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Abstract

This article assesses the rate of obsolescence of patents with measurements of the rate in Japan. Our study departs from Parkes and Schankerman (1989) and Schankerman (1998) because of its application of the ordered probit model. The application of this model enables us to consider the case of noncontinuous renewal fees.

The estimated value of the rate of obsolescence in Chemicals is apparently large. Values of obsolescence rate in each industry except Chemicals are located above 24%. The obsolescence rate obtained by our estimates is apparently higher than in previous studies.

JEL classification number: O31,O32,O34,C34

Key words: Obsolescence rate, Patent, Innovation, Ordered probit model

1 Introduction

The purpose of this paper is to assess the rate of obsolescence of patents by measuring the rate in Japan. In particular, we propose a suitable method for computing the rate of obsolescence of patents. Furthermore, we compare our measured rate with those reported in previous studies.

Since Schumpeter's study (Schumpeter, 1942), it has been recognized that innovation plays an important role in firms' competitiveness and growth. This concern with innovation has been increasing since the 1990s, with development of the new growth theory (Grossman and Helpman, 1991) and firm strategy theory (Porter, 1990). Research and development (R&D) is increasingly aimed at innovation. Such innovation is protected by the patent system because imitations discourage innovations and are eventually reflected in a decrease in the competitive advantages of both industries and nations.

Several studies analyzing patents have appeared since Griliche's pioneering study (1980). It is considered that patent grants are reflections of innovations (Hall, Jaffe and Trajtenberg, 2000). Moreover, Hall, Jaffe and Trajtenberg (2000) constructed patent data by considering the quality. The method of construction of patent stock data by Hall, Jaffe and Trajtenberg (2000) is more appropriate than those used in previous empirical studies. However, little attention has been given to the rate of obsolescence, except in the studies by Parkes and Schankerman (1989), Schankerman (1998), and Nadiri and Prucha (1996). Previously, most other studies assumed an arbitrary rate of obsolescence of 10% to 15% to construct patent stocks by the perpetual inventory method. However, the rate of obsolescence plays an important role in construction of patent stocks, as the patent stock is mostly determined by the obsolescence rate. Moreover we can measure the value of patents (Schankerman, 1998) using the obsolescence rate. Measurement of the value of patents is useful for economic analysis of patents and R&D, in patent litigation, and in estimating the market value of a firm including its patents.

Parkes and Schankerman (1989) and Schankerman (1998) were amongst the first to measure the rate of obsolescence. Their approach depended on estimation of the renewal probability of patents using the relationship between patent value and the renewal cost of patents. In Japan, Goto et al. (1986) and Nakajima and Shinpo (1998) also studied the measurement of rate of patent obsolescence. The main approach of Goto, Honjyo, Suzuki and Takinozawa (1986) was to estimate the rate of obsolescence based on methods used by Bosworth (1978). The cost of patent renewal is not considered. Nakajima and Shinpo (1998) applied the methodology of Parkes and Schankerman (1989) and Schankerman (1998) to Japanese data. However, the data in Nakajima and Shinpo (1998) is problematic. The amount of data is small and aggregated. Furthermore, their estimation results are not significant.

Our study is based on Parkes and Schankerman (1989) and Schankerman (1998). They assume that the renewal fee is a continuous variable. However, generally the renewal fee is not a continuous variable during the periods of registration, but discrete subject to the period of registration. The renewal fee is revised every three or five years in most countries. Therefore, our study departs from Parkes and Schankerman (1989) and Schankerman (1998) because of the application of an ordered probit model. The application of an ordered probit model enables us to consider the noncontinuous renewal fee.

Our presentation is organized as follows. A description of the model is presented in Section 2. Data is presented in Section 3. Empirical results are presented and discussed in Section 4. The conclusion is presented in Section 5.

2 Model

We denoted by r_0 the initial revenue obtained from to holding the patent and $c(t+1)$ the renewal fee in the periods $t+1$ that begin from the establishment of the patent right. The decision rule is that firms renew their patents if and only if,

$$r_0(1-\delta)^{l+t} \geq c(t+1) \tag{1}$$

where δ denotes the rate of obsolescence of patents and l denotes the periods from application to grant.

This renewal fee function will be defined as Heaviside function by

$$c(t+1) = \begin{cases} c_1 & t \leq 2 \\ c_2 & 2 < t \leq 5 \\ c_3 & 5 < t \leq 8 \\ c_4 & 8 < t \leq 11 \\ c_5 & 11 < t \end{cases} \tag{2}$$

We assume that the log of initial revenue obtained from to holding the patent, r_0, is,

$$\ln r_0 = \mu + \epsilon. \tag{3}$$

where μ denotes the patent specific component of the initial revenue obtained from to holding the patent and is treated as a parameter in this analysis and ϵ denotes the random component of the initial revenue obtained from to holding the patent and is normally distributed. The log of initial revenue obtained from holding the patent is normally distributed with mean μ and variance σ^2.

If $Z(l,t)$ is the probability of applying for the patent renewal given renewal fee, the above equation imlpies that,

$$Z(l,t) \geq \frac{1}{\sigma}[\ln c(t+1) - (l+t)\ln(1-\delta) - \mu], \tag{4}$$

where $Z(l,t) = \frac{\ln r_0 - \mu}{\sigma}$.

The renewal fee is raised every three years in Japan. Therefore, the renewal fee is not a continuous but a discrete variable. As before, we assume that ϵ is normally distributed across observations. We have the following probabilities:

$$\begin{aligned}
Pr(t \leq 3) &= \Phi[Z(l,3)], \\
Pr(3 < t \leq 6) &= \Phi[Z(l,6)] - \Phi[Z(l,3)], \\
Pr(6 < t \leq 9) &= \Phi[Z(l,9)] - \Phi[Z(l,6)], \\
Pr(9 < t \leq 12) &= \Phi[Z(l,12)] - \Phi[Z(l,9)], \\
Pr(12 < t) &= 1 - \Phi[Z(l,12)].
\end{aligned} \tag{5}$$

where Φ denotes the comulative standard normal distribution function. The parameters δ, μ and σ can be estimated by the maximum lilelihood estimation method.

3 Data

We construct a patent database for 101 Japanese companies. This is difficult, because there are no existing databases containing data such as dates of patent applications and grants in Japan. Goto and Motohashi (2007) developed a database of patents called ”Institute of Intellectual Property Patent Data Base (IIP Data Base)” that contains data such as the date of patent applications, patent grants and expiration, and number of citations from June 1964 to June 2004. We employ the data of patent grants that were granted in 1985 for 101 large Japanese corporations using IIP Data Base (Goto and Motohashi, 2007).

4 Results

[Figure 1]

The renewal rate is shown in Figure 1. The renewal rate is monotonically decreased to fifteen years. There are no differences of renewal rate among industries except in the periods from four years to nine years. The renewal rate of Drugs is highest and that of Transportation machinery is lowest in the periods from four years to nine years. Ten percent of patents are cancelled within three years. Ninety percent of patents are cancelled after twelve years. Half of all patents are cancelled within six years of initial grant. The rate of relatively early cancellation of patents in Japan is high compared with Germany, France, the United Kingdom and the USA . This is because of the three-year registration period and the cost of registration, which rises with each successive renewal, and becomes very large after ten years

[Table 1]

The estimation results are shown in Table 1. All parameters in all industries are significant with the expected sign. The estimated value for the rate of obsolescence in Chemicals is apparently large. There are not many differences in values of the rate of obsolescence among the other industry groups. Values of the rate of obsolescence in each industry except Chemicals are located above 24%. The estimated rate of obsolescence of patents in Japan in Goto et al. (1986) is 19%. The estimated rate of obsolescence in Pales and Schankerman (1978) is 25%, being the mean of all the individual rates of obsolescence. Pales and Schankerman (1986) estimated the rate of obsolescence of patents in the U.K., France and Germany at from 11% to 26%. Schankerman (1999) estimated the rate of obsolescence at from 4% to 19%. These rates are all lower than our estimate of the rate of obsolescence in Japan.

5 Concluding Remarks

In this paper, we measure the rate of obsolescence of patents using an ordered probit model that is appropriate for estimating the significance of discrete changes in renewal fees. We obtain plausible results. The rate of patent obsolescence differs between various industries. The results demonstrate that technological progress in both Chemical and Drug industries is faster than in other industries.

We assume that the rate of obsolescence of patents is identical among periods and patents in the same industries. To consider the heterogeneity of the rate of obsolescence of patents is important. Such expansions of this model will be investigated in future studies.

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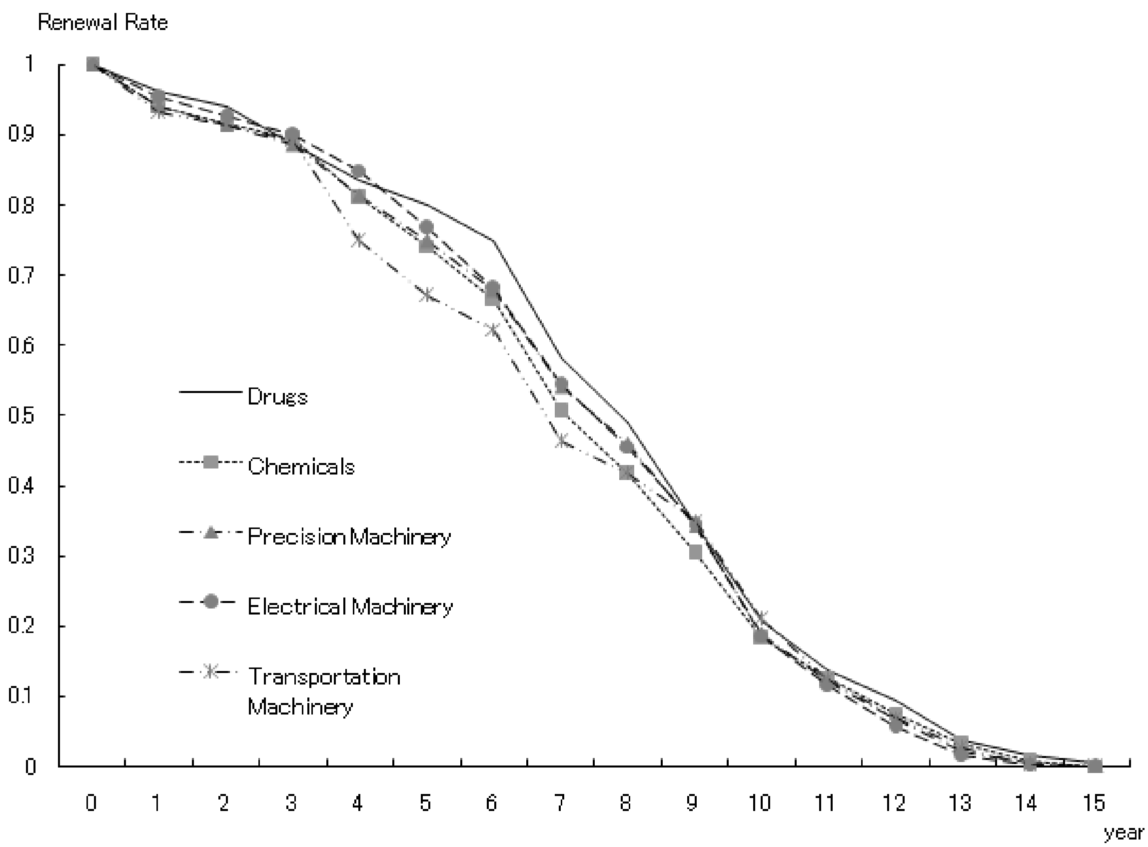

Figure 1: Renewal Rate in Japan

Table 1: Estimates of Ordered Probit Model

	Drugs	*Chemicals*	*Electrical machinery*	*Precision machinery*	*Transportation machinery*
δ	0.274	0.323	0.242	0.245	0.261
	(0.092)	(0.036)	(0.021)	(0.021)	(0.104)
μ	4.613	5.583	3.878	4.046	3.906
	(1.929)	(0.803)	(0.417)	(0.428)	(2.014)
σ	1.886	2.257	1.944	1.854	2.132
	(0.413)	(0.181)	(0.099)	(0.093)	(0.539)
$Log\ likelihood$	-375	-3747	-9606	-9524	-589
$samples$	265	2577	6412	6504	382

Note: Standard errors in parentheses.