

The Research on the Patent Transfer of Universities of China Mainland

Deli Cheng, Weijia Kong

Shanghai International College of Intellectual Property, Tongji University, Shanghai, China

Email address:

Marina_kong@tongji.edu.cn (Weijia Kong)

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Abstract: China accounted for 98% of the total growth of global patent applications in 2016. The rapid growth has been arousing great controversies and doubts about Chinese current patent policies around the world. Chinese universities are making the second largest contribution to patent filing growth. However, a survey of top 10 universities in mainland China suggests that the university sector has not performed as well in patent use as it has in patent filings. This paper talked about the patent quality from purposes for filing patents of university inventors and analyze the non-market factors behind it including many preferential policies. By empirical study, some alienations of patent application were found that most inventors filed patent not for the commercial use but for other purposes such as for personal promotion in academic field, or for the project requirement and for meeting the needs of workload. It comes to the conclusion that the influence of the planned economy is fundamental reasons for the patent surge and the low transfer rate, also the ranking of the Ministry of Education and the preferential financial policies on patent application of Chinese universities play a key role for the low patent transfer. Finally, a few ways towards a better balance between patent quantity and quality are suggested from an institutional perspective.

Keywords: Patent Surge, Patent Quality, Non-Market Factors, Machine Learning, Improvement and Suggestions

1. Introduction

China received about 236,600 of the nearly 240,600 additional patent filings, accounting for 98% of total growth of the world in 2016, more patent applications than the combined total for the United States of America, Japan, the Republic of Korea and the European Patent Office. China established its patent law in 1985, and patent applications grew rather modestly until the end of the 1990s. Since 2002, patent applications in China have surged dramatically. Compared to other developed countries, Chinese filed more and more patents from 2002 and reached up to peak in 2012, when the patent applications for invention of China became No.1 in the world. The surge of patent in China has aroused significant research interest in investigating whether the surge means the growth of innovative capability, also much controversies and doubts that the increases in patent quantity surpass the development of the quality of patents. Many scholars thought that there are too much more patents filed in China recent years and also the patent counts increase much more

rapidly considering its innovative capacity. They hold that the patent subsidy policies greatly enhance the creation of patent applications and patent grants. But most of them don't analyze why these policies were enacted and nor they explain whether the surge will lead to the decrease of patents. Meanwhile other scholars argued that the patent surge is natural increase given the huge economy unity of China, the large amount of scientific faculty and research funds the State invested in. This paper will discuss the patent increase of China universities and the tendency that the inventors file the patents. The rest paper organized as follows: Part 2 reviewed the recent literature and the development of university patents. Part 3 is empirical study that discussed the alienation of patent filing of university inventors. Part 4 explained the institutional factors which lead to the alienation. Some suggestions about how to improve the patent filing policies were given in the last part.

2. Literature Review and University Patent Development

2.1. The State Quo of China Patent Increase

Most scholars (Dand & Motohashi, 2015 [1]; Long & Wang, 2014; [2]) ascribe the patent surge to subsidy policies and address that special care is needed when using patent statistics to evaluate innovation in China because institutional factors and non-innovation related motives for acquiring patents could have distorted patenting behaviors and ultimately patent statistics. [3] But they do not analyze what are the institutional factors except the subsidy policies and, more importantly, why the policies were formulated and enacted. Some empirical studies were conducted about China patents surge and show that patenting propensity may have been boosted as much as 160% by patent promotion policies and that subsidy programs may increase patent counts by more than 30%. [4]

Another group of scholars think that the presence of foreign firms and foreign direct investment (FDI) have contributed significantly to the Chinese patent boom [5]. They estimate that foreign firms in China account for 36% of the annual growth of foreign patenting in China [6]. Other explanations include an increase in R&D expenditures, [7] improvement of legal institutional circumstance, [8] the growing impact of scientific ICT (Information Communications Technology) equipment industry etc. [9]

Some scholars, Nevertheless, point out that the presumed patent surge of China has not really happened – at least if you consider number of patents relative to population, number of enterprises or to R&D expenditures. Zhou attributes the surge to several factors: a large amount of R&D faculty (3.24 million), a large number of enterprises (0.34 million industrial enterprises above designated size), and a third rank in terms of national R&D expenditures (1000 billion) globally in 2012. [10] CNIPA notes that the patent count per 10 thousand people is 4.02 in China, but it is 105 in Japan, 96 in South Korea, and 36 in U.S. [11] The average intensity of patents of three industries is 13.5 per 10 thousand people in China, but it is 225 in U.S. They state that, on a per capita basis, there are far fewer patents in China than in other countries. This idea is supported by Lipu Tian, former director of the State Intellectual Property Office of China [12].

2.2. The Patent Performance of China Universities

There is little debate that, historically, Chinese universities have long been underfunded and have overly focused on undergraduate training, thus making little scientific contribution to economic development in terms of direct profits. [13] A significant shift occurred in the early 21st century with China's rapid and drastic uprising in global economy. As the economy grew, the Chinese government rapidly increased its R&D investment on higher education through a series of national research programs such as "973" and "863" program and also gave great financial and preferential policy support to the "211" and "985" universities, which enabled Chinese universities to make significant

scientific and technological achievements. The university play an increasing important role for the patent surge in China. By the end of 2012, Chinese universities and research institutions owned 45033 valid patents for invention, accounting for 21% of all patents for inventions (217755) of China, ranking No. 2 among five patentees. The surge of university patent is a little serious than that of whole society. Take the period of twelfth five-year (2010-2015) for example, the university patent grants counts increase 40% every year, higher than that of state annually increase (33.5%) [14].

However, Chinese universities have not performed as well in patent commercialization as in patent application. The numbers of patent applications and patent grants from Chinese universities have increased much faster than the number of patent licenses. The patent transfer ratio was 32.26% in 2002 but rapidly decreased to 4.33% in 2012, [15] indicating that the performance of Chinese university patent transfer (UPT) worsened over the decade. The next step will be to understand to know what happened during these ten years by the empirical study and some surveys.

2.3. Cause Analyzing

In the past few decades, the commercialization of university-owned patents has become a hot topic among academic researchers, industry, and government policy makers. [16] University and academic researchers formulated and implemented coherent, feasible patent-transfer strategies. Scholars systematically assessed the performance of patent transfer and identified the some influential factors. For instance, the study of the cooperation between faculty inventors and industry, quality and the technological leadership effect, entrepreneurial activities) and the most of all, the role of TTOs.

About the poor performance of Chinese patent commercialization, roughly there are several kinds of explanations about it.

(1) Lack of incentives from the inventors because of the limitations of ownership over the patent. Experts think that the ownership belonging to the university rather than to inventors decrease the incentive of inventors. [17] He and Chen pointed out that China didn't get what they want by enacting Chinese Baidu-dole Act (Law of Science and Technology Progress P.R.C.) because the inventors has no ownership towards the patents. Zhou and Wang think that the inventors have no incentive for the fossilized management of the university to patent. [18]

(2) Lack of collaborations between university and commercial firma. Some scholars ascribe the low transfer ratio to the insufficient collaborations because the good patents are not known by the firma. Zhu and Shun held the distrust between university and firms for the insufficient communications impeded the patents transfer. [19] Owen-Smith and Powell identified that faculty decision to file patent application is strongly correlated to the perception of accruing benefits and that the stronger the public-private network, the stronger the pool of university patents. [20]

(3) Lack of high quality patents. Many experts recently

explain that there are, in fact, no high quality patents to be transferred in China universities. [21] Ma (2010) suggested that the transfer ratio is necessarily low under current policies because most inventors are not to transfer the patent from the beginning of filing. [22] Based on a comprehensive database of university patents from 155 leading Chinese universities from 1991 to 2009, Fisch (Fisch, Block & Sandner. 2016) found that patent quality did not increase to a similar degree with the patent surge and concluded that subsidy policies should focus primarily on increasing university R&D rather than on decreasing the costs of patenting. Dan (2015) argues that China's innovation capability has been overestimated because its patent policies generally focus on quantity, not on quality or commercial value. Li (2012) demonstrates that regional patent subsidy programs in China stimulate university patent applications.

2.4. Questions to Be Analyzed and the Surveys Introduction

About the problems mentioned above, it seems that some of them have been solved with the new law enacted to some extent. The new Law of Science and Technology Progress amended in 2015 regulated that universities enjoy the right to cope with the patents, also encourage the collaboration between universities and firm by many science and technology platforms established by governments. What's more, with the popular internet, the firm is much easier to

get technology information from the university. The Venture Capital will find you soon like specters as long as you have good technologies. [23]

Therefore, what are the crucial factors which lead to the bad performance in patent application? In the next section, it will illustrate it with empirical study.

3. Empirical Study

3.1. Data Collection and Research Methodology

In order to make clear the reasons why the patents increase rapidly. Our approach is to select top 10 universities as survey sample according to the QS World University Rankings 2014-2015. [24] They are, to be supposed, representatives in their respective areas and conduct research of the highest level in the area.

Patent counts and patent licenses of the 10 universities from the official website of CNIPA were investigated. The data is authentic as all the patent licenses should be registered on this website. The patent counts of total grants and patent license are searched from 2010 to 2012. Defect of the data may be that the transferred patents in the three years are not generally the patents granted in these three years. Table 1 shows that these 10 leading Chinese universities had an average patent transfer ratio of 4.1% from 2010 to 2012.

Table 1. Patent transfer in top 10 Chinese universities (2010--2012).

No.	University	Patent application	Patent licenses	Transfer ratio (%)
1	Tsinghua Uni	5520	74	1.3
2	Peking Uni	1949	10	0.5
3	Fudan Uni	1499	9	0.6
4	Shanghai Jiaotong Uni	3567	80	2.2
5	Zhejiang Uni	5108	144	2.8
6	China university of S&T	2011	174	8.5
7	Nanjing Uni	985	46	4.7
8	Wuhan Uni	777	20	2.6
9	Zhongshan Uni	1583	118	7.5
10	Nankai Uni	1297	70	5.4
Average		2133	74	4.1

Data source: database INNOGRAPHY. Retrieved on 6 June, 2017

Meanwhile, it has been sent out 400 questionnaires anonymously with 30 questions to the 10 universities mentioned above. We sent the E-questionnaire to the technology transfer offices, asking the staff to forward them to 40 faculty inventors who have at least 2 patents. We provide a faculty list of 50 people who have at least 2 patents. Also, we interviewed the patent transfer officers and more than 50 faculty inventors who possess more than 2 patents for invention in Shanghai, Beijing and Xi'an from June to December, 2015. 357 copies of them were taken back, 315 copies are valid questionnaires as follows: faculty inventors with 2-4 patents account for 49%; faculty inventors with 5-7 patents, 35%; faculty inventors with 8-10 patents, 11%; faculty inventors with more than 10 patents, 5%. The questions are designed to check their idea and attitude about patent application and patent commercialization, such as "For what purpose do you file for a patent?" (Multiple choice) etc.

3.2. The Alienated Purposes of the Patent Application

The task of rating the quality of patent is a particularly difficult one, since the distribution of these values is highly skew. [25] But if how the patents were filed and what attitude the applicant hold when they apply for patents were known, it would help us to grasp the quality of patent to a certain degree. Applying for a patent is, in nature, a business behavior for economic returns or protecting technology from copying or stealing because it costs a big sum of money in both applying for it and renewal fee. But in China now, faculty inventors apply for patents for other reasons (See figure 1). Among the choices, only 51% of the respondents choose the "commercialization", about 49% of respondent choose other motives. We will illustrate other motives one by one.

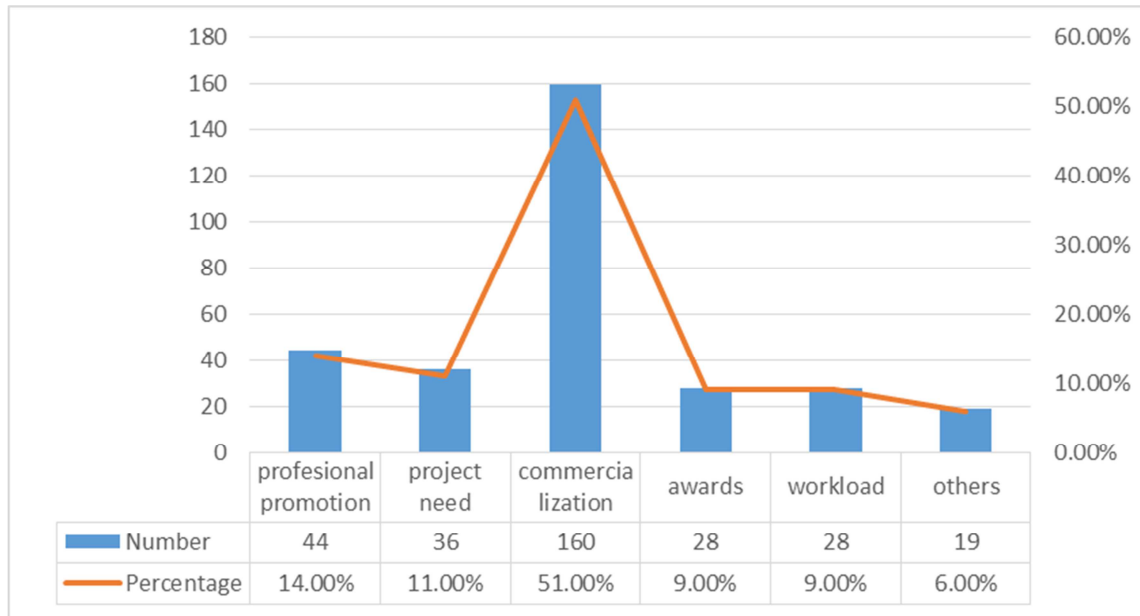


Figure 1. Reply to the question: What motivates you to apply for a patent? The question is: Please choose 5 most important motives for your filing patents. *44 means that there are 44 respondents rank "For commercialization" as first. Data source: the survey.

3.2.1. For Professional Promotion

Many faculty inventors view obtaining a patent as a final result. Quantity of patents has become an important evaluation indicator which was employed in each round of personal promotion. For example, to be professor, an associate professor can apply for more patents as academic achievements. The survey shows that the purpose "For Professional Promotion" accounts for more than 14%. Take famous universities, Shanghai Jiaotong University in Shanghai for example, the university gives patents for invention the same weight as research papers indexed by the Science Citation Index (SCI) in evaluating faculty members' academic achievements. The university regulated in 2005 that an associate professor in engineering fields should meet the needs of three requirements to be promoted as full professorship. One of them is that he or she should produce totally 10 patents and high quality papers. Tongji university has the similar rules in 2005 that 5 patents for invention or papers were required to be full professor.

The faculty inventors were encouraged to apply for more patents because more patents lead to high personal promotion. They rarely care about whether the patents are commercially valuable or not. About the question "how many of your patents do you think have business value?" we provided five choices: all, 3/4, half, 1/3, <1/3. The survey shows that 63% of the respondents think 1/2-1/3 of their patents are of business value; 14% of inventors think 3/4 of patents valuable, 5% of inventors think less than 1/3 of patents valuable, and only 18% of inventors think all patents valuable.

3.2.2. For Project Needs

China university faculty members generally focus on basic research at the laboratory or prototype stage. In the survey, when asked "Do you pay attention to the needs of the

enterprise when conducting scientific research?" only 16% of the inventors answered pay close attention to the needs of the enterprises, 18% of them pay some attention to the needs of the enterprise, 61% of the inventors will not pay attention to the needs of the enterprise. Most patents from these basic researches are non-market oriented technologies.

Many large scientific programs, such as 973 and 863 Project, have been established to solve basic scientific problems which are significant to national strategy in the long run. The technologies from these basic researches are a little far from the current market, and thus difficult to transfer. But a certain number of patents in both applying and final check are required by the administration. Many faculty researchers conducting the 973 and 863 projects tend to apply for more patents to meet the program requirements. The survey shows that this proportion accounts for 11% of the respondents, ranking third. [26]

3.2.3. For Award and Workload

9% of the respondents apply for patent for award according to the survey. The inventors can get remuneration and profit after the applications are granted according to Rules for Implementation of the Patent Law of the People's Republic of China. The amount of monetary award for an invention patent shall be no less than 3,000 Yuan; the amount of monetary award for a patent for utility model or design shall be no less than 1,000 Yuan. Meanwhile, patents can enable the inventors to meet the need of the task which the university authorities set for them. Another 9% of the respondents file patents for fulfilling workload set by university authorities. 6% of the respondents file patents for other kinds of reasons including patent equity investment, skilled migration to other countries etc.

4. Analysis of the Patent Commercialization

In universities, the practice of patents is contorted as analyzed above. Why has this taken place? Some institutional factors may explain this phenomenon.

4.1. The Influence of Planned Economy on the Government

Since 1978, China has transformed from a planned economy to a market economy and opened up to the foreign trade. Rapid economic growth has helped China to become one of the most important world economic powers. [27]

China's reforms were not conceived as a radical plan, but consisting of small, step-by-step changes. The reforms, probing into the unknown gradually, have proceeded by trial and error. We shall therefore characterize China's approach (in keeping with the natural-science phraseology of 'big bang') as evolutionary reform. Evolutionary reform is not intrinsically superior to big-bang reform: it is obviously desirable to create an efficient, market-based economy as quickly as possible. But, as is becoming increasingly clear, any reform process will be protracted. All the institutions of the planned economy were developed as component parts of that system. They are mutually consistent, but incompatible with a true market economy.

Table 2. The targets of patents for invention per 10000 people of selected provinces in 2020.

No.	Province	Year 2015	Year 2020	Location
1	Beijing	41	80	Beijing area
2	Shanghai	14.2	20	East China
3	Guangzhou	12.9	18	South China
4	Heilongjiang	3.3	6.7	Northeast area
5	Shanxi	6.02	12	Northwest area
6	Hubei	4.3	10	Central China
7	Sichuan	3.5	7.5	Southwest area
	State Council	6.2	12	All country

Data source: The State Intellectual Property Office. (2015) *China Intellectual Property Yearbook 2015*, Beijing: Intellectual property Press, pp: 254-300.

The thinking of the evolutionary reform affects much the policy making of the government. Both the central government and local government are used to make all kinds of plans in the social development according to development plan rather than the market reality. [28] Likewise, it is reflected in the planned patent development. For example, the State Council of P.R.C. made out the plan that the target of patents per 10,000 people will reaches up to 12 patents in 2020 from current 6.2 patents during the thirteenth five-year period [29] Accordingly, all the provinces formulate their plan about patent targets. We selected seven most developed provinces according to the seven regions divided as geographic locations. Their targets list as follows (See table 2). It is observed that the potential increase of the patent counts from the table above, with nearly double patents plan. Although the target is expected goal, it is, to some extent, still binding to local authorities who will naturally transfer the task to universities and enterprises which belong to its territory. Thus, the university will also take nearly double patent policies to meet the needs of local government from which, in turn, gain the funding of schooling.

4.2. The Pressure of University Ranking by the Ministry of Education of P.R.C.

That the universities impel their teachers to produce more patents is by no means accidental. The government (Ministry of Education) ranks all public universities every year (almost all famous universities are public in China). A university will get more support and funding from the government if it ranks high, which can enable them to enroll more excellent students. Among the many indicators of ranking, the number of patents is of great importance. Patents is one of five indicators (they

are: State Research Institution, Awards, patent counts, papers, science project counts)[30] by which university science research is evaluated. The more patents they get, the higher the university ranks.

Under this evaluation system, university administrators lay much emphasis on scientific research and patent quantity. Aiming to meet various evaluation requirements, it is natural for universities to relay the pressure on teachers and increase the workload on them. Most schools in universities view patent applications and grants as one of main assessment indicators of teachers' performance assessment.

4.3. The Preferential Financial Policies on Patent Application of the Chinese Universities

China established its patent law in 1985, and patent applications grew rather slow because China's undeveloped economy and its limited innovation capacity shortly after the open-up policy. In 1999, all the patents granted by CNIPA are no more than 8000 while there are more than 80000 patents granted in US [31]. There are huge gap between China and foreign developed countries. The state began to advocate that the country should take subsidy measures to encourage the patent filing. Shanghai Municipal enacted the first subsidy policy all over the country in 1999, according to which the government would pay the application fee and the renewal fee of first three years. Then many provinces followed and nearly all provinces have implemented the patent subsidy policies until 2007. Then "National intellectual property strategic outline" was enacted in 2008 and "Innovation driven development strategy" was implemented in 2011 which enhanced the patent filing once more. Therefore China's

subsidy policies were fully implemented until 2012 and lots of more preferential subsidy policies were enacted, thus the period (2002-2012) is also the fastest development period in patent increase.

With these policies, faculty members could gains much remuneration and profits from applying for patents without paying any costs in the initial stage. The subsidy policies, meanwhile, have little requirements for patent quality (such as business value, protect scope etc.), it is not surprising

that faculty inventors focus on patent quantity only. The survey shows that the inventor's motives to apply patents will weaken much if there are not so much financial subsidy. The survey (See Table 3) shows that policies of subsidy, award and royalties give some incentives to inventors. About 22.6% ($(36+18+14)/3=22.6$) of inventors would not apply for patents if there was no subsidy, award, or royalties.

Table 3. Reply to question about policies of subsidy, award and royalties.

Questions	Yes (%)	No (%)	Total (%)
Would you file if there is no any subsidies?	60	3636	96
Would you file if there is no award?	76	18	94
Would you file if there is no royalty?	79	14	95
Average	71.6	22.6	95

Note: The rest of the answer besides "yes" and "no" is "hard to say" Source: Design by author according to the survey.

In summary, there are two main forces shaping the university patent development. The first one, generating from commercialization, protection of technology and barrier setting for competitors etc. is market force under which high quality patents usually are produced. The second, coming from the administrative authorities including subsidy policy, university ranking and target setting etc., is planned force by which some unscientific patent policies are stipulated, encouraging more patent produce. On one hand, inventors can be better positioned in professional promotion, getting more projects, meeting the needs of workload by applying for patents; on the other hand, policies of subsidy, award and royalties clearly favor those who apply for more patents. It is no wonder inventors try their best for more patents, which eventually leads to a huge number of patents with little business value.

5. Conclusion and Limitations

Although China's universities have made impressive contributions to patent creation, the commercialization have a long way to go. In this paper, the current situation of Chinese patent commercialization and the quality of patents have been reviewed. Patent quality is considered a major cause of unsatisfactory patent use. Most scholars consider the subsidy policy an important negative factor which leads to a patent surge both in university and enterprises in China. But they rarely give the reasons why these subsidy policies are formulated and enforced.

The study began with the description of the status quo of the patent commercialization in China universities. Employing a questionnaire survey, we find several motives for which faculty inventors apply for patents. Only 14% of the inventors think the commercialization is most important for filing patents.

Then the paper further analyzed why the faculty inventors would have skewed attitudes toward the patent application. They are clear they don't apply for some patents for commercialization which is the right purpose of patents. Three institutional factors, produced in planned economy, are

presented, which is the fundamental reason for university patent surge. Some suggestions are put forth about how to change the policies from both institutional and mechanism perspective: (1) Change the thinking mode of planned economy. Several decades of planned economy imposed great influence on the Chinese administrative organizations in many ways. The leaders are used to make plans in all kind of life which sometimes go against the natural regularity. Patents embody the scientific development and develop gradually which is not suitable for plan. The government should realize it and change the planned thinking mode. (2) Modification of the University Assessment System. The assessment systems of government to universities, such as the Ministry of Education, should be changed. Indicators of patent commercial use such as licensing, implementation should receive more attention in the national education assessment system

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