Chapter 7
The Upsurge of Domestic Patent Applications in China: Is R&D Expenditure or Patent Subsidy Policy Responsible?

Hefa Song, Li Zhenxing and Xu Dawei

Abstract This chapter studies the impact of Chinese government policies on the upsurge of domestic patent applications in China. We find that the explosion in the number of patent applications in China is significantly correlated with increased expenditure on R&D by companies, universities and other entities. However, based on regression modeling, we also find that provincial government subsidy programs have played a crucial role in the upsurge in domestic applications since 2010. Disconcertingly, patent quality is diminished by these subsidy programs due to the distorted incentive structure that they create for filing patent applications. The Chinese experience has important policy implications for other countries.

Keywords Patent applications · Subsidies · Government incentives · Policy

7.1 Introduction

In recent years, China has experienced rapid growth in the patenting of inventions. Statistics from China's State Intellectual Property Office (SIPO) indicate a steady growth in the number of domestic patent applications from 1999 to 2013. In 2011, China was ranked in top place globally for the number of filed domestic patent applications, according to SIPO statistics. Furthermore, in 2011 China was ranked

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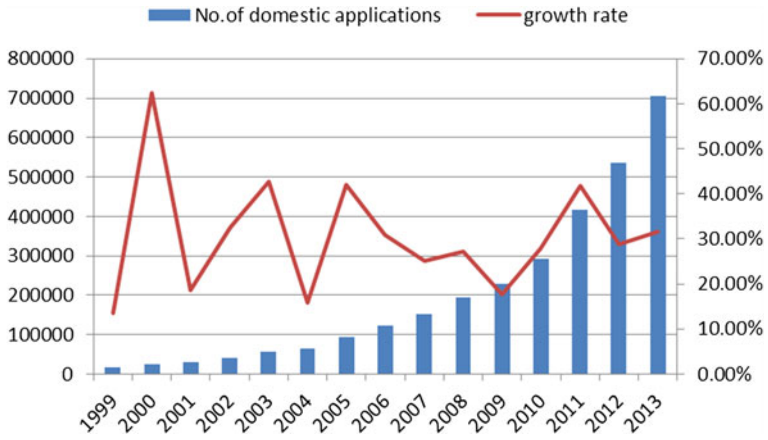

Fig. 7.1 Number of domestic applications received by SIPO and growth rate

in fourth place globally according to the number of filed Patent Cooperation Treaty (PCT) applications (Fig. 7.1).

There are many potential reasons for the upsurge in patenting activity, one of which is the steady growth in national expenditure on R&D, especially as a percentage of GDP. The growth in R&D expenditure is considered to be striking, and based on the rising R&D expenditure, the year 2013 witnessed a milestone when overall R&D expenditure by both government agencies and private entities exceeded two percent of GDP. Patents are often considered as a good representation of efforts in technological development and innovation (Griliches 1990), and the rapid increase in R&D expenditure is an important factor that leads to an upsurge in patenting activity (Hu and Jefferson 2009) (Fig. 7.2).

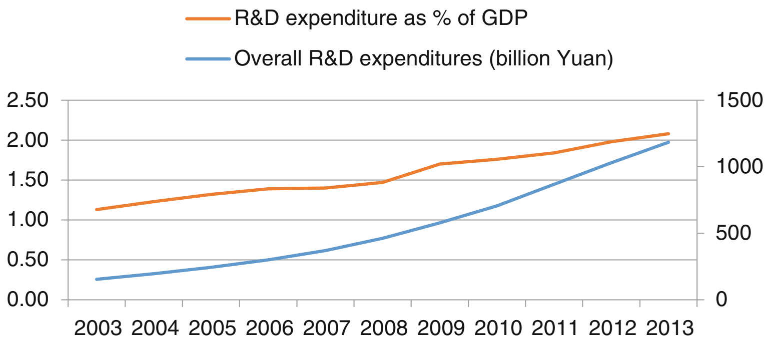

Fig. 7.2 Overall R&D expenditure and its percentage of GDP

Government subsidy programs supporting patent applications are also regarded as an important factor behind such a rapid increase in patent applications. Several studies have identified a significant effect of these programs on the upsurge in patent applications in certain Chinese provinces (Yang et al. 2012; Zhang and Luo 2009). One study found that the number of government subsidy policies and the upsurge in patenting activity was significantly correlated between 1999 and 2007. However, the research to date has only shown that subsidy programs have had a significant effect on the growth in the number of applications, but they have not provided insight into how different types of subsidies (for example, the value of subsidies offered) given at different points in time, influence patenting activity. For example, one study used a dummy variable that indicated whether or not a region had launched its patent subsidy program, but did not consider the amount of subsidy for each application/grant and its effect on encouraging patenting activity. Furthermore, existing research appears only examine the effect of older patent subsidy policies, rather than focusing on recent patent subsidy policies in China.

Mindful of this gap in the literature, this chapter seeks to contribute to the literature in three ways. Firstly, it analyzes the effects of the amount of China's provincial patent subsidies on the upsurge in patenting inventions in China. Secondly, it assesses the impact of new (as recent as 2013) Chinese patent subsidy policies on the growth of patenting inventions in China. Thirdly, the implications from this research for policymakers are discussed.

This chapter makes these contributions while attempting to answer the following overarching questions:

- What is the exact effect of the different factors that have led to the upsurge in the filing of domestic patents in China in recent years?
- What are the implications of these factors for patent quality?
- What may other countries learn from the Chinese policy experience that is directed at building a more IP-intensive economy?

The chapter uses a comprehensive approach that analyzes the economic, legal factors and institutional changes in an attempt to answer these questions.

7.2 Institutional Changes and China's Upsurge in Patenting Activity

7.2.1 Institutional Changes and the Patent System

From the perspective of government initiatives, between 2001 and 2013 there were several dividing milestones in the evolution of China's patent system and innovation system that are worthy of highlighting. Firstly, in 2001, China joined the World Trade Organization (WTO) and became a member of Agreement On

Trade-related Aspects of Intellectual Property Rights (TRIPs), which signaled that the legal and intellectual property (IP) protection environment in China would be improved. The integration of China into the global trading system has drastically changed the business environment of domestic companies, who were forced to make patenting a more important part of their business strategy.

Secondly, with Chinese companies encountering an increased number of IP-related lawsuits in international competition, the central government found it more urgent to strengthen national innovation capacity. In 2006, China issued the Outlook of National Medium to Long Term Science and Technology Development Plan (2006–2020). In order to implement the plan, many supplementary policies were issued to promote R&D and patenting activities, including tax reductions and financial policies. The central government also set the goal that the share of R&D expenditure should reach 2.2 % of China's total GDP by 2015.

The third key milestone came in 2008, when the government promulgated the National Intellectual Property Strategy (2008–2020), which stated the aim of China becoming an advanced country in terms of the creation, utilization, protection and management of IP. As the first national IP strategy, it significantly improved and increased the attention of the public on IP, and was regarded as a fundamental step towards turning China into an innovative country. On the national level, an inter-ministerial joint committee was also established to ensure that implementation of the IP strategy would be supported by every stake-holding ministry. As such, many IP-incentive policies became organizationally feasible.

The last critical point came between 2010 and 2011 in the form of important central-level policies that established the first clear nationwide quantitative patent targets. To implement the National IP Strategy, in 2010 SIPO issued the National Patent Development Strategy (2011–2020), in which the government stated that the total number of invention patents, utility model and industrial design applications would reach two million in 2015. In 2011, the Chinese central government issued the Twelfth Five-Year Plan for National Economic and Social Development. The plan set the target that from 2011 to 2015 the number of invention patents owned, expressed as ownership per 10,000 residents, would be increased from 1.7 in 2010 to 3.3 in 2015.

The period between 2010 and 2011 was the first time that China established clear national targets for the number of patents, and these targets for the first time became a performance indicator of provincial governors assessed by the central government. To meet these targets, and to ensure positive performance evaluations, both the central and provincial/local governments issued a series of policies, including subsidy programs, an appraisal system focusing more on patents, and more intensified enforcement of IP protection. Based upon the author's own experience of working closely with multiple provincial and county IP bureaus/offices in China, these offices were informed of these quantitative patent targets in advance, and so many offices started creating incentive policies as early as 2010 to meet the targets.

7.2.2 Factors Leading to the Upsurge in Patenting Activity

There are many factors that may influence patenting decisions. Regions with larger GDP tend to produce more applications, because a larger GDP is indicative of more active economic activity. Furthermore, in such regions the competition also tends to be more intensified, which makes it more imperative for inventors to patent their innovations. Meanwhile, legislation that provides for stronger IP protection and better enforcement of IP under the law is also favorable and supportive of an increased number of patent applications.

Institutional factors have also been studied in terms of their impact on patenting propensity. For example, the legislative changes in the U.S. in the 1980s led to the so called 'patent portfolio race' in the semiconductor industry, and resulted in more applications during that period (Hall and Ziedonis 2001). Another study also found that foreign direct investment (FDI) is positively correlated with more patent applications (Hu and Jefferson 2009). The reason is that with the economy becoming more open, multinational corporations are able to demonstrate to local stakeholders the critical value of patents in keeping a competitive advantage. Multinationals, despite concerns about IP appropriability in China, also file more applications in China to increase their freedom-to-operate potential (Keupp et al. 2012).

Existing research also extensively debates the factors that led to the upsurge in patenting activity in China in particular. The actual effects of various government incentive policies intended to stimulate IP are rather controversial. Domestic and foreign scholars often criticize these policies for creating a huge quantity of patents while patent quality worsens. One author pointed out that China's IP policies will hamper the country's innovation progress, since the quantitative targets set by the government are overly simplistic, and fail to adequately emphasize commercialization, and may therefore lead to decreases in patent quality. It was also argued by the same study that problematic rules and procedures for patent applications, examinations and enforcement of patent rights would undermine patent quality in China (Prud'homme 2012). It has been suggested that Chinese government policies are more concerned with promoting patent quantity while ignoring patent quality and the technological development of the country is asymmetrical to the number of patent applications (Giacopello 2012).

Inside China, provincial governments are usually held responsible for the upsurge in patenting activity, since they are under pressure from the central government to achieve quantitative patent targets (Prud'homme 2012; Lei et al. 2012). Some empirical research has also found that provincial subsidy programs were responsible for the upsurge (Yang et al. 2012). Some authors also pointed out that patent quality declined under such subsidy programs (Dang and Motohashi 2015), while others argued that the upsurge in patenting activity does not necessarily lead to a decline in quality if the quality of the patent examination process remains stable. On the other hand, other researchers wondered why such a dramatic upsurge in patenting activity could happen in the first place, since IP protection in China continues to be weak (Hu and Jefferson 2009). For example, they argued that if the applicant cannot capture value from the patenting and protection of their IP rights, why would they file an application? Our research provides further evidence on how such an upsurge became possible with the impact of government patent subsidy programs.

This chapter mainly considers two factors in support of the upsurge in patenting activity, and analyzes to what extent these factors have contributed to the exploding number of applications from selected provinces during the extended period from 2002 to 2013. The following two major factors are considered.

7.2.2.1 'Whole Society R&D Expenditure'

R&D is one of the most important factors for generating patentable inventions (Liu 2012). Empirical studies have shown that eliminating patent protection would reduce R&D incentives (Eaton and Kortum 1999). It is reasonable to regard R&D expenditure as a critical factor driving the growth in patenting activity. Therefore, in order to gain protection of their IP, the inventive outcomes of R&D efforts are likely to be patented. However, historical research has tended to consider the implications of R&D expenditure by large and medium-sized enterprises, while ignoring the R&D expenditure by universities and research institutes. Hence, the concept of 'whole society R&D expenditure' is used in our paper. This indicator considers R&D investment from both the public and private sectors, and therefore provides a more complete picture of China's R&D endeavors. By using R&D as an explanatory variable, it was found to be not necessary to include other variables, such as GDP and/or the number of R&D personnel, since R&D expenditure in a province actually reflects the economic strength and R&D effort of a region. However, considering the time delay between R&D investments, the generation of patentable inventions, and the application for patents, we assume that patent applications in a certain year could be the result of prior R&D expenditure made both one year and two years previously. A previous study also considered only one-year and two-year lags in order to simplify the discussion.

7.2.2.2 Provincial Government Subsidies

As previously mentioned, R&D expenditure by itself does not convincingly explain the patenting fluctuations observed in recent years in China. Government incentive policy is likely another crucial factor that influences applicants to apply for more patents. In order to measure the extent to which the subsidy programs of provincial governments affect the incentive, the subsidy policies were collected and used as another major explanatory variable. Although it varies from province to province, subsidy policies share many common features. The total amount of subsidy an applicant may obtain for each patent/patent application depends on both the application subsidy, and the rewards for patent grants. Application subsidies are the kind of subsidies that applicants will unconditionally obtain after filing patent application documents to SIPO, while rewards for patent grants will be given only when the invention is finally granted a patent right. Since it also takes time for policies to diffuse and be communicated to applicants, there is also a delay before the effect of subsidy policies can be observed on the behavior of applicants.

7.3 Research Methods

7.3.1 Data Collection

The data concerning R&D expenditure was obtained through publicly available statistic yearbooks compiled by China's central government agencies, including the National Bureau of Statistics and the Ministry of Science and Technology. The data concerning domestic patent applications were retrieved from SIPO's website. This chapter also collects information from 2002 to 2013 concerning the subsidy policies of each provincial government through the official websites of provincial IP offices.

In total, we gathered 65 policy documents that either issued a subsidy program or revised a former subsidy policy between 2002 and 2013. These subsidies cover the costs of official fees associated with patenting, but sometimes other costs, such as patent attorney fees, are also covered. One study identified that subsidy programs in China started in 1999, but our data collection does not include policies that commenced before 2002 for two reasons. Firstly, many policies in the early years did not clearly state the amount of subsidy obtainable. Secondly, government funding pool before 2002 was set at a relatively low amount. For example, Beijing initiated a subsidy program in 2000, and the total funding available was limited to only 1 million RMB. If we assume that all the available funding was used for invention patents, each application would only have received less than 300 RMB. However, since 2002 the Beijing IP office has paid subsidies according to the amount of SIPO charges, and further provides an additional 1000 RMB to pay patent attorney fees. Therefore, this chapter only considers policies issued after 2002. A summary of the policies collected is shown in Table 7.1.

Table 7.1 Summary of the provincial subsidy policies (2002–2013)

Item	No.
No. of provinces that have issued subsidy policies from 2002 to 2013	31
No. of provinces that cannot identify the issued year of subsidy policies	3
No. of provinces whose amount of subsidy cannot be identified	8
No. of provinces to be analyzed in the regression model	20
No. of subsidy policies retrieved	65
No. of policies of which the subsidy amount cannot be identified	14
No. of subsidy policies to be analyzed in the regression model	51

Table 7.2 Number of subsidy policies for each province (2002–2013)

	Province	No. of subsidy policies
1	Anhui	2
2	Beijing	3
3	Fujian	4
4	Guizhou	3
5	Hainan	3
6	Hebei	3
7	Heilongjiang	2
8	Henan	2
9	Hubei	2
10	Hunan	4
11	Inner Mongolia	2
12	Jiangsu	2
13	Jiangxi	2
14	Liaoning	2
15	Shandong	3
16	Shanghai	4
17	Shanxi	2
18	Shan′anxi	2
19	Sichuan	2
20	Zhejiang	2
	Total	**51**

Source websites of provincial IP offices

It can be seen from Table 7.1 that all of the provincial governments in China (31 in total) have issued subsidy programs. Three provinces were eliminated because the year of policy issuance could not be identified, and a further eight provinces were eliminated because the amount of subsidy could not be identified. This left 20 provinces for our study to focus on. In total, 51 subsidy policies clearly indicated both the year of issue and the amount of subsidy. In summary, our study is based on 51 subsidy policies of 20 provincial governments (see Table 7.2).

7.3.2 Descriptive Analysis

In terms of the distribution of the subsidy polices, it can be seen from Fig. 7.3 that there are three vertices that occurred in 2003, 2006, and 2010, respectively. In January 2003, the Ministry of Science and Technology started to implement a 'talent, patent, and technology standard' strategy with the aim of improving science and technology competitiveness.[1] Many provincial governments issued subsidy

[1]http://www.most.gov.cn/ztzl/qgkjgzhy/2003/mtbdzl/200605/t20060509_32046.htm.

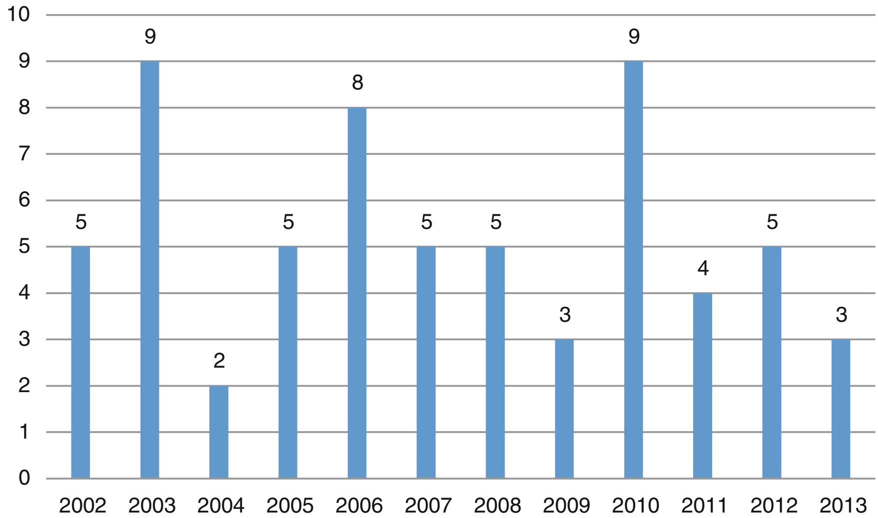

Fig. 7.3 Number of provincial subsidy policies: time distribution

programs to implement the strategy, and hence the number of policies peaked in 2003. The vertex in 2006 is probably due to the provincial response to the Outlook of National Medium to Long Term Science and Technology Development Plan (2006–2020), promulgated in 2006. This policy document was anticipated by provinces even before its official promulgation, and set out goals to build an innovation-driven country. The vertex in 2010 is probably explained by provincial offices anticipating, and quickly reacting to, the quantitative patent targets set out in the National Patent Development Strategy published in 2010, and the 12th Five Year Plan. Furthermore, as mentioned in Sect. 7.2.1, based upon our experience working directly with provincial IP offices, these offices were often informed in 2010 of the forthcoming patent targets and started preparing to meet them by creating and drafting patent subsidy policies even before the plans were officially published.

Figure 7.4 shows the relationship between three important variables. It can be seen that R&D investments, the number of applications, and the accumulated number of subsidy policies have all seen a steady growth during a period of more than ten years. In particular, the number of invention patent applications increased much more rapidly after 2010, while at the same time R&D investment also increased at an accelerated pace. In terms of growth rate, the growth in invention patenting reached a peak in 2011. However, the R&D growth rate either one or two years prior did not witness such a dramatic change. Figure 7.5 clearly indicates that the accelerated patent growth since 2010 could be driven by factors other than R&D growth, which we hypothesize is primarily driven by provincial patent subsidy policies.

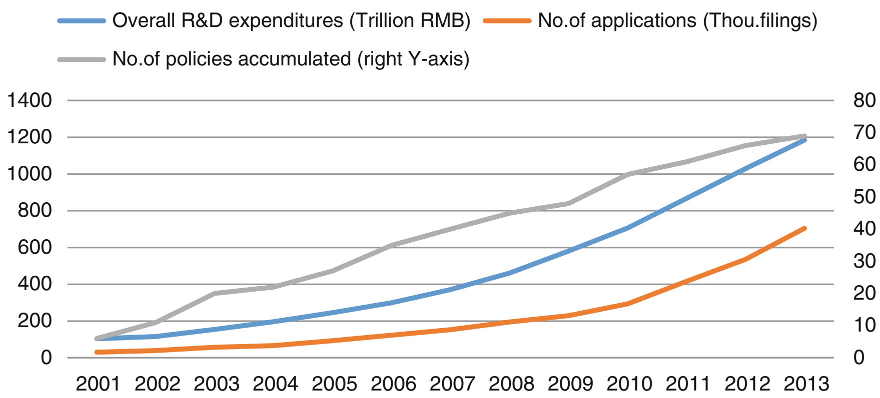

Fig. 7.4 R&D, the number of applications and accumulated number of subsidy policies

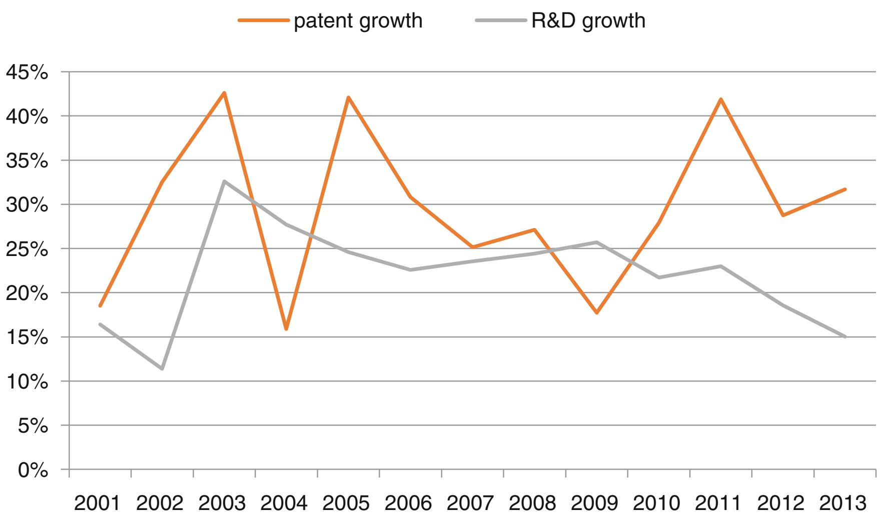

Fig. 7.5 Invention patent growth rate and R&D growth rate

7.3.3 Quantitative Model

7.3.3.1 Regression Model Analysis of the Number of Patent Applications

We contend that the sharp upsurge in invention patent applications in 2011 is directly related to institutional changes in China before 2011. As mentioned in Sect. 7.2 of this chapter, the National Patent Development Strategy (2011–2020), promulgated in 2010, and the 12th Five Year Plan, which followed soon thereafter, set the first nationwide quantitative targets. Furthermore, as mentioned, provincial IP offices were often informed in 2010 of the forthcoming patent targets and started preparing to meet them by creating patent subsidy policies even before the plans themselves were officially published for public consumption.

According to our experience working directly with provincial IP offices, in order to ensure positive annual performance evaluations by the central government, which were now tied to meeting quantitative patent targets, it was perceived to be necessary for provincial governments to more quickly institute, and make more ambitious, patent subsidy policies than they were used to. Therefore, we argue that subsidy policies launched during and after 2010 are more sizeable and are more rapidly instituted and diffused than those in prior years, which were not directed at meeting specific quantitative patent targets *set by the central government* or tied to performance evaluations of government officials.

Conventionally, from our experience, it usually takes two years for patent subsidy policies to take effect after being enacted, since the process of understanding the policies, receiving notice of acceptance of the policies from SIPO, and to obtain confirmation that the proposed subsidy policy had passed government examination, is quite lengthy. In this chapter, considering that the policy delay effect between 2002 to 2009 and 2010 to 2013 is likely to be different, this chapter uses a regression model analysis that considers such a difference between the two periods. To simplify the discussion, we assume a one-year lag for the effect of policies following their introduction for the period from 2010 to 2013, in contrast to a two-year lag effect for 2002–2009. Since the stated variable in this paper is the number of invention patent applications (PAT_{it})[2] of a provincial unit, the regression model the paper uses are:

$$\begin{aligned} \log \mathrm{PAT}_{it} = & \beta_{li} + \beta_2 \cdot \log \mathrm{RND}_{it-1} + \beta_3 \cdot \log \mathrm{RND}_{it-2} + \beta_4 \cdot \mathrm{ES}_{it-2} \cdot \mathrm{DVF}_t \\ & + \beta_5 \cdot \mathrm{ES}_{it-1} \cdot \mathrm{DVS} + u_{it} \\ & (\mathrm{t} = 2004,\ 2003\ldots 2013;\ \ \mathrm{i} = 1, 2, 3\ldots 20) \end{aligned} \tag{7.1}$$

β_{1i} varies according to the specific provincial units analyzed ($\mathrm{i} = 1, 2, 3\ldots 20$), hence some important provincial fixed effects are considered in the current regression model. The explanatory variable includes R&D (RND in the equation), and expected subsidy (ES), which are described in Sect. 7.3.3.2 below. R&D expenditure as an explanatory variable could be delayed for one or even two years, depending on the R&D cycle. For example, the delay effect means that the number of applications from 2005 may be explained by R&D expenditure in 2003 and 2004. In the equation above, $\log \mathrm{RND}_{it-1}$ and $\log \mathrm{RND}_{it-2}$ reflects R&D output that are one year delayed and two years delayed, respectively. The time starts from 2004, because there is a two-year delay for the period from 2002 to 2009.

[2]Our model only addresses the impact of subsidy policy on invention patent growth, though other forms of patents may also experience an upsurge due to incentivizing policies.

There are two dummy variables in the Eq. (7.1). The first is in order to control for the first stage (2004–2009), ES is two-year delayed (DVF in the equation). The second is in order to control for the second stage (2010–2013), ES is delayed for only one year (DVS in the equation). They are defined as:

$$DVF_t = \begin{cases} 1, \, t = 2004, \, 2005 \ldots 2009 \\ 0, \, t = 2010, \, 2011 \ldots 2013 \end{cases} \quad DVS_t = \begin{cases} 1, \, t = 2004, \, 2005 \ldots 2009 \\ 0, \, t = 2010, \, 2011 \ldots 2013 \end{cases} \tag{7.2}$$

Therefore, for the first period of 2004–2009, the ES is considered as being two-year delayed. While for the second period, starting in 2010 and ending in 2013, the ES is considered as being one-year delayed. Therefore, Eq. (7.1) thus takes into account the difference of such policy delay effects at different stages.

7.3.3.2 Equation for Expected Subsidy

ES is the Expected Subsidy for invention patent applications, which basically includes fees for application, document printing, examination, and maintenance during the application stage. For reference, the typical fees charged by SIPO in respect of invention patents, are listed below.

Based upon a review of the provincial subsidy measures of all 20 provinces analyzed for this chapter, the typical patent subsidy amount offered to a successful subsidy applicant was identified for each province. In practice, the provincial government subsidies consist of two parts: the application subsidy (AS_{it}) and the granted rewards (GR_{it}). Annex A provides a list of the AS and GR provided by each of the 20 provinces analyzed in this chapter, according to the years analyzed. The AS is given to any applicant who files an application document accepted by SIPO, while GR is only given to applicants that succeed in obtaining a patent right.

The AS and GR per province cover some, or all, of the patent fee costs mentioned in Table.[3] Upon review of the patent subsidies collected, it is apparent that some provincial governments do not subsidize patent applications, but instead only give rewards after patents have been granted. In this situation, the AS value for these provinces is set as zero (see Annex A for a list).

Furthermore, it also has to be considered that not all invention patent applications can be granted, and therefore subsidies for grants should consider the possibility of passing the substantive examination by the local IP office. Hence, we create the parameter of PGR_i which stands for the average possibility (in terms of time) of passing the substantive examination for a province. Next, the ES (expected subsidy) in this chapter is calculated as:

[3]In some instances, some provincial governments in China provide subsidies related to patents that cover other costs related to patenting.

$$ES_{it} = AS_{it} + PGR_i \times GR_{it} \quad (t = 1999, 2000...2013;\ i = 1, 2, 3...20) \quad (7.3)$$

The equation expresses the Expected Subsidy for applicants in the regions consisting of application subsidy (AS_{ii}) and granted rewards (GR_{it}). For PGR_i, this chapter finds that the average time span from filing an application to obtaining a patent right is approximately two years. This chapter calculates the *PGR* based on the Eq. (7.4):

$$PGR_{it} = GPAT/APAT_{it-2} \quad (t = 2004, 2003...2013;\ i = 1, 2, 3...20) \quad (7.4)$$

In Eq. (7.4), $GPAT_{it}$ is the number of patents granted in the year *t*. $APAT_{it-2}$ s the number of applications in the year $t-2$. It should be noted that the indicator *PGR*, in effect, allows the model to distinguish the effect of the possibility of an application from a province in year *t* to get their patents granted, which further affects their expected amount of subsidies based on Eq. (7.3).

7.3.3.3 Correlation Analysis of Variables

Before conducting the regression, we first conducted a correlation analysis. If the variables were not statistically correlated, regression analysis may have limited value. Table 7.4 shows that all the variables are correlated at the 0.01 level. Therefore, we can continue the regression model in the next section.

Table 7.3 Invention patent fees during the application stage (RMB)

Fee for application	900
Fee for document printing	50
Fee for examination	2500
Fee for maintenance (during the application)[a]	300
In total	3750

[a]During the examination stage, if the patent has not been granted by the second year, a maintenance fee should be paid to ensure that the application is still valid from the third year until the grant

Table 7.4 Correlation matrix of the variables

		ES	PAT	RND
ES	Pearson correlation	1	0.267**	0.314**
	n	240	240	240
PAT	Pearson correlation	0.267**	1	0.925**
	n	240	240	240
RND	Pearson correlation	0.314**	0.925**	1
	n	240	240	240

**$p < 1\ \%$

7.3.3.4 Limitations of the Method

Although we have taken a number of steps to ensure the rigor of our modeling, it should be noted that we may have omitted some yearly fixed effects from our estimations. As such, our findings should be treated with caution as to representing intensively tested correlations, let alone causality. Ideally, future research could strengthen our modeling approach.

7.4 Results and Discussion

7.4.1 Results

Considering the heterogeneity of each province, this chapter uses the fixed effects least squares dummy variable model (LSDV) to estimate the coefficient in Eqs. (7.1) and (7.2). The results are shown in the following tables.

Therefore, the regression model for application number is formulated as:

$$\begin{aligned}\log PAT_{it} =& 3.66 + 0.58 \cdot \log RND_{it-1} + 0.46 \cdot \log RND_{it-2} + 7.73 \times 10^{-6} \cdot ES_{it-2} \cdot DVF \\ &+ 10.2 \times 10^{-5} \cdot ES_{it-1} \cdot DVS_t + u \\ &(\mathrm{t} = 2004, 2003\ldots2013;\ \ \mathrm{i} = 1, 2, 3\ldots20)\end{aligned}$$

It is shown in Table 7.5 that both RND values, which are one-year delayed and two-year delayed, are significantly correlated with the number of patent applications, indicating that R&D investment made one year and two years previously, contributes greatly to the upsurge of patent applications in the recent years. In terms of government subsidies, our model has identified that during 2004–2009, subsidy policies (ES) do not exert a significant effect on generating more applications. This result appears to indicate that the upsurge of applications from 2004 to 2009 is highly correlated with more R&D investment and growing patenting awareness, while policy incentives may have played a much lesser role and is not measureable in the regression model formulated by this research.[4] In contrast, during the period from 2010 to 2013, it is found that subsidy policies (ES) are shown to have a significant effect on the number of applications, with the confidence level at 0.01 (See Table 7.5).

[4]Two reasons our findings differ from in this regard may be because we examined the value of subsidies rather than the number of subsidy policies, and also used a different time frame of analysis (2004–2009 instead of 2001–2007).

Table 7.5 Regression results for Eq. 7.1

Variables	Coefficient (and standard error)	t-statistic
Constant	3.661244 (0.193939)**	18.87836
LOG(RND(-1))	0.577326 (0.225308)*	2.562385
LOG(RND(-2))	0.457221 (0.228200)*	2.003594
ES(-2)*DVF	7.73E-06 (3.65E-05)	0.211691
ES(-1)*DVS	0.000102 (3.83E-05)**	2.671194
R^2	0.964	
Adjusted R^2	0.959	
F-statistic	205.704	
Number of observations	200	

*$p < 5$ %; **$p < 1$ %

7.4.2 Discussion

Our results indicate that R&D investment is an important driver for patenting growth in China. However, patent subsidy policies from 2010 to 2013 also increased the propensity of invention patenting activity in China. It is argued that one of the reasons for this is that since 2010, provincial governors may have taken more effective measures to implement these subsidy policies, since for the first time their performance assessments are tied to meeting specific quantitative patent targets set by the central level government. In practice, most of the application subsidies need to be approved by the local/provincial government, therefore the efficiency of the approval process would influence the expectation of obtaining the promised subsidies greatly. Our experience working with local officials also convince us that local IP offices have sped up the approval process to accelerate the policy stimulation. Further, other authors have commented that using patent targets as an evaluation indicator in the assessment of local officials induced more patent applications (Prud'homme 2012; Lei et al. 2012). The results in this chapter also provide evidence for this argument.

Perhaps another reason for the significant policy incentive is that after years of interaction between government and industry, Chinese companies became better aware and more familiar with government policies, and have employed them faster in recent years. The widely adopted use of information technology has also facilitated the dissemination of government policies and so the impact is greater.

However, it should be noted that the coefficient during this period of time (2010–2013) is still quite small. An important reason is that the independent variable used in this paper is ES (average subsidy on each application), while the dependent variable is the total number of applications in a region. The coefficient is smaller, which indicates that the elasticity of total applications to cost of patenting is relatively small. Secondly, this chapter only addresses the impact of subsidy policies on the growth of invention patents, and the results indicate that the incentive effect of subsidy policies on the upsurge in invention patents is not as great as expected.

Thirdly, another reason for the limited effect, as measured by the current study, is that this chapter does not consider the subsidy programs launched by local (i.e. sub-provincial) governments, instead only those at the provincial level are considered. In the Chinese institutional system, pressure for filing more applications at the provincial level would be transferred to the local level. To fulfill the objective, local governments also launched many subsidy programs between 2010 and 2013. In many cases, applicants to these programs are required to use the application fee receipt from SIPO as certification in order to be able to apply for patent subsidies from local governments. However, we have not found an effective approach for collecting information concerning all the subsidy programs at the local level, as, depending on the definition used, there are hundreds or thousands of local (e.g. counties, other units) governments in China.

Although the intention of our study was not to measure the quality of China's domestic patent applications, the results, however, do provide implications concerning patent quality. The charge for filing an application for an invention patent with SIPO is 3750 RMB (refer to Table 7.3). Considering that 60 % of applications enjoyed a 70 % fee waiver applied by SIPO, which is a usual practice in China, the real cost of each application is only 2175 RMB $(3750 \times 0.6 \times 0.3 + 3750 \times 0.4)$. As many applicants received further subsidies from provincial/municipal level governments, the real cost for filing a patent application is far less. Furthermore, according to our investigation, due to the level of subsidies in some cases applicants may even make money simply by filing patent applications.

It has been argued that patent quality is probably hampered by the application incentives provided by the subsidy policies. As has previously been pointed out, a fundamental problem with the present patent system is that it discourages 'good' patent behavior, and creates more incentive for applying for low quality patents (Wagner 2009). Patent quality will not be improved until applicants have strong and unequivocal incentives to obtain high quality patents. Based on a questionnaire survey of more than 300 patent examiners and attorneys, Liu et al. (2012) found that the incentives for patenting exert greater influence on the decision to apply for patents than considerations of the IP protection environment, or the capability of patent office examinations to determine patent quality. In this respect, we contend that patent quality in China may be negatively affected by the significant lowering of patenting fees due to government subsidies. Before the subsidy policies were introduced, applicants may not have sought to patent some of their lower quality inventions due to the high application fees and relatively low benefit it returns. However, with the support of government subsidies, the cost of patenting inventions is much lowered and the incentive for applying for lower quality patents is somewhat increased.

7.5 Conclusions and Policy Implications

This chapter discusses the factors behind the recent upsurge in Chinese domestic patent applications. We have identified that the explosion in the number of patent applications in China is highly correlated with increasing R&D investment from both government and enterprises, while patent subsidies also played an important role from 2010 to 2013. This being said, the limitations of the method we used to reach this conclusion, as explained in the methodology section, should be considered. The Chinese experience of mass patenting subsidies has many future policy implications.

Firstly, since most subsidy programs do not differentiate between the types of applicant, such mass unconditioned subsidy programs are unsustainable. With the growing number of patent applications and grants, provincial governments find it increasingly difficult to have adequate budget to provide such subsidies. An appropriately designed subsidy should only support smaller companies or other economically disadvantaged entities. For large (and perhaps some medium-sized enterprises), or high-tech firms recognized by the Ministry of Science and Technology, the need to subsidize their patenting activity is highly questionable, since they either already have adequate financial resources or receive other forms of support (Long et al. 2013). Government programs should support entities that can proportionally benefit the most from such support, instead of subsidizing all companies overwhelmingly, regardless of the applicant type.

Secondly, in the design of these subsidy programs, it is important to clarify their primary objectives. The purpose of the Chinese central government including a patent indicator in the national 12th Five Year Plan was to improve patenting awareness and enhance the innovation capability of Chinese industries. However, considering the complexity of innovation capability, most subsidy policies lose sight of the primary goal, and instead focus only on quantity. This is another rationale to explain why patent quality will decline with the implementation of such policies with goals deviating from those originally intended. Since 2013, concerns over patent quality have exerted great pressure on the continuation of subsidy programs. Furthermore, in December 2013 SIPO issued a policy calling for an improvement in the quality of patent applications. As a consequence, most provinces then started to revise their subsidy programs.

Thirdly, subsidies should be properly structured in order to truly encourage innovation or the commercialization of new inventions. Through only subsidizing patent applications or rewarding patent grants, the mere target seems to simply encourage more patenting, regardless of quality. However, innovation is not just the introduction of inventions into the social system, rather it requires ensuring that inventions actually have economic effects and value (Schumpeter 1942). Therefore, there is still a great gap to bridge between producing more patents and enhancing national innovation capacity. From this perspective, subsidies targeting only patent applications and grants, at least at China's current stage of technological development, are likely to be a waste of public resources. This chapter proposes that government subsidies should instead be moved down the innovation value chain to provide monetary support to patent commercialization and entrepreneurial activities, rather than just for filing patent applications.

Fourthly, on the technical level, governments should make sure that applicants properly obtain subsidies, which often presents a significant challenge. In Chinese practice, most of the subsidies consist of application subsidies and grant reward subsidies. To obtain application subsidies, the applicant usually needs only to hand in a certification that SIPO has already accepted the patent application. However, in many cases the applicant may withdraw the application after obtaining the subsidy. Such moral hazards create further misuse of public resources. It is observed that subsidies given on condition of the patent being finally granted provides a stronger incentive for applicants to file applications of better quality.

Finally, the workings of patent subsidy programs in China raise questions over the appropriateness of governance of China's IP regime. With these subsidy programs, SIPO received a large amount of patent fees and employed more examiners to deal with the surge in the number of applications. As part of this process, many provincial governments' fiscal resources were transferred to a department of the central government, and ultimately, the surplus of patent fees was given to the central government. It is debatable whether it is appropriate that provincial governments, who were tasked with meeting patent targets set by the central level, in turn are also required to 'subsidize' the central government in this way.

Appendix A: Subsidy amounts for each province

Province	Period	Application subsidy	Grant reward
Zhejiang	2002	3000	0
Zhejiang	2003	3000	0
Zhejiang	2004	3000	0
Zhejiang	2005	3000	0
Zhejiang	2006	0	4000
Zhejiang	2007	0	4000
Zhejiang	2008	0	4000
Zhejiang	2009	0	4000
Zhejiang	2010	0	4000
Zhejiang	2011	0	4000
Zhejiang	2012	0	4000
Zhejiang	2013	0	4000
Shanghai	2002	0	0
Shanghai	2003	3450	0
Shanghai	2004	3450	0
Shanghai	2005	3450	0

(continued)

(continued)

Province	Period	Application subsidy	Grant reward
Shanghai	2006	3450	0
Shanghai	2007	3450	0
Shanghai	2008	3450	0
Shanghai	2009	3450	0
Shanghai	2010	3450	0
Shanghai	2011	3450	0
Shanghai	2012	3260	0
Shanghai	2013	3260	0
Shandong	2002	0	0
Shandong	2003	0	0
Shandong	2004	0	0
Shandong	2005	0	0
Shandong	2006	1500	1500
Shandong	2007	1500	1500
Shandong	2008	1500	1500
Shandong	2009	0	4000
Shandong	2010	0	4000
Shandong	2011	0	4000
Shandong	2012	0	4000
Shandong	2013	0	4000
Sichuan	2002	1000	0
Sichuan	2003	1000	0
Sichuan	2004	1000	0
Sichuan	2005	1000	0
Sichuan	2006	1000	0
Sichuan	2007	1000	0
Sichuan	2008	1200	0
Sichuan	2009	1200	0
Sichuan	2010	2415	0
Sichuan	2011	2415	0
Sichuan	2012	2415	0
Sichuan	2013	2415	0
Shan'anxi	2002	0	0
Shan'anxi	2003	3500	0
Shan'anxi	2004	3500	0
Shan'anxi	2005	3500	0
Shan'anxi	2006	3500	0
Shan'anxi	2007	3500	0
Shan'anxi	2008	3500	0
Shan'anxi	2009	1000	0

(continued)

(continued)

Province	Period	Application subsidy	Grant reward
Shan'anxi	2010	1000	0
Shan'anxi	2011	1000	0
Shan'anxi	2012	1000	0
Shan'anxi	2013	1000	0
Shanxi	2002	0	0
Shanxi	2003	1200	0
Shanxi	2004	1200	0
Shanxi	2005	1200	0
Shanxi	2006	1200	0
Shanxi	2007	1200	0
Shanxi	2008	1200	0
Shanxi	2009	1200	0
Shanxi	2010	1200	0
Shanxi	2011	1200	0
Shanxi	2012	1200	0
Shanxi	2013	1200	0
Inner mongolia	2002	3450	0
Inner mongolia	2003	3450	0
Inner mongolia	2004	3450	0
Inner mongolia	2005	3450	0
Inner mongolia	2006	3450	0
Inner mongolia	2007	3450	0
Inner mongolia	2008	3450	0
Inner mongolia	2009	3450	0
Inner mongolia	2010	3450	0
Inner mongolia	2011	3450	0
Inner mongolia	2012	3450	0
Inner mongolia	2013	3450	0
Liaoning	2002	0	0
Liaoning	2003	0	0
Liaoning	2004	0	0
Liaoning	2005	3450	0
Liaoning	2006	3450	0
Liaoning	2007	3450	0
Liaoning	2008	3450	0
Liaoning	2009	3450	0
Liaoning	2010	3450	0
Liaoning	2011	3450	0
Liaoning	2012	3450	0
Liaoning	2013	3450	0

(continued)

(continued)

Province	Period	Application subsidy	Grant reward
Jiangxi	2002	2070	0
Jiangxi	2003	2070	0
Jiangxi	2004	2070	0
Jiangxi	2005	2070	0
Jiangxi	2006	500	2500
Jiangxi	2007	500	2500
Jiangxi	2008	500	2500
Jiangxi	2009	500	2500
Jiangxi	2010	500	2500
Jiangxi	2011	500	2500
Jiangxi	2012	500	2500
Jiangxi	2013	500	2500
Jiangxi	2002	2000	0
Jiangxi	2003	2000	0
Jiangxi	2004	2000	0
Jiangxi	2005	2000	0
Jiangxi	2006	3450	0
Jiangxi	2007	3450	0
Jiangxi	2008	3450	0
Jiangxi	2009	3450	0
Jiangxi	2010	3450	0
Jiangxi	2011	1000	3000
Jiangxi	2012	1000	3000
Jiangxi	2013	1000	3000
Hunan	2002	0	0
Hunan	2003	0	0
Hunan	2004	0	2000
Hunan	2005	0	2000
Hunan	2006	0	2000
Hunan	2007	0	2000
Hunan	2008	0	2000
Hunan	2009	0	2000
Hunan	2010	0	2000
Hunan	2011	0	3000
Hunan	2012	0	3000
Hunan	2013	0	3000
Heilongjiang	2002	0	0
Heilongjiang	2003	0	0
Heilongjiang	2004	0	0
Heilongjiang	2005	0	0

(continued)

(continued)

Province	Period	Application subsidy	Grant reward
Heilongjiang	2006	0	0
Heilongjiang	2007	0	0
Heilongjiang	2008	0	0
Heilongjiang	2009	0	0
Heilongjiang	2010	3450	1000
Heilongjiang	2011	3450	1000
Heilongjiang	2012	3450	1000
Heilongjiang	2013	3450	1000
Henan	2002	475	0
Henan	2003	475	0
Henan	2004	475	0
Henan	2005	475	0
Henan	2006	475	0
Henan	2007	475	0
Henan	2008	475	0
Henan	2009	475	0
Henan	2010	1500	0
Henan	2011	1500	0
Henan	2012	1500	0
Henan	2013	1500	0
Hebei	2002	0	0
Hebei	2003	0	0
Hebei	2004	0	0
Hebei	2005	800	1000
Hebei	2006	800	1000
Hebei	2007	800	1000
Hebei	2008	1000	1500
Hebei	2009	600	1500
Hebei	2010	600	1500
Hebei	2011	600	1500
Hebei	2012	600	1500
Hebei	2013	1000	2000
Hainan	2002	475	0
Hainan	2003	475	0
Hainan	2004	475	0
Hainan	2005	1000	0
Hainan	2006	1000	0
Hainan	2007	1000	0
Hainan	2008	0	3000
Hainan	2009	0	3000

(continued)

(continued)

Province	Period	Application subsidy	Grant reward
Hainan	2010	0	4000
Hainan	2011	0	4000
Hainan	2012	0	4000
Hainan	2013	0	4000
Guizhou	2002	0	0
Guizhou	2003	0	0
Guizhou	2004	0	0
Guizhou	2005	0	0
Guizhou	2006	0	2400
Guizhou	2007	0	2400
Guizhou	2008	0	2400
Guizhou	2009	0	2400
Guizhou	2010	0	2400
Guizhou	2011	0	2400
Guizhou	2012	0	2600
Guizhou	2013	0	2600
Jiangsu	2002	2000	0
Jiangsu	2003	2000	0
Jiangsu	2004	2000	0
Jiangsu	2005	2000	0
Jiangsu	2006	3450	0
Jiangsu	2007	3450	0
Jiangsu	2008	3450	0
Jiangsu	2009	3450	0
Jiangsu	2010	3450	0
Jiangsu	2011	1000	3000
Jiangsu	2012	1000	3000
Jiangsu	2013	1000	3000
Fujian	2002	3450	0
Fujian	2003	3450	0
Fujian	2004	3450	0
Fujian	2005	3450	0
Fujian	2006	3450	0
Fujian	2007	3450	0
Fujian	2008	3450	0
Fujian	2009	3450	0
Fujian	2010	3450	0
Fujian	2011	3450	0
Fujian	2012	0	5000
Fujian	2013	0	5000

(continued)

(continued)

Province	Period	Application subsidy	Grant reward
Beijing	2002	1000	0
Beijing	2003	1000	0
Beijing	2004	1000	0
Beijing	2005	1000	0
Beijing	2006	2150	0
Beijing	2007	2150	0
Beijing	2008	2150	0
Beijing	2009	2150	0
Beijing	2010	2150	0
Beijing	2011	2150	0
Beijing	2012	2150	0
Beijing	2013	2150	0
Anhui	2002	0	0
Anhui	2003	0	3000
Anhui	2004	0	3000
Anhui	2005	0	3000
Anhui	2006	0	3000
Anhui	2007	0	3000
Anhui	2008	0	3000
Anhui	2009	0	3000
Anhui	2010	0	5000
Anhui	2011	0	5000
Anhui	2012	0	5000
Anhui	2013	0	5000

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