The role of intellectual property rights in innovation spaces: The cases of China and India

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1. Introduction

This chapter describes the development of China and India as innovation spaces, with a focus on the developments of their patent systems and on the flows of patents into and out from these countries. Patent systems and patent-like rights have been used in various nations and to various degrees since the 14th and 15th centuries (Granstrand, 1999; Guellec & Potterie, 2007). However, China's first patent law was adopted as late as 1984, which can be compared to the adoption of formal patent laws in 1623 in England, in 1790 in the United States, and in 1856 in India (based on the British patent law) (Holgersson, 2012).

Many Asian countries, not the least China, have historically had limited protection of inventions against imitation. Even when patent systems have been available, the actual protection given by those systems has been limited since the enforcement of patents has been difficult or impossible for inventors. Therefore, inventors (individuals, firms, and other types of agents) have often resorted to other types of mechanisms to deter imitation and to appropriate sufficient returns from innovation investments, such as by technological specialization, by secrecy, or by establishing personal relationships ('guanxi') (Keupp et al., 2010). The limited enforcement and/or use of intellectual property rights (IPR) systems by developing and newly industrialized countries is not surprising, however, since allowing domestic imitation of foreign innovators enables catching-up in relation to more innovative and industrialized countries (Granstrand and Holgersson, 2014).

During the 2000s, the situation started to change with both China and India focusing increasingly on building up institutions and competences related to IPRs. These changes have partly come as a result of the creation and enforcement of the Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) by the World Trade Organization (WTO). China joined the WTO on 11 December 2001, while India was one of the original members (from 1 January 1995).[1] Subsequently, the situation has progressed further, with innovation and intellectual property (IP) policies being adopted at the national level. For example, the 12th Chinese five-year plan (2011-2015) [2] states that:

> *China should upgrade its capabilities in indigenous research and innovation in science, technology and administration, train more innovative talents and improve education for workers. In a word, we will strive to speed up the construction of an innovation country.*

In terms of IP, China issued the "Outline of the National Intellectual Property Strategy"[3] in June 2008, here exemplified by a couple of strategic foci that were included:

> *(13) Revise laws and regulations to punish infringements on IPRs and strengthen judicial punishment. Help right holders to improve consciousness and capacity to protect their own interests. Lower the cost of right enforcement. Increase the cost of infringements. Curb infringements effectively.*
>
> *[...]*

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[1] As a developing country India was however allowed to adopt a transitional stage of the application of TRIPS until 1 January 2000, after which legislation had to be adjusted.

[2] China's 12th five-year plan has been translated by the Delegation of the European Union in China, and the translation is available here: http://www.britishchamber.cn/content/chinas-twelfth-five-year-plan-2011-2015-full-english-version

[3] An English translation of the "Outline of the National Intellectual Property Strategy" is available here: http://english.gov.cn/2008-06/21/content_1023471.htm

(15) Strengthen the knowledge propagation on intellectual property right and increase the awareness of intellectual property right in the whole society. Carry out the ordinary intellectual property right education extensively.

In November 2010, the State Intellectual Property Office (SIPO) in China published the "National Patent Development Strategy (2011-2020)"[4], describing how the previously issued outline was to be implemented, including a number of quantitative goals:

The capacity and level to create patents will be improved by a large margin. The annual quantity of applying for patents for inventions, utility models and designs will reach 2 million. China will rank among the top two in the world in terms of the annual number of patents for inventions granted to the domestic applicants, and the quality of patents filed will further improve. The number of owning patents every one million people and the number of overseas patent applications filed by Chinese applicants will double. The proportion of patent applications in industrial enterprises above designated size will reach 8% and the quantity of owning patent rights will significantly rise.

These quantitative goals are being supported by incentives such as cash bonuses, tax cuts, resident permits, and academic tenures. These incentive systems have then been criticized for their focus on the quantity of Chinese patenting rather than the quality of it (Lohr, 2011; Tung, 2011).

Policies in India have made a similar transition to a more innovation-related focus. This can be illustrated by a statement in the early 2000s by the president of India at the time, Dr. A.P.J. Abdul Kalam, in which he highlights the planned shift from imitation to innovation[5]:

Today India has become one of the strongest in the world in terms of scientific manpower in capability and maturity. Hence, we are in a position not only to understand the technologies that we may have to borrow, but also to create our own technologies with extensive scientific inputs of indigenous origin.

As compared to the policies of China, Indian policy documents have raised more concerns about the intense privatization of knowledge through the use of IPRs internationally, and placed less emphasis on increasing domestic patenting and strengthening IPRs, as exemplified by the Science and Technology Policy 2003[6]:

The process of globalisation is leading to situations where the collective knowledge of societies normally used for common good is converted to proprietary knowledge for commercial profit of a few. Action will be taken to protect our indigenous knowledge systems, primarily through national policies, supplemented by supportive international action. For this purpose, IPR systems which specially protect scientific discoveries and technological innovations arising out of such traditional knowledge will be designed and effectively implemented.

Nevertheless, the Indian government has declared 2010-2020 as the decade of innovation and one of the key elements of the "Science, Technology and Innovation Policy 2013" is the positioning of "India among the top five global scientific powers by 2020" (p. 4). This goes in line with China's goal to become an R&D and innovation-based nation by 2020, which was stated in "The National Medium- and Long-Term Plan for the Development of Science and Technology (2006-2020)", published by the Chinese government in early 2006.

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[4] An English translation of the "National Patent Development Strategy (2011-2020)" is available here: http://graphics8.nytimes.com/packages/pdf/business/SIPONatPatentDevStrategy.pdf

[5] As cited on the website of the Indian Department of Science and Technology: http://dst.gov.in/stsysindia/stp2003.htm

[6] Available on the website of the Indian Department of Science and Technology: http://dst.gov.in/stsysindia/stp2003.htm

Given these nations' increased focus on innovation, and the role of IPRs in this process, this chapter aims to shed some light on China and India as innovation spaces. The chapter especially focuses on the specific institutional aspect concerning the patent system and the use of it.

Skepticism has been raised about the IPR systems in these countries, for example regarding the large quantities of low quality patents being granted in China (The Economist, 2010). However, a substantial amount of the patents filed in these countries stem from foreign inventors, not the least from Western countries. Further, Asian inventors do not limit themselves to patenting in their domestic markets. In fact, from 1996 to 2009 China climbed from the 27^{th} to the 8^{th} position on the ranking of top foreign countries patenting in the US, while India climbed from the 30^{th} to the 16^{th} position (Granstrand and Holgersson, 2014).

This chapter aims to bring some clarity to the current developments of China and India as innovation spaces, especially in terms of their IPR developments. More specifically, the chapter aims to answer three questions related to this development: (1) Who patents in China and India? (2) Where do Chinese and Indian inventors patent? (3) What do Chinese and Indian inventors patent?

2. Concepts and definitions used in the data collection

A patent grants its holder the right to exclude others from commercially exploiting the patented invention without authorization during a limited time period. The purpose of patent systems is to incentivize private innovation investments by enabling innovators to appropriate sufficient returns on investments. In return the patent applicants pay patent fees and let the patent documents be published, thus stimulating not only the creation of technical knowledge (technology), but also the diffusion of it.

Focus is here on 'invention patent applications' as opposed to utility model patents and design patents, which are used as complements to invention patents in some countries. Invention patent applications are in the following mentioned simply as 'patent applications'. Patent applications are submitted to patent and trademark offices (PTOs), which are typically national entities (exceptions include the World Intellectual Property Organization – WIPO – and the European Patent Office – EPO). These PTOs evaluate the patent applications upon the underlying inventions' characteristics of novelty, non-obviousness, and usefulness/technical character. If the requirements for patentability are fulfilled and fees are paid, a national patent is granted, which then also needs to be enforced in the national market and institutional system in cases of infringement. This national patent may typically be complemented with patents for the same invention in other nations, and this set of related national patents for the same invention is typically called a patent family.

The national origin of patents and patent applications is ambiguous, as the underlying inventions could be created by inventors across national borders, and/or by inventors working in multinational firms or by multiple inventors across multiple firms with various nationalities. However, the residence of the first named applicant (or inventor) is typically used as an indicator of the national origin of a patent. This approach is used here as well, especially since it is the approach used in the WIPO statistics database.

Based on the origin, the incoming and outgoing patent application streams related to a specific nation can be classified, see Figure 1. First, *outgoing applications* from a specific nation are either domestic, if they are filed at the domestic PTO, or foreign, if they are filed at any foreign PTO. Second, *incoming applications* to a specific nation's PTO are either resident, if they origin from the same nation, or non-resident, if they origin from any other nation. Thus, any domestic application from a nation is also a resident application to that nation's PTO, while any foreign application from a nation is also a non-resident application to some other nation's PTO.

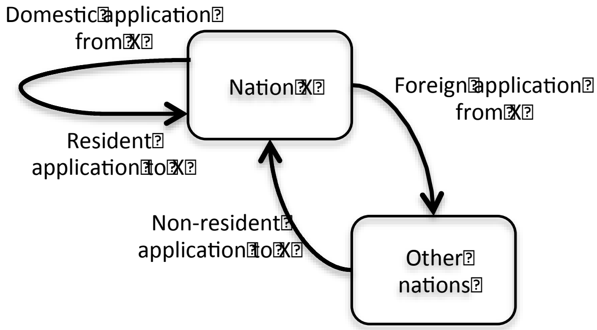

Figure 1 Classification of incoming and outgoing patent application streams to/from a country

3. Patenting in and from China and India

As described above, the policies of China and India have shifted with an increasing focus on innovation and IP (at least to some extent). This section will study the patenting in and from China and India, based on statistics from WIPO.[7] As also described above, applicants to any given national PTO can be divided into resident applicants, that is, applicants with the same nationality as the PTO, and non-resident applicants, that is, applicants with another nationality than the PTO.

With respect to the share of resident vs. non-resident applicants, China and India exhibit quite large differences. Actually, while roughly 1/5 (21%) of all patent applications to the Chinese PTO in 2011 had *non-resident* origin, roughly 1/5 (21%) of all patent applications to the Indian PTO had *resident* origin (the latter is a share that has been fairly constant throughout the 2000s.). The low share of non-resident applicants in China comes as a result of the fact that resident patenting in China has been heavily promoted during the early 2000s. The absolute number of resident Chinese patent applications have grown from 25 000 (2000) to 416 000 (2011), i.e. with a multiple of 17. Although the number of non-resident Chinese patent applications has also been growing with a high pace, the lower growth rate has meant that the share of non-resident applications has dropped from roughly 1/2 to roughly 1/5 between 2000 and 2011.

[7] Note that there are some limitations in this dataset, especially for recent years in which data may not yet have been properly reported from various PTOs. For example, the total number of non-resident patent applications to all PTOs around the world should equal the total number of filings from all countries to PTOs abroad. However, while the former number is roughly 755 000 for 2011, the latter is roughly 816 000. Nevertheless the data is useful, as comparisons within the same datasets are more interesting than comparisons across datasets for the purpose of this chapter.

In the following, this chapter will mainly focus on the one hand on non-resident patent applications to China and India, respectively, and on the other hand on foreign patent applications from China and India, respectively. The reason for this is that this enables the illumination of the importance of China and India in international patenting, without being biased due to domestic/resident patenting streams (which has major influence on statistics, as indicated above by the Chinese developments).

Relative growths of non-resident applications to the Chinese and Indian offices have been larger than the relative growth of the total worldwide patenting, as illustrated by Figure 2, in which the total worldwide patenting has been normalized by dividing it with a constant (19,4) to end up at the same 2011 value as China. Thus, referring to massive amounts of resident applications behind the increase in patenting at the Chinese and Indian PTOs is only partially correct for China, and hardly correct for India. In section 3.1 the non-resident application streams to China and India are investigated, more specifically to probe the question of whom (which nationalities) patent there (RQ1).

Foreign patenting from China and India has also increased steeply, although at lower absolute levels. This indicates the increasing role of these nations in creating inventions that are not only good enough to be covered by patents at the domestic PTOs, but also at foreign PTOs. In section 3.2 the destinations of the foreign patenting streams from these countries are identified (RQ2). Not surprisingly, it turns out that the PTO in the US (USPTO) is the most important receiving office. The US is therefore used as a reference market to indicate the technological areas in which China and India focus their patenting, which also indicates the focus of their R&D efforts. Section 3.3 presents results on this, both on the most important technologies in terms of absolute size and on the most important technologies in terms of technological specialization (RQ3).

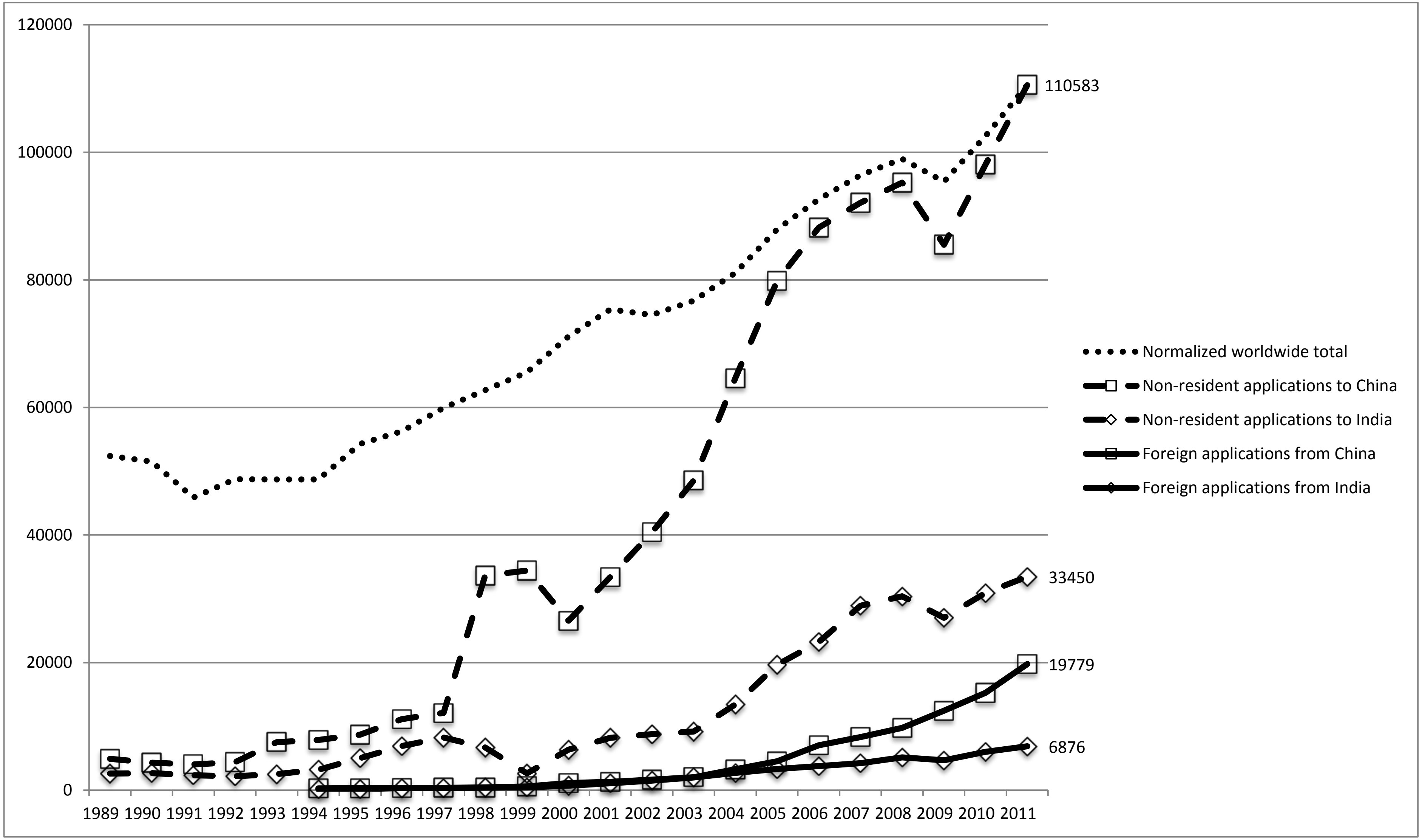

Figure 2 Yearly patent applications to and from China and India and normalized worldwide total (legend in order of 2011 magnitude)

3.1 Who patents in China and India?

In terms of non-resident applications, which in 2011 amounted to roughly 111 000 in China and 33 000 in India, an interesting question to probe is what the origins are of these applications to the Chinese and Indian PTOs, respectively. This is here investigated by looking at the share of non-resident applications that originate from various nations, and by looking at the revealed market advantage (RMA) that various national origins have on the two markets. The RMA measure was introduced by Granstrand and Holgersson (2014), building upon the measures of revealed comparative advantage (RCA) (Balassa, 1965) and revealed technological advantage (RTA) (e.g., Soete, 1981, 1987).

The RMA indicates whether the share of foreign patent applications to a specific PTO from a certain national origin is larger than the share of total foreign patent applications to that PTO from all national origins. Thus, it indicates whether a national origin is more (1<RMA) or less (0≤RMA<1) focused on a specific PTO for its foreign patent applications than the worldwide focus on that PTO. The formal definition of RMA of country a in market i is:

$$RMA_{ai}=\frac{p_{ai}/\sum_{i=1}^{N}p_{ai}}{\sum_{j=1}^{N}p_{ji}/\sum_{j=1}^{N}\sum_{i=1}^{N}p_{ji}}$$

Here p_{ai} is the number of foreign applications from country a to receiving office i, and N is the total number of countries.[8] For statistical purposes, it is advisable to use the symmetric version of this index (here used for correlation calculations), namely the revealed symmetric market advantage (RSMA), as defined below (for a motivation, see Granstrand and Holgersson, 2014):

$$RSMA_{ai}=\frac{RMA_{ai}-1}{RMA_{ai}+1}$$

Now, looking at the main origins of non-resident patent applications to the Chinese PTO (over a three-year period to decrease impact from temporary variations) it is clear that Japan and US contributed to more than 60% of these applications during 2009-2011 (see Table 1). This might not be surprising, as these are by far the main foreign patenting nations worldwide (US applicants filed 549 000 foreign applications during 2009-2011 while Japanese applicants filed 532 000 foreign applications during the same period). Japan and US are focusing more than other nations on the Chinese output market for patents not only in absolute terms, however, but also in relative terms, indicated by RMA indices above 1 for both of them. Actually, there are only ten nations that have RMAs above 1 in China in the studied period, and the only major ones of these are Japan, US, and Korea. Further, there is a significant positive correlation between the total number of foreign applications from all nations active in foreign patenting during 2009-2011 and the RSMA of these nations in China.[9] A plausible explanation is that the largest IP "producing" nations have identified the importance of holding a competitive IPR position also in China. However, this is subject to large variations, as indicated by

[8] Note that since p_{ai} is the number of foreign applications from country a to receiving office i, the following holds since a domestic patent application is not a foreign application: $p_{ai}=0\ if\ a=i$.

[9] The Pearson correlation is 0,32. The Spearman correlation is 0,70, which might be of more interest in this case (since the linear relationship included in the Pearson correlation is not necessarily of interest). Both are significant at the p = 0,01 level.

the variation in RMAs below and above 1 among the main origins (see Table 1), which apart from Japan and US mainly include European countries (Korea being the exception).

Now, looking at patent applications to the Indian PTO, non-resident patent applications are much more frequent than resident applications, as described above. The main origins of non-resident patent applications to the Indian PTO are again dominated by US and Japan (see Table 1), and patent applications to the Indian PTO from US applicants (30 000 during 2009-2011) actually outnumber the domestic applications from Indian applicants (25 000 during 2009-2011). A number of mainly European countries (with a few exceptions) are then also important origins for Indian non-resident patenting. Although US as the largest applicant origin also has an RMA above 1, the positive correlation between the total number of foreign applications from various nations active in foreign patenting during 2009-2011 and the RSMA of these nations in India is smaller than in the case of China.[10]

Table 1 Main origins' shares of non-resident patent applications in China and India 2009-2011,

Origin of non-resident patent applications in *China*	**Share**	**RMA**	**Origin of non-resident patent applications in *India***	**Share**	**RMA**
Japan	35,2%	1,45	United States of America	32,9%	1,32
United States of America	25,7%	1,03	Japan	13,5%	0,56
Germany	10,0%	0,77	Germany	11,8%	0,90
Republic of Korea	7,2%	1,14	Switzerland	5,3%	1,31
France	3,6%	0,65	France	5,1%	0,93
Netherlands	3,1%	0,91	Netherlands	4,5%	1,33
Switzerland	2,6%	0,65	United Kingdom	3,4%	0,86
United Kingdom	1,8%	0,45	Sweden	2,8%	1,27
Sweden	1,8%	0,81	Republic of Korea	2,4%	0,38
Italy	1,2%	0,59	China	2,4%	1,10
Finland	1,0%	0,84	Italy	2,1%	1,05
Other origins (below 1% share)	6,9%	-	Canada	1,7%	0,67
			Finland	1,7%	1,42
			Unknown	1,4%	-
			Denmark	1,2%	1,18
			Israel	1,1%	0,85
			Belgium	1,1%	0,90
			Australia	1,0%	0,87
			Other origins (below 1% share)	4,6%	-

[10] The Pearson correlation is 0,11 and the Spearman correlation is 0,40. Only the Spearman correlation is significant at the p = 0,01 level.

3.2 Where do Chinese and Indian inventors patent?

As illustrated in Figure 2, Chinese foreign patenting has increased steeply during the last decade. Table 2 presents the PTOs that during 2009-2011 received the largest shares of the foreign patent applications from China (and India), together with China's RMAs in those nations. It is quite clear that China focuses its foreign patenting on the US, both in absolute terms and in relative terms (compared to other nations' focus on the US, as indicated by the RMA above 1). Similar to the incoming patents to China being mainly from US, Japan, and European nations, the outgoing patents are mainly directed to these nations. However, large receivers of Chinese patent applications also include India, Korea, Hong Kong, etc. (see Table 2).

Indian foreign patenting has also increased steeply during the last decade, as illustrated in Figure 2, and the focus on the US market is even more evident than in the case of China. Table 2 shows the main receiving offices of Indian foreign patent applications, and the USPTO receives 68% of these, meaning that India focuses twice as much as the general worldwide focus on US. EPO is the second largest receiver of Indian patent applications, while Japan receives a relatively low share of foreign applications from India. Due to index constructions, the massive focus on the US downplays the RMAs of India in other countries, and worth noting in light of this is the relatively large shares of applications (and thereby high RMAs) from India that are still received by South Africa and New Zealand. These countries do, similar to India (see section 3.3), invest and patent extensively in pharmaceuticals, biotechnologies, medical technologies, and chemistry, which can be compared to Japan, where there is limited focus in these areas. The technological distance between two countries is likely a determinant of how frequent inventors in one country patent in the second country, and vice versa. This needs further research, however.

Table 2 Main receiving offices' shares of foreign patent applications from China and India 2009-2011

Receiving offices of foreign patent applications from *China*	Share	RMA	Receiving offices of foreign patent applications from *India*	Share	RMA
United States of America	54,8%	1,64	United States of America	67,6%	2,02
European Patent Office	13,3%	1,37	European Patent Office	7,2%	0,74
Japan	7,2%	0,97	China	2,9%	0,22
India	4,7%	1,12	Japan	2,8%	0,37
Republic of Korea	3,6%	0,69	Australia	2,4%	0,80
China, Hong Kong SAR	2,9%	1,74	Canada	2,2%	0,53
Canada	2,0%	0,48	Republic of Korea	1,8%	0,35
Russian Federation	1,8%	0,94	South Africa	1,4%	1,67
Australia	1,8%	0,58	Brazil	1,4%	0,79
Other offices (below 1% share)	7,8%	-	Mexico	1,3%	0,69
			New Zealand	1,0%	1,55
			Other offices (below 1% share)	8,0%	-

3.3 What do Chinese and Indian inventors patent?

A related question to that of where Chinese and Indian inventors patent is the question of what they patent. This is here probed by using US patent data as a proxy for patenting activities from these countries, since the US has traditionally been the most important market for foreign patenting from other countries (and, as proven above, it is the most frequent one for foreign patenting from China and India). Although this approach has been common in previous research (e.g., Patel and Pavitt, 1994; Granstrand et al., 1997; Granstrand and Holgersson, 2014), it is related to some limitations as country choices for foreign patenting is for example dependent upon the activities of the inventor and its competitors, as well as upon the (potential) customer base and the institutional environment in the specific country of question.

Nevertheless, data on patenting in the US gives a useful indication of the technological focus of various actors/nations. In fact, there is a fairly high correlation between the technology shares (defined as the share of a country's patents in a specific technology) as measured by EPO patenting and the technology shares as measured by USPTO patenting, and this holds for both China and India.[11] This is then an indication of the validity of using US patent data as a proxy for foreign patenting.

Apart from using technology shares, i.e. the shares of Chinese and Indian patenting at the USPTO in different technological areas, the revealed technological advantage (RTA) is here used as an indicator of these nations' relative focus in various technological areas as compared to all non-resident applicants' focus in various technological areas when patenting at the USPTO. The formal definition of RTA of country a in technology i is:

$$RTA_{ai}=\frac{p_{ai}/\sum_{i=1}^{M}p_{ai}}{\sum_{j=1}^{N}p_{ji}/\sum_{j=1}^{N}\sum_{i=1}^{M}p_{ji}}$$

Here p_{ai} is the number US patent publications from country a in technological area i, M is the total number of technological areas, and N is the total number of countries. To avoid biasing the results, patent publications from US patentees are excluded from the dataset, meaning that only non-resident patent publications are considered in the denominator when calculating the RTAs. Similar to the use of RMA above, a symmetric version of the RTA, i.e. the revealed symmetric technological advantage (RSTA), is calculated for statistical purposes (here used for variance calculations):

$$RSTA_{ai}=\frac{RTA_{ai}-1}{RTA_{ai}+1}$$

Table 3 presents Chinese and Indian patenting in various technological areas. China clearly focuses on computer technologies, electronics, and information and communication technologies (ICTs), both in absolute terms and in relation to other countries' focus (as measured by RTA). China focuses relatively less on for example pharmaceuticals, biotechnologies, and chemistry.

India also focuses on computer technologies, but in contrast to China India also focuses heavily on pharmaceuticals, chemistry, and biotechnologies, see Table 3. India also has a very strong relative position (although fairly small in absolute sense) in IT methods for management.

[11] For China, the Pearson correlation is 0,59 and the Spearman correlation is 0,75. For India, the Pearson correlation is 0,67 and the Spearman correlation is 0,61. All four correlations are significant at the p = 0,01 level.

Table 3 Technology shares and revealed technological advantages 2009-2011 (the five largest numbers in each column in bold)

	China		India	
Technology	**TS**	**RTA**	**TS**	**RTA**
1 - Electrical machinery, apparatus, energy	**11,6%**	**1,54**	2,0%	0,27
2 - Audio-visual technology	**9,3%**	1,25	3,2%	0,43
3 - Telecommunications	**6,4%**	**1,59**	2,8%	0,69
4 - Digital communication	**10,2%**	**2,47**	**5,0%**	1,22
5 - Basic communication processes	1,5%	0,89	1,7%	1,02
6 - Computer technology	**15,2%**	1,20	**23,5%**	**1,87**
7 - IT methods for management	0,6%	0,78	3,7%	**4,62**
8 - Semiconductors	3,5%	0,53	0,6%	0,09
9 - Optics	2,6%	0,52	0,2%	0,05
10 - Measurement	3,0%	0,74	1,6%	0,38
11 - Analysis of biological materials	0,3%	0,52	0,7%	1,24
12 - Control	1,6%	1,06	1,4%	0,89
13 - Medical technology	2,0%	0,54	2,3%	0,61
14 - Organic fine chemistry	2,2%	0,70	**16,3%**	**5,23**
15 - Biotechnology	1,4%	0,66	**4,3%**	**2,00**
16 - Pharmaceuticals	2,4%	0,71	**16,3%**	**4,86**
17 - Macromolecular chemistry, polymers	0,6%	0,39	1,1%	0,67
18 - Food chemistry	0,3%	0,37	1,0%	1,10
19 - Basic materials chemistry	0,9%	0,63	1,9%	1,27
20 - Materials, metallurgy	0,9%	0,85	0,9%	0,83
21 - Surface technology, coating	2,4%	0,78	1,5%	0,48
22 - Micro-structural and nano-technology	0,0%	0,43	0,0%	0,95
23 - Chemical engineering	1,8%	0,97	1,0%	0,55
24 - Environmental technology	0,5%	0,54	0,3%	0,33
25 - Handling	1,5%	0,74	0,8%	0,39
26 - Machine tools	1,9%	0,85	0,5%	0,23
27 - Engines, pumps, turbines	1,2%	0,55	1,2%	0,55
28 - Textile and paper machines	0,6%	0,33	0,6%	0,32
29 - Other special machines	1,4%	0,70	0,9%	0,44
30 - Thermal processes and apparatus	2,2%	**2,23**	0,5%	0,50
31 - Mechanical elements	2,5%	1,00	0,5%	0,21
32 - Transport	1,2%	0,44	0,4%	0,15
33 - Furniture, games	2,8%	**1,67**	0,3%	0,17
34 - Other consumer goods	1,5%	1,15	0,7%	0,53
35 - Civil engineering	2,0%	1,32	0,5%	0,30

A nation's (or any actor's more generally) overall focus on specialization vs. diversification across technologies can be indicated by the variance of the RSTA measure across technologies, since a nation that specializes in some technologies at the expense of others will have a higher variance in RSTA than a nation that has a focus in various technologies similar to the worldwide average. As expected from the results described above, the variance of China's RSTAs is lower (0,054) than that of India's RSTAs (0,16). This means that while China has larger foreign patenting than India, it is also more similar distributed to general foreign patenting across countries of origin, as compared to India. Thus, India is more specialized in some technological areas, such as pharmaceuticals, biotechnologies, medical technologies, and chemistry, as described above.

4. What has been learnt

The research underlying this chapter has been guided by three interrelated questions. These questions have been probed by studying and analyzing worldwide patent statistics as provided by WIPO. This section will recall the questions, and briefly summarize the results that have been presented in more detail above.

RQ1: Who patents in China and India?

The first question was studied by analyzing the origin of patent applications to China and India, respectively. First, the results show that while only 1/5 of all patent applications to the Chinese PTO has non-resident origin, as much as 4/5 of all applications to the Indian PTO has non-resident origin. This probably has more to do with the high absolute numbers of resident applications in China than a low interest among non-resident inventors to apply for patents there. The largest share (35,2%) of non-resident Chinese applications has Japanese origin, followed by US (25,7%), Germany (10,0%), and Korea (7,2%). The situation in India is fairly similar, where the largest share (32,9%) of non-resident Indian applications has US origin, followed by Japan (13,5%), Germany (11,8%) and Switzerland (5,3%). Clearly Japan and Korea focus more on China than on India in their foreign patenting, which probably partly has to do with both geographical and technological proximities between these nations and China.

RQ2: Where do Chinese and Indian inventors patent?

The results related to the second question show that both China and India direct a majority of their foreign patent applications to the USPTO. While a little more than half (54,8%) of China's foreign applications are submitted to the USPTO, as much as 2/3 (67,6%) of all foreign applications from India goes to the USPTO. Further, the EPO is a large (although much smaller than the USPTO) receiver of foreign applications from both China (13,3%) and India (7,2%). While the third and forth largest receiver of foreign applications from China are Japan (7,2%) and India (4,7%), the third and forth largest receiver of foreign applications from India are China (2,9%) and Japan (2,8%).

RQ3: What do Chinese and Indian inventors patent?

The third question was probed by using Chinese and Indian inventors' patenting in the US as a proxy for the general patenting of China and India. The results show that China holds strong positions in patenting within computer technologies, electronics, and ICTs, while less so in for example pharmaceuticals, biotechnologies, and chemistry. Similar to China, India holds a strong position within computer technologies, but also within pharmaceuticals, chemistry, and biotechnologies.

5. Discussion and new research questions

As illustrated in this chapter, innovators and patentees do not necessarily only cover their national product/service markets with patents. They could (and should) also focus on covering other important markets, for example nations with large and important output markets and nations in which they localize manufacturing activities, with the aim to inhibit rivalry production. China is already the largest manufacturing nation in the world, and the importance of covering this manufacturing market will increase even further while the massive market potential is realized and while the IP laws are strengthened in line with the TRIPS agreement. Further, when the indigenous innovation activities of China gain additional momentum that will provide yet another reason for non-resident innovators to patent in China, although R&D nations are typically less important for innovators to protect by patents than production nations and output market nations (Holgersson, 2012). Increased focus on innovation in China will also lead to even further strengthened IP positions throughout the world, for example in terms of large portfolios of patents held by Chinese actors in various jurisdictions.

The IP future for India is not as clear, although the sheer market size will probably attract foreign patentees with increasing pace in parallel with a strengthened IPR system. While China's focus on electronics and ICTs have probably spurred patenting and patent numbers a lot, since these industries are of a *complex* character in which patent propensities and patent frequencies are high (e.g., Holgersson, 2013), Indian innovators have mainly focused on *discrete* types of technologies. Products and services built upon discrete technologies are based on few patentable inventions (Cohen et al., 2000), thus focusing on such technologies limits the patentable output and patent numbers. Nevertheless, at present India seems to have lagged behind China in terms of IP developments. For example, China but not India has gained a position in the group of the five largest PTOs (including also EPO, USPTO, and the Japanese and Korean PTOs), a group called IP5 that jointly discusses how to improve international collaboration and efficiency in the patent examination process.

While this chapter has focused on the development and use of IPRs in China and India, it relates to the development of these nations as innovation spaces more generally. The increased non-resident patenting in China and India indicates the increased importance of these national (input and output) markets for innovative products from around the world. Analogously, the increased foreign patenting from China and India indicates the increased importance of these nations as innovators, especially within certain technological areas. These parallel developments create new opportunities and challenges for innovators, not only for Chinese and Indian ones but maybe even more so for foreign ones, and especially for incumbent technological leaders.

This chapter started with stating three research questions, which have been investigated throughout the chapter. However, the investigation of these questions has, as most commonly is the case in research, led to new questions that need additional research. The chapter now ends by stating three such questions, which could provide some guidance for further discussions and/or research.

1. What does it mean for the future competitiveness of China and India, respectively, that Chinese inventors hold such a strong domestic position in IPRs, as opposed to the Indian situation?

2. This chapter hypothesizes that the patenting from one country to another country is to some extent determined by the technological distance between the two countries. Why might that (not) be true?

3. This chapter focuses on the increasing importance of two large quickly developing countries as origins and destinations of innovations and patents. What might be the parallel development of developed nations with limited size, such as Finland, Sweden, and Switzerland, and especially what might be the future role of their domestic PTOs for resident as well as non-resident patent applicants? How might that impact the domestic innovation systems in such small nations?

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