The Influence of China Regional Patent Subsidy Policy to Patent Application: An Empirical Analysis

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Abstract—Patent subsidy policy is an important policy tool for the government to encourage and guide the innovation subjects to apply for patent. This paper mainly adopts the Mann-Whitney U test to quantitatively analyze the impact of regional patent subsidy policy on patent application. It takes four provinces as the research objects. The result shows that patent subsidy policy of each region has different effects on different kinds of patent application, and thus some policy suggestions are proposed. In addition this paper presents the thinking and prospect for the applicability of Mann-Whitney U test in patent issues.

I. INTRODUCTION

Recently, China's patent application has been growing rapidly. According to the *World Intellectual Property Report 2015*[11] issued by the World Intellectual Property Organization (WIPO), from 2011, China had become the largest country in invention patent application by surpassing the U.S., and occupies the first place for five consecutive years. The rapid growth of patent filing is closely related to not only the development of economy but the improvement of indigenous innovation ability. At present, China's total amount of domestic patent application and international patent have been ranked in the forefront all over the world. But in order to enter the innovative country ranks, it is very important to realize the transition from patent application to patent quality power[1], especially in key technologies and new technology which lead the future development and occupy the leading position of intellectual property rights[8].

Accompanied by the generation of patent system, our country released the *Patent Cost Mitigation Measure for Individual Application* in February, 1985. It marked the birth of China's patent-funded system. With the continuous improvement and development of the patent law system, national policy for patent cost mitigation are revised several times and gradually improves. The policy boosts the rapid growth of patent application in our country. At the same time regional subsidy policy pushes capital available which greatly solves the economic burden of applying or maintaining patent for innovative subjects. So it greatly enhances the regional patent application.

Since 1999, local government began to actively develop patent subsidy policy and invested funds for patent. So far, all provinces have released patent subsidy policy based on related national policy except Ningxia province.
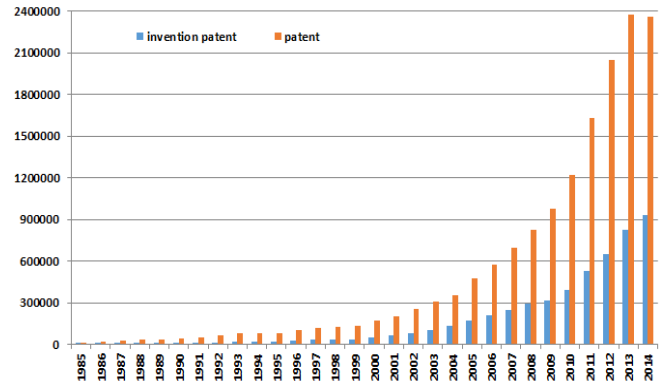

Figure 1   The number of patent application of China (1985-2014)
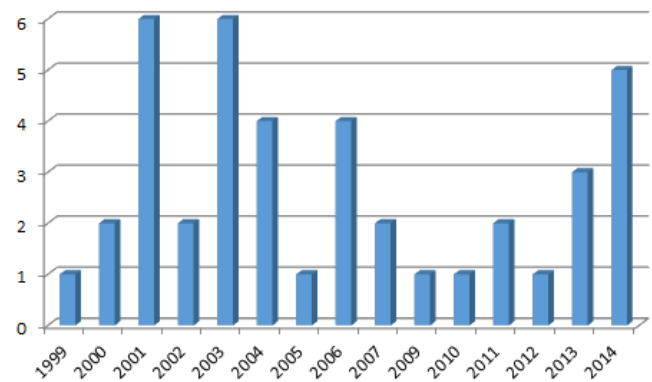Data Source: State Intellectual Property Office of China

Figure 2   The time summary of regional original subsidy policy
Data Source: State Intellectual Property Office of China

As an important measure of intellectual property right in our country, patent subsidy policy plays a positive role in increasing awareness of patent and promoting growth of patent application. It is impelled to change for building an innovative country and implementing of intellectual property rights constantly. Lester C. Thurow thinks that different areas of technology play different role in scientific and technical progress in United States by studying the development of technology industry in different stages. He connects patent system and government policy to make concrete example analysis. Finally he proposes that government's patent policy should be different for various industries. At the same time it needs to reduce the loss of monopoly for incentive innovation[9]. Jia-chun Wen thinks that there are at least two aspects of interest-driven for the process of patent subsidy policy. The first is the objective need of government intervention when patent system runs in scientific and economic development environment[10]. Zucker and

Friedman consider that government-fund has an important positive impact on university's patent output and patent implementation[15][3]. Ping-fang Zhu and Wei-min Xu think policy can significantly enhance the level of corporate R&D investment by researching the Science and Technology subsidy policy in Shanghai and tax relief policy for medium-sized industrial enterprises in R&D investment and its patent output[14]. On the other hand, many scholars point the negative effects of patent subsidy policy. To a certain extent it has become a quick success of measure. It will inevitably produce a lot of "junk patent". It departs from fundamental purpose of patent system which promotes the progress of scientific and technological[5]. Yuan considers that the patent subsidy policy would not only lead to unfair market competition, intensifies patent structural imbalance, but also reduce the quality of patent, and thereby impede technological innovation[12]. Guan deems that current patent subsidy policy has led to a lot of junk patent and patent bubble. It distorts the patent system and makes man-made obstacles for technology transfer[4].

Researches on patent subsidy policy at this stage mainly are theoretical research, descriptive statistics, case studies and qualitative analysis. Quantitative analysis has certain development. Qin-hong Zhang and Jian-wen Luo consider that the subsidy policy is helpful in increasing the quantity of all kinds of patent application except the design patent. However, the negative effect of the subsidy policy on the quality of the applied patent is also proved. The above conclusions are then explained by analyzing the cost and benefit in applying patent[13]. Wei Li and Xiang-yang Xia think the impacts of the patent promoting policies, including the patent subsidy policy and the S&T grant policy, on regional patent growth are analyzed by using nonparametric test, multiple linear regression and Granger causality test. The outcomes show that the patent subsidy policy and the S&T grant policy is helpful in increasing the quality of all kinds of patent application, and increasing can be kept by working effectively in coordination with each other. Moreover, to some extent, the rapid growth of the quantity of the utility model patent and the layout—design invention patent does not lower the regional patent quality. This paper mainly adopts the Mann-Whitney U test to quantitatively analyze the influence of regional patent subsidy policy to patent application[6].

II. RESEARCH METHODS

Because the complexity of patent application data, we cannot make judgment on the parameter and distribution pattern of patent application. By drawing on domestic scholars' research about quantitative analysis on the impact of patent subsidy policy to patent application rising, we choose two independent samples to make nonparametric tests and examine if there is significant difference between them. We try to analyze the method's broad applicability and the results consistency.

SPSS provides a variety of two independent samples of non-parametric test. We adopt the Mann-Whitney U, namely the Wilcoxon rank-sum test. It is the most common method which is used in two independent sample tests. It can be used to test two independent samples from the same population. The null hypothesis of the test method is H_0: two independent samples from no significant difference in overall. In fact the Mann-Whitney U test is a rank sum test. It has nothing to do with statistic and size of sample values in inspection process. So the Mann-Whitney U test can be used in not only the sample value of continuous data but the sequence data.

This paper attempts to explore the following questions:

1) Whether there is significant difference between patent application which before and after the implementation of patent subsidy policy (including the total patent, invention patent, utility model patent and design patent), and the features;

2) If there is not a significant difference or the difference inconspicuous, then expand the sample size to analyze the characteristics presented;

3) Select Beijing, Jiangsu, Zhejiang and Guangdong province as the research objects to verify the method's broad applicability and results' consistency and reliability.

III. ANALYSIS PROCESS

A. Beijing's Situation

Beijing is rich with resources about education, science and technology. The number of patent application in 1985 is 1540, accounting for about 10% of country's patent application. In 2014 the number is 131111, accounting for about 6.3% of the total number of patent application. The average growth is at a rate of 16.0% from 1985 to 2014. Overall, patent application in Beijing has gone through three main phases (Fig. 3): the first phase (1985-1992) is the initial stage of development, relying on the existing stock of resources. The patent application is growing very rapidly. The second phase (1993-1998) is stagnant stage. Annual patent application remained at about 6300. There is even negative growth in some year. The third stage (since 1999) is stabilizing stage. The average annual growth is at a rate of 20%. It is worth noting that the boundaries of two stages are 1993 and 1999 which roughly corresponds to the twice reform of patent system. The positive role of patent system reform on patent application can be inferred.

In order to improve the second phase which is previously mentioned, Beijing has promulgated and implemented the *Beijing Patent Application Subsidy Interim Measures in 2000* (Tab. 1) in August, 2000. It is clearly showed three kinds of patent about patent application fee and substantive examination fee (Tab. 2).

Figure 4 The change before and after *Beijing Invention Patent Application Subsidy Interim Measures* on invention application
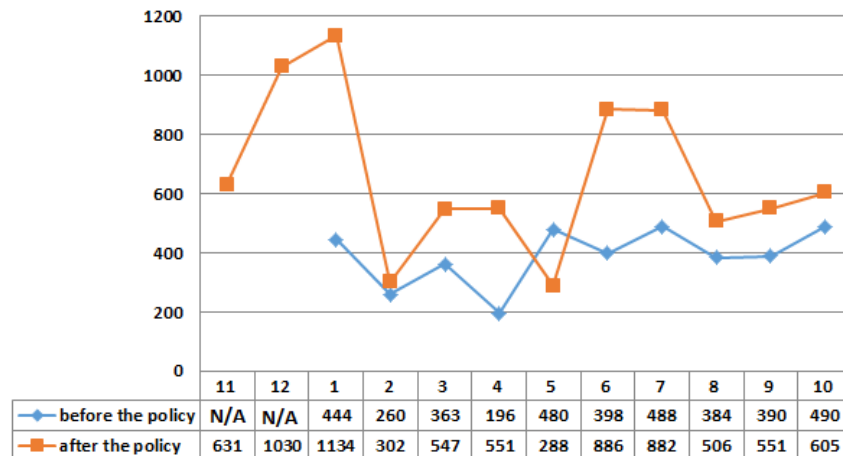
2) Validity analysis of revised patent subsidy policy on patent application

Reference to above analysis, we analyze the significant difference between a year before and after the implementation of *Beijing Patent Application Subsidy Interim Measures for the fund management* in January 2007. Result is shown in Tab. 3.

Through the analysis of Tab. 3, we conclude that there is slightly difference between two data of invention patent application. The other data on the 0.05 significance level cannot reject the null hypothesis. Therefore no statistically significant difference exits between them. The published time of patent subsidy policy has a different effect on patent application in short-term and long-term. So we decide to expand the sample size, the outcome is shown in Tab. 4.

The table data shows that there is no significant difference between two sets of design patent application data. Fig. 5 is the comparison between the numbers. The graphics found no significant change, so the subsidy policy has no substantive enhance on design patent application.

Table 3 SAMPLE TEST RESULTS OF BEIJING PATENT APPLICATION SUBSIDY INTERIM MEASURES FOR THE FUND MANAGEMENT

	Number of month	Total patent	Invention patent	Utility model patent	Design patent
P value	12	0.101	0.045	0.478	0.843

Table 4 EXTENDED SAMPLE TEST RESULTS OF *BEIJING PATENT APPLICATION SUBSIDY INTERIM MEASURES FOR THE FUND MANAGEMENT*

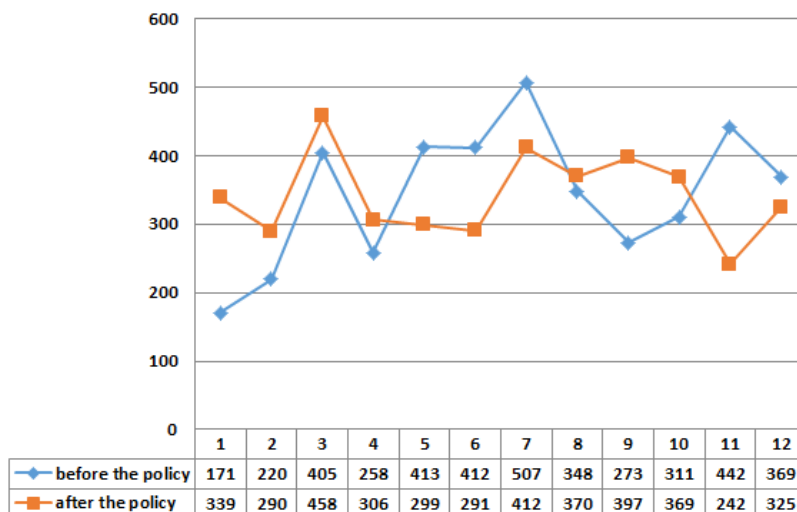|	Number of month	Total patent	Invention patent	Utility model patent	Design patent
P value	24	0.000	0.000	0.001	0.433

Figure 5 The change before and after *Beijing Patent Application Subsidy Interim Measures For The Fund Management* on design patent application

Table 5 SAMPLE TEST RESULTS OF *BEIJING PATENT MEASURES FOR THE SUBSIDY FUND MANAGEMEN*

	Number of month	Total patent	Invention patent	Utility model patent	Design patent
P value	12	0.089	0.089	0.078	0.033

In addition, the significant difference between a year before and after the implementation of *Beijing Patent Measures for the Subsidy Fund Management* in September 2014 is also analyzed. As shown in table 5, there is slightly significant difference only between two sets of design patent application data. The impact of this policy is not fully revealed. Because of the policy issued relatively new, further analysis can't be carried out by expand the sample size.

The results show that: the promulgation of *Beijing Invention Patent Application Subsidy Interim Measure*s in 2002 has a significant effect on invention patent application. There is only slightly effect on invention patent application after the implementation of *Beijing Patent Application Subsidy Interim Measures for the fund management* in 2007. Expanded sample size of design patent which doesn't pass the test indicates patent subsidy policy has no substantial improvement on design patent application. And for the implementation of *Beijing Patent Measures for the Subsidy Fund Management* in 2014, it has only slightly effect on design patent application. The impact of this new policy is not fully revealed.

B. Other Provinces

According to above analysis, we make the similar analysis to Jiangsu, Zhejiang and Guangdong province. All of the three provinces gain front rank of patent application on quantity and quality in recent years. It has a direct relation to their strong innovation ability of scientific and technological. The patent subsidy policy also plays an important role in promoting the growth and the awareness about patent application. Jiangsu Province promulgated the *Interim Measures of Jiangsu Provincial Patent Special Funds* in 2001. Then the relevant policies are revised in 2006 and 2011. Zhejiang Province released *Zhejiang Patent Special Funds Interim Measures* in 2001; policies are revised in July, 2003 and October, 2006. Guangdong Province released *Guangdong Province Invention Patent Application Fee Assistance Interim Measures* in 2000 and then made the revision in 2003, 2007 and 2014. The relevant policies of three provinces are shown in table 6. Based on the same consideration of data availability, this paper makes an effective choice. These are 12 months' patent application data before and after the month of policy released. The obtained results are shown in the table below.

Table 6 RELEVANT POLICY DOCUMENTS FOR PATENT APPLICATION OF JIANGSU, ZHEJIANG AND GUANGDONG PROVINCE

Province	File name	Effective time	Posting institutions
Jiangsu	Interim Measures of Jiangsu Provincial Patent Special Funds	2001.09	Department of Finance of Jiangsu Province, Intellectual Property Office of Jiangsu Province
	Measures of Jiangsu Provincial Patent Subsidy Funds	2006.11	
	Measures of Jiangsu Intellectual Property Creation and Utilization (Patent Grant) Special Funds	2011.06	
Zhejiang	Zhejiang Patent Special Funds Interim Measures	2001.11	Zhejiang Provincial Department of Finance, Science Technology Department of Zhejiang Province
	Zhejiang Patent Special Funds Measures	2003.07	
	Zhejiang Patent Special Funds Measures (Revised)	2006.10	
Guangdong	Guangdong Province Invention Patent Application Fee Assistance Interim Measures	2000.09	Guangdong Intellectual Property Office
	Guangdong Province Invention Patent Application Fee Assistance Interim Measures (Revised)	2003.09	
	Guangdong Invention Patents Application Subsidy Measures	2007.12	Guangdong Intellectual Property Office, Department of Finance of Guangdong Province
	Measures of Guangdong Patent Application Subsidy and Incentive Special Funds	2014.05	

Source: Internet

Table 7 SAMPLE TEST RESULTS OF JIANGSU PROVINCE

	Test time	Number of month	Total	Invention	Utility model	Design
P value	2001.09	12	0.010	0.008	0.078	0.078
	2006.11	12	0.017	0.068	0.060	0.014
		24	0.000	0.000	0.000	0.000
	2011.06	12	0.010	0.012	0.002	0.143
		24	0.000	0.000	0.000	0.002

Table 8 SAMPLE TEST RESULTS OF ZHEJIANG PROVINCE

	Test time	Number of month	Total	Invention	Utility model	Design
P value	2001.11	12	0.006	0.000	0.020	0.033
	2003.07	12	0.000	0.000	0.002	0.020
	2006.10	12	0.198	0.478	0.266	0.143
		24	0.000	0.000	0.000	0.000

Table 9 SAMPLE TEST RESULTS OF GUANGDONG PROVINCE

	Test time	Number of month	Invention patent
P value	2003.09	12	0.000
	2007.12	12	0.242
		24	0.002
	2014.05	12	0.242

The results indicate that:
1) The first patent subsidy policy in Jiangsu province has significant impact on the invention patent. The second version policy has remarkable effect only on design patent application. It is not suit for invention patent and utility model patent. But it has obviously improved by expanding the sample size. The current policy mainly affects the application of invention and utility model patent, and has a marked effect on design patent application after expanding the sample size.
2) The first and second implementation of patent subsidy policy in Zhejiang province affects all three kinds of patent application, while the present policy cannot reject the null hypothesis. It is effective by expanding sample size.
3) The patent subsidy policy in Guangdong province only aims at invention patent, so this paper only consider the impact on invention patent application. The result is as same as Zhejiang province. After the release of original patent subsidy policy, invention patent application has obviously ascended, and then the following effect is not apparent. It appears the obvious difference after expanding the sample size.

IV. CONCLUSION AND DISCUSSION

This paper mainly adopts the Mann-Whitney U test to quantitatively analyze the influence of regional patent subsidy policy to patent application. It takes Beijing, Jiangsu, Zhejiang and Guangdong province as the research objects. We can achieve conclusion as follows.

Patent subsidy policy of each area has different effects on different kinds of patent application. Our results show that patent subsidy policy has a certain degree of positive role. For the constantly changing of patent subsidy policy, the original implementation of patent subsidy policy has a larger influence. The revised policy is not obvious or invalid, but it is improved by expanding the sample size. Although it is difficult to eliminate the interference of other factors, we still think that there is a difference in the time required for a patent subsidy policy to have a significant role in promoting. In addition the current patent subsidy policy has stressed the diversity on different types of patent for preventing "blowout" type growth.

Therefore, in order to play the positive role of subsidy policy on patent application more effectively, this paper put forward the following suggestions to promote the policy more reasonable combined with the specific situations of the existing regional patent subsidy policy.

A. The topic of subsidy should be improved.

The fundamental purpose of the patent application subsidy is not to pursue growth of the number of applications, but to support and encourage technological innovation of enterprises, and drive them to apply for patents for the valuable and potential of innovations. Application for patent is a kind of market behavior, and it can be regarded as healthy technology competition between enterprises. Thus, the government should provide a platform, rather than become a conductor. In addition, the patent management department should establish and consummate the mechanism of patent quality evaluation gradually, and promote the topic of patent subsidy changed to be quality-oriented.

B. A thorough patent subsidy system should be constructed.

Governments at all levels including the intellectual property management departments should establish a coordinated and unified management system for patent subsidy, and break the status that everyone goes his own way. First of all, the matching mechanism for the subsidy of province, city and county should be explored. Among them, the government should take the city level as the main body. The object and amount of subsidy will be determined by the city level, and the matching ratio of the governments at all levels should depend on the status of financial income and patent applications.

C. The objects of subsidy should be distinguished and treated differently.

The extensive subsidy mode based on fixed subsidy should be changed in policy formulation. The government should make a diversified subsidy way according to the different type of applicant. That is to say, the government should subsidy for enterprises, universities and research institutions with different requirements, standards and quotas.

Despite our careful analysis and resulting outcomes, this work still suffers from several limitations and weaknesses. At first, it has certain restriction to analyze the influence of regional patent subsidy policy on patent application based on Mann-Whitney U test. Because this test makes up rank from small to big, then using non-parameter test to examine the rank of each group. Moreover the test statistics calculation is based on the original data in samples according to the rank arrangement from small to big. So it loses the concrete numerical information of original data, and the test efficacy would reduce. Therefore, the result has the certain approximate behavior. Secondly, we only test that whether

there is a significant change about the amount of patent applications before and after the release of patent subsidy policy, but we still can't prove that this significant change has some certain relationships with the policy. That is because the change in the amount of patent applications may be caused by a series of factors together[2][7].

There are various avenues for future research. An important research question to be answered is investigating how to eliminate the influence of other factors on the quantity of patent application in the test process. What factors will affect the amount of patent applications? What are the effects of these factors on the results of the test? In addition, it would be worthwhile to investigate the influence path of patent subsidy policy on patent application. What policies are more effective in promoting the increase in the amount of invention patent applications? Do the policies have totally the same effects on enterprises, universities and research institutions? And if it's not, the next inquiry should thus investigate that what policies are more effective for different types of subsidy object.

ACKNOWLEDGMENTS

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