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Patent elasticity, R&D intensity and regional innovation capacity in China

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ABSTRACT

This study uses patent to measure regional innovative capacity and its changing tendency in mainland Cina. We provide an empirical analysis of patent applications from above-scale enterprises between 2008 and 2012 in China along two dimensions, geographical location and R&D intensity. We found that patents are much more elastic, than that in Japan, US and Europe. The gaps in provincial innovation capacity in China are narrowing as a whole, whereas the gaps in the central region and western region continue to grow. Furthermore, regional innovation performance can be both affected by patent application fees and R&D input.

1. Introduction

1.1. Patent and regional innovation in China

The Chinese patent applications have maintained robust growth after approximately 30 years of rapid development, particularly in recent years [1]. Patent filings from 2008 to 2012 were more than 1.8 times as many as the total number of patents filed in the 23 years since the national patent system was implemented (1985–2007). As patents are widely regarded as indicators of innovative strength, this surge of patent output in China can also be deemed a sign of great development in China's innovative capacity [2–4]. This context has given rise to keen research interest in seeking the reasons behind patent growth in China. In order to establish itself as an innovative nation and improve its capability of independent innovation, the Chinese government has made huge R&D expenditures especially in the past more than ten years. Many local studies have testified that China's dramatic increase in patents filings were greatly correlated with its R&D intensity [5]. However, the amount of improvement in innovation given a certain amount of R&D input has remained unclear.

Besides R&D expenditures, patent may also be sensitive to its filing fees, an aspect which has received even less attention than R&D input in China's case. By investigating fees adjustment and the change of patent applications in Europe, Japan and the United States, Gaetan and Bruno found that fees affect the behavior of applicants with patent-fee elasticity at −0.30 [6], which is in line with the even earlier study of price elasticities estimated by de Rassenfosse and van Pottelsberghe [7,8]. Both results confirm that patents are an inelastic good. While, what is the case in China? As a big manufacturing country, China is experiencing significant boom in patent applications, especially in recent decade years. In this study we testified that different from the cases studied in other areas, in China, patent is rich in elasticity, that is, patent is sensitive to its charging fees. This may be explained as that the filing fees of patent are potentially much higher than the income expectation of a patent applied. Compared with patent-benefit, patent filing fees are priced high, and a low rate of patent return is connected with the quality of innovation on the one hand, and on the other hand, the strength of patent protection and market environment of a country. Seeing from different patent elasticity and compared with more developed areas, like Europe, Japan and United States, China still need to put great effort on improving patent quality and upgrading its innovation environment.

To explore patent R&D elasticity and patent-price elasticity in China, one of the major factors need to be considered is the patent

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charging standard and it's CPI (consumer price index). In China, The present charging standard for patent application was put into effect in 2002, and hasn't changed during these years. The opposite of such invariability is the fact that China's consumer price index has been changing all along, which should be taken into consideration.

And meanwhile, one should put special care on its regional variation when examining patent elasticity as China is such a huge country with serious imbalanced development. This regional variation is also embodied in its patent applications. For example, in the case of invention patents filed by enterprises above a designated size (hereinafter referred to as above-scale enterprises), Guangdong Province originated 1700 times as many patent filings as the Tibet Autonomous Region (Xizang) in 2008. This imbalance lasts for many years without obvious improvement. Similarly, the proportion of patented inventions in the three regions varied greatly in 2008, with 81.22% of 59,254 filings originating in China's eastern region, 11.66% in the central region, and 7.12% in the western region. These proportions shifted slightly by 2012 to 75.89%, 15.62% and 8.49% in that order, of a total of 176,167 filings. Judging from the dynamic changes in the data, the gaps in patent filings are narrowing, however, the problem of imbalance in regional development remains serious. Furthermore, the development of patent production largely depends on the scale and level of research and development input, and from this perspective, there also exist large regional gaps in terms of R&D expenditures in mainland China. In 2008, the R&D expenditures of above-scale enterprises reached approximately 307.3 billion RMB (Chinese Yuan), with the eastern, central and western region each accounting for 74.32%, 16.62% and 19.06%. The total expenditures increased to 720.1 billion RMB in 2012 and the proportions of patent filings for the eastern, central and western regions shifted slightly to 72.36%, 18.07% and 19.06%, respectively. In view of the huge differences across regions and provinces in China, we assumed that there exists regional differentiation in patent elasticity and which has important implications for the making of patent-related policies. To better present the dynamic changes of innovation disparity between regions, we calculate internal R&D expenditures and patent fees based on the 2003 price level and take the provincial price level into consideration. The regional divisions (eastern, central and western) are based on the standard divisions used in the "China Statistical Yearbook of Science and Technology" (2009–2013). Time-series data for patent applications in each region and the national total are provided in Table 1:

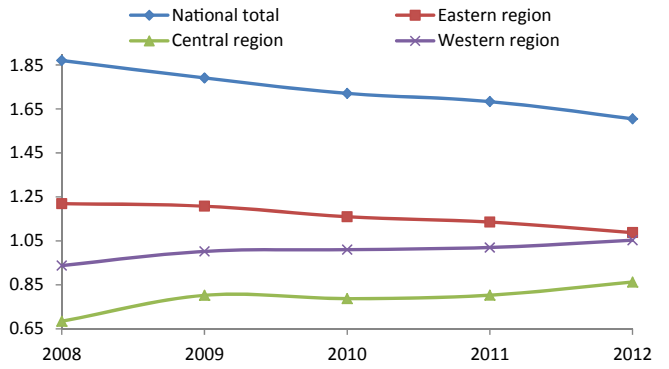

Fig. 1. Trend of coefficient of variation of patent inventions (from the perspective of regional location).

After measuring the coefficient of standard deviation of applications of each region dynamically, we got the results presented in Figs. 1 and 2. Based on the results, we found the disparity in innovation capacity is narrowing in the country as a whole, however, different changing rules can be found when explore from the perspectives of geographical locations and R&D intensity. So, in the following research and analysis, we need to specify the whole country in order to better understand the internal changing rules of regional innovation capacity in the mainland of China.

Furthermore, using the 2008 data as the base level, this paper compares changes in the number of patent filings, business incomes and patent application fees, and above-scale enterprises' internal R&D expenditures from 2008 to 2012. The results show that patent filings have increased more rapidly than either fees or

Table 1
Descriptive statistics of the patent applications of above-scale industrial enterprises (2008–2012).

Region	Year	Provinces	Max	Min	Median	Average	Coefficient variation
Eastern	2008	12	18802	43	2702.5	4036	1.22
	2009	12	27768	149	3177.5	6080	1.21
	2010	12	31911	184	4440.5	7416	1.16
	2011	12	36053	219	5703.5	8750	1.14
	2012	12	44200	279	7548	11253	1.09
Central	2008	9	1587	281	658	806.11	0.68
	2009	9	3786	495	880	1552.56	0.80
	2010	9	4340	530	1101.5	1948.78	0.79
	2011	9	5385	564	1373	2344.56	0.80
	2012	9	8147	770	1390	3142.22	0.86
Western	2008	10	1007	11	276	356.60	0.94
	2009	10	1650	12	338	550.10	1.00
	2010	10	2067	16	427	712.40	1.01
	2011	10	2483	19	521	874.30	1.02
	2012	10	4316	17	805	1285.70	1.05
National total	2008	31	18802	11	603	1911.42	1.87
	2009	31	27768	12	1009	2982.07	1.79
	2010	31	31911	16	1383	3666.16	1.72
	2011	31	36053	19	1756	4349.77	1.68
	2012	31	44200	17	2460	5682.81	1.61

Note: 1.Max, Min and Average each refers to the maximum value, the minimum value and the average value. Coefficient variation = Variation/the Average. 2. The eastern region comprises 12 provinces: Beijing (BJ), Tianjin (TJ), Hebei (HB), Liaoning (LN), Shanghai (SH), Jiangsu (JS), Zhejiang (ZJ), Fujian (FJ), Guangdong (GD), Guangxi (GX), Hainan (HAI) and Shandong (SD).The central region includes nine provinces: Inner Mongolia (NM), Jilin (JL), Heilongjiang (HLJ), Anhui (AH), Jiangxi (JX), Henan (HEN), Hubei (HUB), Hunan (HUN), and Shanxi (SHX). And the western region is comprised of ten provinces: Chongqing (CQ), Sichuan (SC), Guizhou (GZ), Yunnan (YN), Tibet (XZ), Shaanxi (SHA), Gansu (GS), Qinghai (QH), Ningxia (NX), and Xinjiang (XJ) (Detail maps can be seen in Section 2.2).