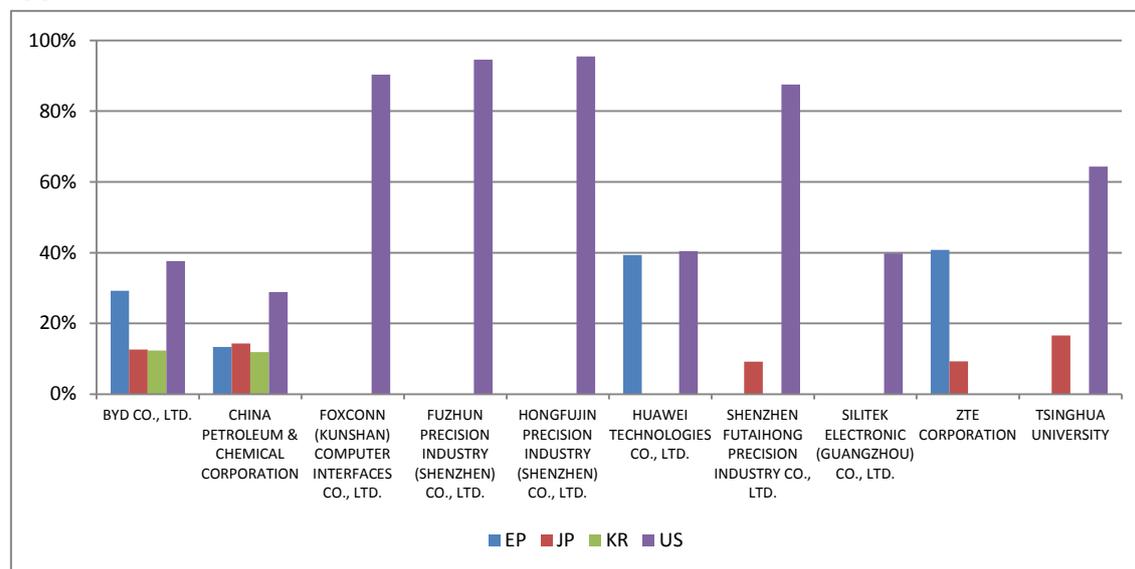
Interestingly even these top 10 applicants protect the majority of their patentable inventions only in one or two jurisdictions, with USPTO receiving the majority of applications (see Figure 32 and Figure 33). This compares to the more aggregate trend in Figure 2.1. That said, this initial analysis seems to show that the chemical and automotive companies in the top list, namely BYD and China Petroleum target more IP offices on average and that they aim for a broader geographical patent coverage than the companies in the electronics and the ICT sector.

Figure 32: Average number of foreign offices per family for top 10 applicants, 1970-2012



Source: WIPO IP Statistics Database.

Figure 33: Share of total patent applications abroad among top patent applicants, 1970-2012



Source: WIPO IP Statistics Database.

Note: The graph only displays the top IP offices, i.e. those that have more than a 9% share.

More information on the main rationale and filing behavior of Chinese top patent-filing firms is required to deepen the analysis. A questionnaire or structured interview guide on international IP filing strategies has been developed (see Appendix 1) to garner more useful data and information to validate and further deepen the analysis proposed here. In the course of a mission to China, this questionnaire could be tested with Huawei, Tencent and ZTE as participants; Tencent is an online game and Internet company.

Some general preliminary findings emerge:

- **International IP Filing Strategy – Increasing importance over time:** All the three firms described their international patent filing strategy as maturing rapidly; the share of patents filed abroad relative to patents filed only in China is growing strongly. While this trend is well-documented for firms in the telecommunications equipment sector, this result is also applicable to Tencent – the Internet content company. Interestingly, the three firms mentioned a clear desire to focus on filing high quality patents, and to avoid an exponential growth of patents filed at home and abroad in future years, e.g. a generalized “stabilization of patents filed” at a high level.
- **International IP Filing Strategy – Motives and rationales:**
 - o The top rationales for filing patents abroad cited by all three firms for international patenting are: (i) the increasing internal focus on R&D and innovation, (ii) the fact that their sales and investments are increasingly taking place in foreign countries, (iii) the competitive environment of their product space, and (iv) the desire to protect inventions, avoiding technical imitation. IP is thus sought in countries where markets and competitors are and where potential imitators are established.
 - o In particular, Huawei and ZTE contribute to technologies and standard-setting processes for future telecommunication technologies, such as 5 G, which require patent protection. If these become part of a standard, the lifetime of the technology and the protection is also significantly longer than for other technologies, justifying increased patent protection.
 - o As suggested by Tencent, patent applications in the US also allow for the protection of certain technologies or processes, e.g. software or business methods via patents which usually would be harder or

impossible to obtain domestically. This can be a driver for patent filings in the US.

- While the protection of one's technology was at the core of initial patenting strategies, more strategic motives are now becoming important, i.e. mostly (i) the desire to build up a patent portfolio similar to ICT firms in industrial countries to avoid litigation and (ii) to improve the prospects of collaboration with other firms. In many cross-licensing agreements, a firm-internal patent portfolio is also useful to these firms in the negotiation to offset licensing costs of technologies owned by third parties.
- A newer trend among the two telecommunication equipment firms is also the interest to generate future revenue streams of their existing IP portfolio via the selling or licensing of technology abroad. Tencent, like most other Internet companies, stated that no pro-active IP monetization scheme is being pursued.
- Beyond IP protection alone, the filing of patents via the PCT and other patents filed abroad are also part of an effort to create the image of an international and innovative company, and to help with product marketing for these firms.

- **International IP Filing Strategy – Geographic scope of filings abroad:**

- Patents are filed in a few targeted industrialized countries, on average 3-5 countries per patent in the past. The focus has traditionally been on the US, Europe, Japan, Korea, and – to a lesser extent – South East Asian countries. For these firms, the USPTO will always be a target office for a new patent, as will the EPO. Japan is of a lesser importance than the other aforementioned countries to these Chinese firms. Beyond these initial countries it mostly depends on business needs and filing patterns of competitors if protection is sought in additional markets. When companies get sued in particular countries, as happened in Australia and Canada for one of the firms, this is an additional incentive to file patents there.
- All three companies also confirmed however that the range of foreign countries targeted by patenting has increased over the recent years. On average, filings outside of key industrialized markets stay the exception. Still, more recently, on a limited number of occasions other low- and

middle-income countries have been added as patenting destinations.

- **International IP Filing Strategy – Use of the PCT versus the direct Paris route used:**

- All three firms indicated a clear trend towards greater use of the PCT system rather than use of the bilateral Paris route. Independently from the number of countries targeted, most international filings are done through PCT as - by their account - it is the most convenient way for international filing. When the application is time-sensitive and only one or two countries are targeted the Paris route is an option for these firms.

- **International IP Filing Strategy – Barriers to filing abroad:**

- The greatest barriers to filing abroad mentioned were the costs of filing at the national level, and the fact that examination standards vary across countries, often yielding different results with different time horizons.

Additional research and a full deployment of the questionnaire in Appendix 1, including to non-ICT firms, would help generate more insights into the development and the rationale of international IP filing strategies of Chinese IP-intensive firms.

3.5 Chinese use of the Patent Co-operation Treaty for filing abroad

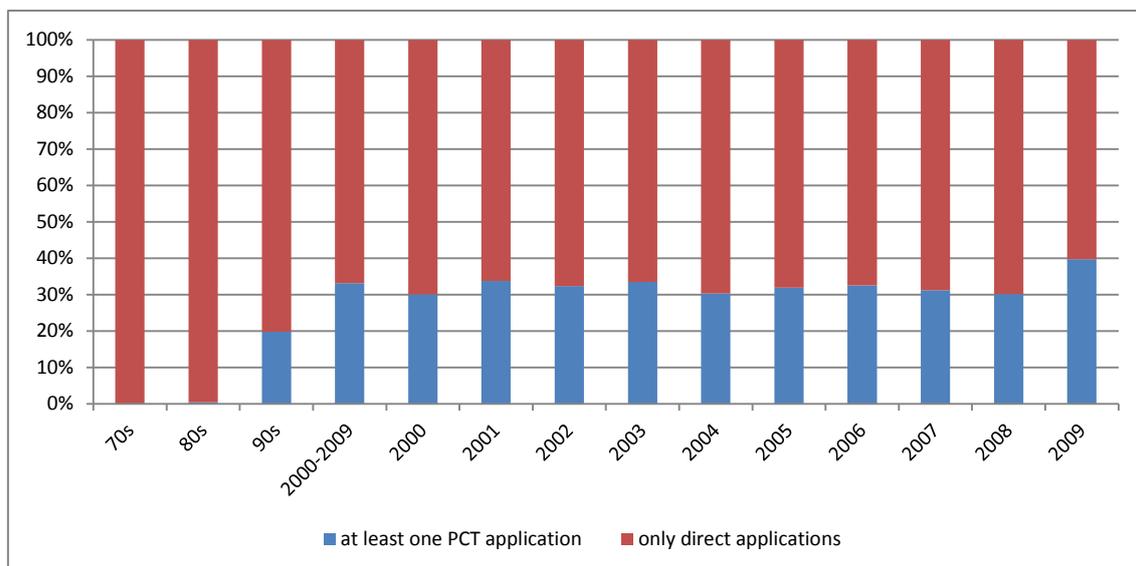
One third of foreign-oriented patent families by Chinese residents have at least one application via the PCT.³¹ Figure 34 shows that the share of families with at least one PCT application has grown from an average 20% per annum in the 1990s to an average of 33% between 2000 and 2009. Nonetheless, the share of patent families with at least one PCT application among Chinese foreign-oriented patent families

³¹ The PCT, an international treaty administered by WIPO, facilitates the acquisition of patent rights in a large number of jurisdictions. The PCT system simplifies the process of multiple national patent filings by reducing the requirement to file a separate application in each jurisdiction. However, the decision on whether or not to grant patent rights remains in the hands of national and regional patent offices, and patent rights remain limited to the jurisdiction of the patent-granting authority. The PCT international application process starts with the international phase, during which an international search and possibly a preliminary examination are performed, and concludes with the national phase, during which national and regional patent offices decide on the patentability of an invention according to national law.

between 2000 and 2009 is somewhat smaller than is the case for the US (45%) or Germany (40% on). Yet, it is larger when compared to both, the Republic of Korea and Japan (20%).

Besides, the Chinese use of the PCT system for filing abroad has intensified strongly since 2009, a trend not captured in the above data. In 2013, China surpassed Germany to become the third largest user of the PCT system, with Japan as the second-highest user.³² Indeed, ZTE Corporation with 2,309 PCT applications was the second most important and Huawei Technologies, Co. with 2,094 PCT applications the third most important PCT filer in 2013.

Figure 34: PCT usage among Chinese foreign-oriented patent families, 1970-2009



Source: WIPO IP Statistics Database.

Interestingly, Chinese university and research institutes have the highest share of foreign-oriented patent families applied through the PCT route. This must be interpreted by keeping in mind their relatively small number of accumulated patent families in total volume. Individuals have the lowest share of families originated via PCT applications. In turn, companies seem to have idiosyncratic strategies of PCT route usage, with some companies employing the PCT route for all filings abroad,

³² Press release “US and China Drive International Patent Filing Growth in Record-Setting Year”, Geneva, March 13, 2014, PR/2014/755.

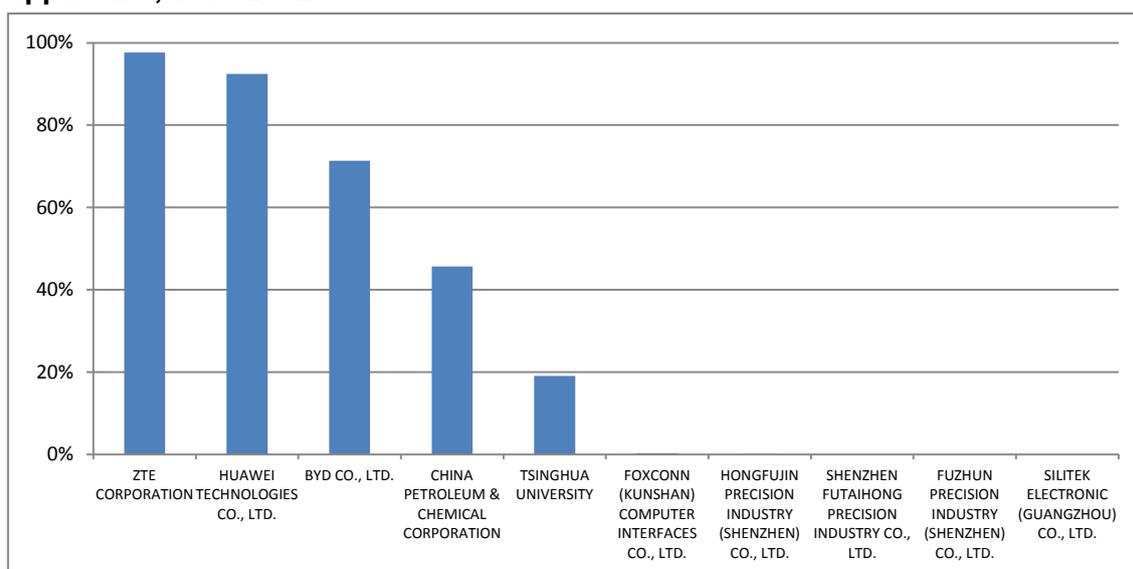
others never using it, and yet others using the PCT selectively (see Table 4 and Figure 35).

Table 4: The share of foreign-oriented families via the PCT route for applicant types, 1970-2012

Type of applicant	% share of PCT families	% share of non-PCT families	Number of PCT families	Number of non-PCT families	Number of families
Company	32.3%	67.7%	14,554	30,493	45,047
Individual	27.4%	72.6%	4,411	11,693	16,104
University	42.3%	57.7%	1,236	1,685	2,921
Research institute	65.1%	34.9%	826	442	1,268
total	32.2%	67.8%	21,027	44,313	65,340

Source: WIPO IP Statistics Database.

Figure 35: Share of families applied through the PCT route among top 10 applicants, 1970-2012



Source: WIPO IP Statistics Database.

To understand the idiosyncrasies in the use of the PCT route among applicants regression techniques are used in what follows (see Appendix 2 for more details). A baseline regression model is constructed which controls for the type of a family, i.e., whether a family is originated via patent for invention or via utility model application, the type of an applicant, i.e., whether it is a company, individual, university or research institute, the size of a family and whether a family has an application with SIPO among other applications within a family. The estimation results of the baseline specification model with the year fixed effects included are presented in column (1) of Appendix 2

Table 1. This appendix also provides further details on the regression techniques employed. All the explanatory variables are statistically significant signifying the strength of the baseline model. The main findings of these calculations are:

- Research institutes are more likely to apply through the PCT route compared to companies, universities and individuals.³³
- Families originated through patent for invention applications are more likely to be applied through the Patent Cooperation Treaty (PCT) route.
- The bigger the size of a family, the more likely it is to be applied through the PCT route.
- Patent families which include applications with SIPO among other patent offices are more likely to use the PCT route.
- Digital communication, biotechnology and pharmaceutical firms are more likely to use the PCT route compared to companies in other technology fields.

Some of these findings are obvious, for instance, the fact that larger patent families or patent invention triggered-families tend to make use of the PCT route more frequently.

Others are less obvious, and need more analytical work, for instance, why academic inventors would favor the PCT more than their counterparts based in companies. This will be subject to future research.

³³ On this point compare the Special theme on the use of the PCT by universities and research institutes, in the 2014 edition of the PCT Yearly Review published by WIPO at http://www.wipo.int/export/sites/www/freepublications/en/patents/901/wipo_pub_901_2014.pdf. See also WIPO (2011b).

Conclusion

This study is the first of its kind analyzing foreign-oriented patent families by Chinese residents. Its findings shed light on the scope and rapidly changing importance of international patenting strategies of Chinese firms and other actors engaged in invention and innovation.

Future work will have to elaborate more on the detailed drivers of Chinese filing abroad, and on understanding the potential for the future of such filings, including from firms, sectors and in technology fields which currently file much less frequently abroad than the most active firms in the ICT sector, although they have a sizeable domestic patent stock and active domestic filing behavior. Finally, the quest to conduct analysis with consolidated domestic and international patent filings on the level of unique companies also deserves further attention, in particular if pairing this data to company information such as R&D expenditures, revenues and exports can help generate more systematic analysis of the determinants of Chinese international filing strategies.

Appendix 1: Questionnaire on international patent filing strategies



INTERVIEW GUIDE ON INTERNATIONAL PATENT FILING STRATEGIES

1. Name of the enterprise:	
Name of the Company:	Postal Address:
1.1 Name of the person interviewed	
Name:	Position/ Title:
	E-Mail:
1.2 Main industry sector the company is active in (judged by revenues generated)	
1.3 General company facts:	
a. Enterprise revenue 2013: _____ 2012: _____	
b. Number of employees 2013: _____ 2012: _____	
c. Number of scientists and engineers employed 2013: _____	
d. R&D expenditures 2013: _____ 2012: _____	
2. Please list goods produced and/or service provided by your enterprise by decreasing importance on total sales. Please also indicate the proportion (in percent) over total revenues.	1. <u>percent</u> 2. <u>percent</u> 3. <u>percent</u> 4. <u>percent</u> 5. <u>percent</u>

A. IP ASSETS– PROTECTION AND OWNERSHIP

Did you apply for the following IPRs?				
If the answer is YES , please indicate the total numbers of IPRs that your company filed in China (local) or internationally between 2010 and 2013!				
a. Patents	___ Filed (local)	___ Filed (international)		

b. Industrial Designs	___ Filed (local)	___ Filed (international)
c. Utility Models	___ Filed (local)	___ Filed (international)

B. International IP Filing Strategy – Entering new markets

A. International IP Filing Strategy – General questions

- 1) Please describe the patent filing strategy of your company? What leads you to decide to patent particular technologies?
- 2) How would you describe your international patent filing strategy (patenting abroad)?
- 3) How does the growth rate of patent filings at home compare to the growth rate of filing abroad? Is the share of patents filed abroad stable or has it increased or decreased over time?
- 4) What is the link between the quality of the patented invention and the propensity to patent abroad? Are patents filed abroad always more valuable?

B. Drivers of filing abroad

- 1) Of those patents you file at home, how do you decide which to file abroad?
- 2) How are the patents selected that will be filed internationally versus those patents that stay at the local level? What is the rationale for filing patents abroad? Examples: exporting, investing abroad, avoiding technical imitation, selling or licensing IP abroad

C. International IP Filing Strategy – Geographic scope of filings abroad

- 1) In how many countries do you typically secure patent protection abroad? Has the number of foreign jurisdictions in which you seek patent protection abroad increased over time?
- 2) Which are the jurisdictions outside China you will typically seek patent protection in?
- 3) Are these always the same countries or which factors influence international patenting in foreign countries?
- 4) Has the range of foreign countries increased over the recent years? Have new developed or developing countries increasingly been a patenting destination?
- 5) What are the main reasons to file in particular countries?

D. International IP Filing Strategy – Technological fields and sectors

- 1) In which technological fields do you mostly patent abroad?
- 2) Are these technological fields similar to those you patent via SIPO?
- 3) Do you patent different technological fields in different countries abroad (for example USA as compared to Germany)? What are the factors influencing this decision if any?
- 4) Have new technological fields emerged for which you seek international patent protection in recent years?

E. International IP Filing Strategy – Licensing income generated

- 1) Do you generate licensing income from your patents filed abroad?
- 2) Has this increased over time and what are the main sources of licensing income (subsidiaries, foreign firms, etc.)?

F. International IP Filing Strategy – Use of the Patent Co-Operation Treaty (PCT) versus the direct Paris route

- 1) Do you use the PCT for all your international patenting activities?
 - a. If yes, what are the reasons?
 - b. If no, what are the reasons?
- 2) Which are the factors influencing whether you use the direct & bilateral Paris patent filing abroad route or the PCT?
- 3) Does it depend on the geographic location or the patentable invention / the technical field at stake? Or is the strategy of using the PCT uniformly applied across all patents abroad?
- 4) Does the size of the patent family influence the use of the PCT?
- 5) What are the advantages and disadvantages of the using the PCT?
- 6) Please evaluate the value of the international search report produced by the PCT process? Is it useful to you? What are its strengths and weaknesses

G. International IP Filing Strategy – Process

- 1) How do you file patents abroad?
 - a. In-house legal counsel
 - b. Via foreign subsidiary
 - c. Foreign patent attorney and agent
- 2) How would you qualify the ease and accessibility of filing abroad?
- 3) What are the main challenges that you face in terms of process?
- 4) Have these challenges been reduced by your increased experience in filing abroad and a better network of legal contacts in this regard?

H. International IP Filing Strategy – Costs

- 1) What is your overall expenditure for filing patents (abroad and at home)?
- 2) What is the share of expenditures for filing patents abroad? Has it increased or decreased over time?
- 3) How would you assess the cost for filing abroad? Do costs limit your filings abroad? Are they a barrier to filing abroad?
- 4) How do costs differ between countries and what is the share of pure filing costs versus the costs for translations, patent attorney, etc.

I. International IP Filing Strategy – Barriers to file abroad

- 1) Which are the main barriers for filing abroad?

J. International IP Filing Strategy – Comparison to other countries

- 1) Do you see your international patent filing strategy and behavior as similar to firms in other advanced countries such as Japan, the Rep of Korea, the United States of America or countries in Europe?
- 2) What are the main similarities?
- 3) What are the main differences, and are they diminishing over time?

Appendix 2: Regression analysis

In order to control for potential heterogeneity in the use of the PCT route among different industries 35 industry dummy variables are included. The results of the regression with industry dummy variables included are presented in column (2). The explanatory power of the model increases (the Pseudo R^2 rises from 0.33 to 0.44) signifying a good addition to the baseline model.

Patent applicants appear to have heterogeneous strategies in their use of the PCT route. Given that Probit estimation results in inconsistent estimates when too many fixed effects are used, first dummy variables for only the top 100 patent applicants are included. These applicants are responsible for about 50% of all patent families by Chinese residents. The results are presented in column (3). As a robustness check an additional 200 dummy variables are included for the top patent applicants. Results are presented in column (4).

Appendix Table 1: Probit analysis of the PCT system usage

	Probit (1)		Probit (2)		Probit (3)		Probit (4)	
IPR type	0.227***	(0.004)	0.184***	(0.005)	0.163***	(0.009)	0.171***	(0.010)
Applicant (Company)	-0.293***	(0.016)	-0.305***	(0.017)	-0.106***	(0.017)	-0.050***	(0.017)
Applicant (Individual)	-0.106***	(0.013)	-0.089***	(0.014)	-0.034**	(0.014)	0.003	(0.017)
Applicant (University)	-0.178***	(0.008)	-0.166***	(0.010)	-0.049***	(0.015)	-0.010	(0.021)
Family size > 5	0.574***	(0.018)	0.550***	(0.036)	0.440***	(0.012)	0.438***	(0.013)
Family domestic	0.411***	(0.005)	0.393***	(0.005)	0.340***	(0.012)	0.348***	(0.017)
Tech_id_2	-	-	-0.129***	(0.005)	-0.052***	(0.007)	-0.041***	(0.008)
Tech_id_3	-	-	0.050***	(0.008)	-0.001	(0.008)	0.007	(0.009)
Tech_id_4	-	-	0.507***	(0.007)	0.101***	(0.011)	0.109***	(0.012)
Tech_id_5	-	-	-0.030**	(0.014)	-0.048***	(0.014)	-0.053***	(0.014)
Tech_id_6	-	-	-0.063***	(0.005)	-0.007	(0.007)	0.003	(0.007)
Tech_id_7	-	-	0.045**	(0.023)	0.015	(0.022)	0.005	(0.022)
Tech_id_8	-	-	-0.025***	(0.009)	0.001	(0.010)	0.005	(0.012)
Tech_id_9	-	-	-0.086***	(0.007)	-0.025**	(0.010)	0.023**	(-0.023)
Tech_id_10	-	-	-0.047***	(0.008)	0.014	(0.010)	0.022**	(0.011)
Tech_id_11	-	-	0.083***	(0.029)	0.069**	(0.027)	0.062**	(0.029)
Tech_id_12	-	-	-0.042***	(0.011)	0.010	(0.013)	0.002	(0.014)
Tech_id_13	-	-	0.103***	(0.013)	0.072***	(0.012)	0.063***	(0.013)
Tech_id_14	-	-	0.092***	(0.016)	0.059***	(0.014)	0.049***	(0.014)
Tech_id_15	-	-	0.180***	(0.019)	0.129***	(0.019)	0.106***	(0.019)
Tech_id_16	-	-	0.206***	(0.016)	0.130***	(0.016)	0.129***	(0.016)
Tech_id_17	-	-	0.114***	(0.021)	0.073***	(0.019)	0.076***	(0.020)
Tech_id_18	-	-	0.033	(0.025)	-0.005	(0.019)	-0.018	(0.019)
Tech_id_19	-	-	0.018	(0.014)	-0.003	(0.012)	0.0001	(0.013)
Tech_id_20	-	-	-0.029**	(0.013)	-0.015	(0.012)	-0.015	(-0.015)
Tech_id_21	-	-	-0.090***	(0.009)	-0.024**	(0.011)	-0.025**	(0.012)
Tech_id_23	-	-	0.038***	(0.012)	0.020*	(0.011)	0.021*	(0.011)
Tech_id_24	-	-	0.109***	(0.021)	0.043**	(0.018)	0.037**	(0.018)
Tech_id_25	-	-	0.006	(0.013)	0.028**	(0.013)	0.028**	(0.014)
Tech_id_26	-	-	-0.044***	(0.010)	-0.021**	(0.010)	-0.020*	(0.011)
Tech_id_27	-	-	0.035**	(0.016)	0.059***	(0.017)	0.051***	(0.017)
Tech_id_28	-	-	0.062***	(0.018)	0.035**	(0.016)	0.001	(0.016)
Tech_id_29	-	-	-0.011	(0.011)	0.014	(0.012)	0.005	(0.012)
Tech_id_30	-	-	0.023*	(0.012)	0.024**	(0.012)	0.026**	(0.013)
Tech_id_31	-	-	-0.017	(0.010)	0.029**	(0.012)	0.031**	(0.012)
Tech_id_32	-	-	0.069***	(0.014)	0.014	(0.012)	0.001	(0.012)
Tech_id_33	-	-	0.012	(0.010)	0.012	(0.009)	0.001	(0.009)
Tech_id_34	-	-	0.017	(0.012)	-0.016**	(0.009)	-0.006	(0.010)
Tech_id_35	-	-	0.071***	(0.012)	0.016***	(0.009)	0.060***	(0.013)
Year FE	Yes		Yes		Yes		Yes	
Firm FE	No		No		Top 100		Top 300	
Pseudo R ²	0.329		0.436		0.598		0.611	
Observations	64,555		63,066		57,299		55,672	

Notes: The table reports marginal effects after the Probit regressions where the dependent variable equals 1 if there are PCT applications within a patent family, and the dependent variable equals 0 otherwise. Standard errors are reported in the parentheses. *IPR_type* equals 1 if an application type is patent for invention, and *IPR_type* equals 0 if an application type is utility model. The dummy variable for *Research institute* applicant type is omitted from the regressions. For the description of 35 technology fields see

http://www.wipo.int/ipstats/en/statistics/technology_concordance.html and Schmoch (2008). Since a family can include several technology fields at the same time, the dummy variable *Tech_id_i* equals 1 if the technology field *i* is presented in a family, and it equals 0 otherwise. The dummy *family_domestic* equals 1 if there is SIPO application within a family and it equals 0 otherwise. *Tech_id_1* and *Tech_id_22* are omitted from the regressions because of collinearity.

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