Chapter 2
The Analysis to Influencing Factors on the Technological Innovation Based on the Patent Maintenance Time

Yongzhong Qiao

Abstract Compared with the numbers of patent applications and patent granted, the numbers of valid patents and their maintenance times can better embody one country’s technological innovation capability. In this book, 2921 patents, which granted by the State Intellectual Property Office in China in 1994 and up to April 30, 2007 terminated due to unpaid fees, are analyzed based on the patent information perspective by multivariate linear regression using SPSS software (11.5). The results show that the average maintenance time of patents, which granted by the State Intellectual Property Office, is shorter and the terminated speed quicker. The effecting degrees of a nationality of applicants, a examination time, a types of patentees, a number of inventors and a claims number of patents on the patent maintenance time followed by weakening.

Keywords Patent maintenance time · Technological innovation · Influencing factors

2.1 Introduction

The attractiveness of a technology as an investment object depends decisively on its current life cycle stage. It is a widespread approach to study technology life cycles\(^1,2\) by observing the evolution of patent applications and the patent


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Y. Qiao (✉)
Intellectual Property Research Institute, Xiamen University, No. 422, Siming South Road, Xiamen, Fujian, China
e-mail: qyzh1@163.com

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maintenance time. Patent activity is also used to describe life cycles at the levels of products and industries from the patent maintenance perspective.

The most important reason that patents applied and maintained by spending a lot of energy and funds is that patents, especially invention patents are important intangible assets. The quantity and the quality of effective patents of enterprises reflect their innovation capability, competitive strength and market potential. The quantity and the quality of effective patents in a country mark it’s the technological innovation capability and the level of technological development potential. Obtaining a patent is only a right to use the invention, and the effective maintenance of patents is the beginning of its real role. The main purpose of patents is to maintain and use them, but only to apply and grant. Therefore, a research of the maintenance situation of patents should be one of the core content of patent issues.

Patent information is a valuable, rare, not imitate and irreplaceable resources, which relate with the technological development. It contains the standardization data associated with the new ideas and the new technological development. It also is many measuring innovative tools and methods of research focus. There are many research results on the relation of the technological development and the economic growth by the patent information. Some scholars have been studied more micro aspects of technological innovation and technological protection by the patent information. They believe that the claims of patent applications should be bitterly reflect patentee’s technological capabilities. Therefore, it is very

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6In China, patent includes invention patent, utility models patent and design patent. Because utility models patent and design patent need not substantive examination, so many scholars at home and abroad believe the quantity of inventions patents is one of indicators to measure the innovation capability of enterprises, a region and a nation. Therefore, in this book “patent” just refers to invention patent.
important that the research of the maintenance situation of patent or the effective patent issues by the patent information.

In this book, 2921 patents that up to April 30, 2007 terminated due to unpaid fees, of which 3838 granted by the State Intellectual Property Office in China (SIPO) in 1994, are analyzed based on the patent information perspective by multivariate linear regression using SPSS software. The purpose is to understand the weight of the factors to effect the patent maintenance time, and appropriately extend the patent maintenance time by studying the impact degree of the time needing from application to granted, types of patentees, the number of inventors and the number of patent claims on the patent maintenance time.

### Table 2.1 Legal status of patents

<table>
<thead>
<tr>
<th>Terminated for failure to pay the maintenance fees</th>
<th>Unexpired</th>
<th>Expiration</th>
<th>Abandoned, withdrew, invalid</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patents</td>
<td>2921</td>
<td>875</td>
<td>35</td>
<td>7</td>
</tr>
<tr>
<td>Percent (%)</td>
<td>76.1</td>
<td>22.8</td>
<td>0.9</td>
<td>0.2</td>
</tr>
</tbody>
</table>

2.2 Data Collection and Design of Variables

1. Data collection.
2. Variables design.

2.3 Basic Status of Patents

#### 2.3.1 Data Collection

Based on the Database of Related Information of the Patents Granted by SIPO in 1994, the data of patents granted in 1994 is analyzed by SPSS 11.5. The general status is as shown in Table 2.1.

Among 3838 patents granted by SIPO in 1994, Up to April 30, 2007, 2921 patents, accounting for 76.1 % of the total number of patents granted, had been terminated for failure to pay the maintenance fees. 875 patents, comprise of 22.8 % of the total number of patents granted, remain valid. There are 35 patents at expiration, which make up 0.9 % of the total number of granted patents. In addition, there are 7 patents terminated in declaration of abandonment or considered abandoned, withdrew and invalid, which make up 0.2 % of the total number of granted patents.

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14See Sect. 1.2.1.
15See Sect. 1.2.2.
2.3.2 Analysis of the General Maintenance Status of Patents

The changing curve of patents terminated for failure to pay maintenance fees is as shown in Fig. 2.1. We can see that the second year after granted (i.e. 1996) the terminations rate of patents is the highest, after that year the number of patents terminated tends to steadily decline year after year.

The very important problem is reflected by above data and Fig. 2.1, namely the maintenance ratio of patents granted by SIPO in 1994 is very low and the terminated speed of patents is fairly fast. During the period of 12 years and 4 months after granted, among 3838 patents, except that 1 was terminated on declaration of abandonment, 2921 were terminated for failure to pay maintenance fees, which account for 76.1% of the total number of granted patents. Up to 2003, among America’s patents granted in 1991, patents terminated for failure to pay maintenance fees account for 53.7% of the total number of patents granted within 12 years. The China’s ratio of patents terminated for failure to pay the maintenance fees to the total number of granted patents is less 22.4 percentage points than that of America’ patents.

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16There is only 1 patent terminated by the declaration of abandonment, while 2921 were terminated for failure to pay maintenance fees. So the terminated patents mentioned hereinafter should mean the patents terminated for failure to pay maintenance fees unless there is a specific explanation, and the maintenance time of patents means the period from grant to termination for failure to pay maintenance fees.

2.4 Multiple Linear Regression Analysis of the Factors to Influent the Maintenance Time of Patents

2.4.1 Regression Results

Assume that there are \( k \) independent variables impacting a dependent variable, and a multiple linear regression model is specified as:

\[
y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \cdots + \beta_k x_k + \epsilon
\]

The interpretation of the regression equation is the interpretation of the regression coefficient.

In a multiple linear regression, the regression coefficient \( \beta \) is reflected a “net” role in the corresponding independent variable \( x \) on the dependent variable, namely the role of \( x_i \) to \( y \) if the rest variables controlled or excluded. However, the unstandardized coefficients are statistical variables that having metric unit, there are different metric units for different independents. Therefore, different metric units cannot be compared, and the “net” role of \( x_i \) to \( y \) cannot be judged by the value of \( \beta_i \). In order to different metric units may be compared, the relative size of the role of independent variables is determined; the regression equation must transfer for the standardized regression equation, and the regression coefficient transfer for the standardized regression coefficient.

Based on the Database of Related Information of the Patents Granted by SIPO in 1994, the maintenance time of patents (\( Y \)) as the dependent variable, and the number of claims, the examination time, the number of investors, the nationality of applicant, the enterprises and the individual (the individuals and the enterprises as a virtual variables for institutes and universities) as the independent variable, the results of the multiple linear regression analysis on the data of patents granted in 1994 by SPSS (11.5) as Tables 2.2, 2.3 and 2.4.

The number of claims, the examination time, the number of investors, the nationality of applicants, the enterprises and the individual (the individuals and the enterprises as a virtual variables for institutes and universities) as independent variables \( X_1, X_2, X_3, X_4, X_5 \) and \( X_6 \). The multiple linear regression models can be drawn as following:

\[
Y = 4.378 + 0.004X_1 - 0.271X_2 + 1.990X_3 + 0.053X_4 + 0.864X_5 + 0.734X_6
\]

<table>
<thead>
<tr>
<th>Table 2.2 Model summary(^a)</th>
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<tbody>
<tr>
<td>R</td>
</tr>
<tr>
<td>----</td>
</tr>
<tr>
<td></td>
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<tr>
<td>0.347(^b)</td>
</tr>
</tbody>
</table>

\(^a\)Dependent variable: the maintenance time of patents

\(^b\)Predictors: (constant), individual, the examination time, the number of claims, the number of investors, the nationality of applicant, enterprises
The standardized coefficients of the dependent variable (the maintenance time of patents) ($Y$) on six independents respectively are 0.009, $-0.128$, 0.314, 0.035, 0.113, 0.116.

This figure shows the influential degree of six independents variables for the dependent variable ($Y$). In other words, for the maintenance time of patent, the greatest impact for it is the nationality of applicant; second impact are the examination time, the enterprises and the individual; finally impact are the number of investors and the standardized coefficients.

### 2.4.2 Progression Analysis

Table 2.3 shows the information of ANOVA (b). The value of sum of squares (3520.341), df (6), mean square (586.723), $F$ Change (66.402) and Sig. $F$ Change (0.000(a)) indicate that the overall condition of model better. Table 2.2 indicates the model summary (b). The value of the overall correlation ($R$) between the dependent variable ($Y$) and six independents variables is 0.347, and the value of
$R^2$ is 0.121. In other words, the explanation degree of six independents variables to the dependent variable (the maintenance time of patents) is only 12.1%. The main reasons led to such results are that the influent factors of the maintenance time of patents are many and complex. Of course, another important reason is that the cited index of patents (the forward citations and the backward citations) that granted by SIPO cannot be obtained from the existing patent databases, but this cited index is very important for the maintenance time of patents. However, we believe that the reason that the explanation degree is low cannot induce to the value of this research, because there is not better indictors to analyses the situation of the maintenance time of patents from the patent information in the existing conditions. Therefore, this model has an important value for the research of the weight distribution of the influent factor on the maintenance time of patents.

In six independents variables, the influent degree of the nationality of applicant on the maintenance time of patents is highest (standardized coefficients is 0.314). This research achievement provides an important inspiration that domestic applicants should study the experiences of patent application and patent maintenance from foreign applicants.

The influent degree of the examination time is less than that of the nationality of applicant. Its standardized coefficient is $-0.128$. Namely, the maintenance time of patent will increase 0.128 years if the examination time decreases a year. Therefore, we must attach importance to the examination time of patents for extending the maintenance time of patent and effectively realizing the value of patent rights. The influencing factors of the examination time of patents include the examination procedures of patents, the examination efficiency of patents and the level of writing of the file of patent applications and so on.

The individuals and the enterprises are virtual variables for the institutes and universities. Their standardized coefficients respectively are 0.113 and 0.116. In other words, when other variables is same, compare with the institutes and universities, the maintenance time of patents of the individuals and the enterprises are more than 0.113 years and 0.116 years respectively. This shows that the maintenance times of patents of the enterprises, the individuals and the institutes show a weakening trend.

The number of inventors and the number of claims, as the independent variables, cannot be significant test (the value of P is less than 0.05). This shows that the influent degree of the number of inventors and the number of claims are very low. Their standardized coefficients respectively are 0.035 and 0.009; this also indicates that the explanation degrees of two independent variables are less than that of other influent factors.

### 2.5 Conclusions and Inspiration

The value of patent is to maintain it. This book uses standardized linear regression with *the Database of Related Information of the Patents Granted by SIPO in 1994* to study the influent degrees of different influencing factors to the maintenance
time of patents from the patent information by SPSS software (11.5). The conclusion can draw. The average maintenance time of innovation patents is shorter and the terminated speed quicker, which granted by the State Intellectual Property Office in China. Effects of the applicant’s country, the examination time, types of patentees, the number of inventor and the number of patent claims on the Patent maintenance time is follow by weakening.

This conclusion provides three main inspirations to us. First inspiration is that we must comprehensively and in-depth study the real reasons why the maintenance times of patents granted by the State Intellectual Property Office in China are short and the terminated speeds of patents for failure to pay maintenance fees is quicker. At the same time, we must effectively solve these problems for the role of the patent system better played, and the utilization rate of public resources increased. The second inspiration is that we must recognize the status quo to maintain domestic patents and its impact to China’s technological innovation, and appropriately adjust the patent system and relating policies. Its purpose is to improve the capacity to application and management patents of domestic patentees. The third inspiration is that we must improve the examination ability of patent examiners and the examination efficiency, strengthen the time concept of applicants and patent attorneys, and as short as possible the examination time of patents.

It is worth mentioning that research on the impact factors to the maintenance time of patents and its weight only from the perspective of the patent information in this study. In fact, there are many factors to impact the maintenance time of patents. For example, the level of patent strategy of patentees, the management level of patent, the conditions and the systems of the implementation, licensing, transfer of patents, the market conditions of patents trading, the available technology and the level of the creativity standards of the patents examination, the identified mode of patent infringement and the amount of compensation all will impact it. In order to reasonably extend the maintenance time of patents, improve the patent quality in China, and strengthen China’s capability for independent innovation, we hope that the maintenance time of patents researched from these perspectives in the future if conditions permitted.
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