

Who Does not Maintain Patents?

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Abstract--This research aims to understand the patterns between the legitimate patents and expired patents in the field of communication technology. This study use patentometric methods to investigate USPTO data on expired patents in communication technology. We used the USPC—National Bureau of Economic Research (NBER) Patent Data Technological Classification to identify patents relevant to communication technology. A total of 195,391 utility patents in communication technology was granted between 1994 and 2009. The results show that the expiration rates in Phase II, III, and IV are 9.90%, 15.28%, and 15.10% respectively. Although the number of expired patents increased over the period studied, the proportion of patents expiring decreased slightly in all three phases. Although US corporations hold the greatest number of patents granted by the USPTO, the proportion of patents from foreign corporations has been increasing rapidly. Japan has a high number of granted patents and high expiration rates especially in Phase III and IV. Sweden has a relatively high number of patents but the expiration rates in Phases II, III, and IV are quite low. This may show that Swedish patentees attach much importance to patent protection and that their patents may have higher value.

I. INTRODUCTION

Patent renewal fee systems were adopted in Japan and in western European countries in the 1950s, and later were implemented in Asia, Africa, and Central and South America. In 1980, the United States Patent and Trademark Office (USPTO) also implemented a patent renewal fee system [1]. Renewal fees were required of utility patent owners at four, eight and 12 years from the date on which the patent was granted. Renewal fees were set to recover a certain percentage of the cost of processing the applications of patents. The USPTO set separate fee schedules for small and large entities. Small entities means independent inventors, small business concerns employing up to 500 persons, and non-profit organizations. Small entities are charged at 50% of the rate chargeable to large entities. With effect from March 2013, a new category of micro entities was added, chargeable at 25% of the rate for large entities [2].

There are complex variables that influence a patentee to renew a patent or to let it expire. These complex variables include economic returns from renewed patents, company policy on renewing patents, patent renewal fees, changes in the economy, and technological obsolescence [1]. Hirabayashi and Myers (1988) used a questionnaire to survey 676 individual patent owners whose patents had expired due to fee nonpayment [3]. The survey showed that 59% of patent owners had allowed their patents to expire due to financial burden, 36% due to unprofitable invention, 28% due to not

being familiar with the maintenance fee procedure, and 25% due to not having been notified that the maintenance fee was due [3].

Patent renewal data are widely used when measuring patent value [4]–[10]. Baron and Delcamp took renewal and litigation as indicators of the private value of patents [4]. Meyer and Tang analysed patent citation, patent family, renewal and litigation data for university-owned patents [8]. Lanjouw, Pakes, and Putnam built a model and discussed how to measure innovation of countries by patent renewal data [11].

Shankerman and Pakes used European Patent Office (EPO) patent data to examine the distribution of the values of patent rights in the UK, France, and Germany during the post-1950 period [12]. The results revealed that more than half of the patents expired after eight years and only 25% still survived after 12 years [12]. Yang and Chen analyzed four fields of Taiwan invention patents from 1968 to 1991. The results showed that 50% of pharmacy patents were unmaintained after seven years, 50% of textile and mechanical patents were unmaintained after eight years, and 50% of computer patents were unmaintained after 11 years [13].

Brown analyzed renewal of patents with the USPTO from 1982 to 1990. The results show that 82% of the patents granted between 1982 and 1990 were renewed at four years; 69% were again renewed at eight years, and 57% were again renewed at 12 years. The annual renewal rate was in a declining trend from 1986 to 1990. Four-year renewal rates fell from 85% to 79%, and eight-year renewal rates fell from 76% to 66%. Due to the data cutoff point, the analysis of 12-year renewal covered only patents granted in 1982. The study also found that patentees who were company owners, patentees from Japan, and the patent technology classes chemical and electrical were associated with higher patent renewal rates [1].

Hirabayashi and Myers examined the expiration of US patents due to nonpayment of first-time (four year) maintenance fees from 1981 to 1983. They found that the expiration rate of patents was 17%. The expiration rates of patents with first inventors from the USA, and of those with first inventors from foreign countries, were 18% and 14% respectively. Among the foreign countries, Japan had the most granted patents but the expiration rate was only 5%. The expiration rates by patent ownership were US corporations 34%, US individuals 31%, foreign corporations/governments 23%, foreign individuals 7%, and US government 5% [3].

Lanjouw used West German patent data from 1953 to 1988 to estimate the private value of patent renewal protection. A dynamic model was built and indicated that the aggregate value of protection generated per year was of the order of 10% of related R&D expenditure [14]. Schubert compared the patent value of the EPO patents granted from 1986 to 1996. The mean life of patents with inventor countries Japan and Denmark was about 14.45 years. The life of patents with other inventor countries was about 12 to 14 years [15].

Hence, many previous studies consider that patent renewal data may be used for measuring patent value. The longer patent life or higher patent renewal rates usually intimate higher patent value. Thus, observing maintenance pattern can help us identify patents with well quality. For the above purpose, we take communication technology for example. Communication technology is a key research field which is one part of information and communications technology (ICT). Communication technology covers telecommunications (telephone lines and wireless signals), and computer/telephone software, middleware, storage, and audiovisual systems, which enable users to access, store, transmit, and manipulate information.

The objective of this research was to study patent renewal data to elucidate who does not maintain patents in communication technology. Data on communication technology patents granted between 1994 and 2013 were collected from the USPTO database. We first analyzed the patent counts and patent expiration rates after the four-, eight-, and 12-year maintenance fee payments. We then analyzed patent expiration rates by type of patentee, top ranking countries, and top ranking patentees.

II. METHODOLOGY

This study utilizes patentometric methods to explore USPTO data on expired patents in communication technology. Patentometrics uses objective statistics to

observe quantitative and qualitative performance of a research topic. Through analysis based on the indicators, one can understand the structure of technological production capacity, as well as trends in technological development, which establishes common frames of reference for further research.

Data collection

The source of patent information used in this study was the database of the USPTO, from which data were retrieved using the United States Patent Classification System (USPC). Since the USA is a major market and US patents are considered the epitome of global technological development, filing a patent application in the United States is a strategic action for most inventors and owners worldwide to maintain competitive advantage. Compared with the International Patent Classification system, the USPC is updated more frequently and provides more detailed information on relevant patents, reflecting the advancement and innovation of technologies more accurately.

To identify patents relevant to communication technology, we searched using the USPC—National Bureau of Economic Research (NBER) Patent Data Technological Classification. A total of 195,391 utility patents on communication technology were granted between 1994 and 2009.

In general, US utility patents are protected for a term of 20 years from the filing date. The owner of a utility patent has to pay a one-time issue fee at the time when the patent is granted, and may then pay maintenance fees to extend the patent up to three times. The terms of protection after the respective fee payments are four, four, four, and eight years. As shown in Figure 1, patents are protected for four years from the date of grant, in Phase I. Then the first maintenance fee should be paid after 3.5 years to extend the patent from the fifth to the eighth years, in Phase II. The second and third maintenance fees should be paid after 7.5 years and 11.5 years respectively to extend the patent from the ninth to the 12th years in Phases III and after the 13th years in Phases IV.

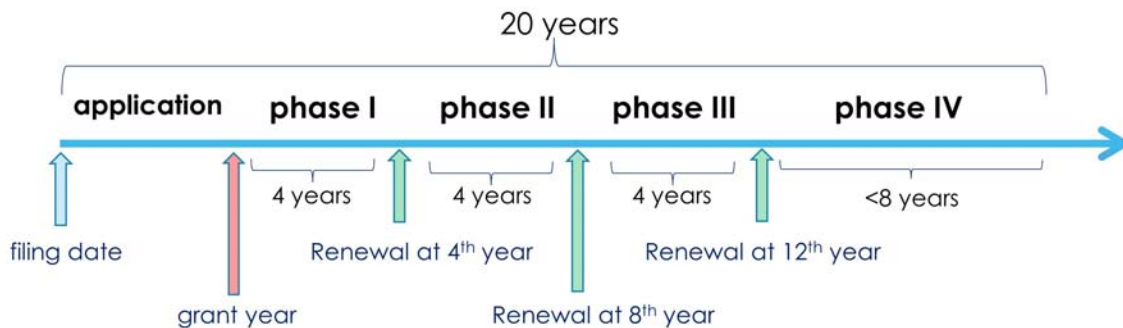


Figure 1. Patent renewal periods

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TABLE 1. SHARE OF SURVIVING AND EXPIRED PATENTS OF PHASES II, III, AND IV AMONG PATENTS IN COMMUNICATION TECHNOLOGY GRANTED 1994–2009

	surviving patents (%)	expired patents (%)
Phase II (patents granted 1994–2009)	90.10%	9.90%
Phase III (patents granted 1994–2005)	74.75%	15.28%
Phase IV (patents granted 1994–2001)	58.87%	15.10%

III. RESULTS

A. Trends in patent expiration in communication technology

For this study we first analyzed the numbers and percentages of patents in the different phases of the patent lifecycle from 1994 to 2013. Table 1 shows the percentages of expired patents in Phases II, III, and IV of the patent lifecycle. Among the total of 195,391 patents on communication technology granted as valid patents (Phase I), after four to eight years (Phase II), 90.10% of patents granted from 1994 to 2009 had been renewed, while 9.90% had expired. In Phase III, only the patents granted over 7.5 years can be analyzed. These patents account for 90.03% of all patents. 15.28% of the patents had expired and 74.75% remained effective. In Phase IV, the patents granted over 11.5 years are analyzed. These patents account for 73.97% of all patents. 15.10% of the patents had expired and only 58.87% remained effective.

After 12 years from grant of patent (Phase IV), 15.10% of patents granted from 1994 to 2001 had expired and 58.87% remained effective to the end of patent life. This means that only 58.87% of patents remained enforceable to the end of the full patent life. Next, we will further discuss the trends relating to expired patents.

Figure 2 shows the numbers and rates of granted and expired patents annually. The bar chart shows the patent counts and the line graph shows the rates of patent expiration. The expired patent counts and patent expiration rates in Phase

II are shown in orange. The expired patent counts and expiration rates in Phase III are shown in green. The expired patent counts and expiration rates in Phase IV are shown in purple.

The number of patents granted annually in communication technology shows an increasing trend from 1994 to 2009. The number of patents granted grew from 5,406 in 1994 to 19,129 in 2009, a 3.5-fold increase. But the number of patents granted decreased from 1997 to 2005.

The expiration rate in Phase II was 9.90%. The number of expired patents increased, but the expiration rate shows a slightly decreasing trend. The expiration rate decreased sharply from 2001 to 2003 and was lowest in 2003. In Phase III, the number of expired patents also shows an increasing trend. The average expiration rate of patents granted from 1994 to 2005 is 15.28%. The expiration rate in Phase III shows a decreasing trend. The rate is highest (18.22%) in 1996, then decreases sharply from 1996 to 1999. The rate is lowest (12.58%) in 1999, then rises to almost 14%. In Phase IV, the number of expired patents shows an increasing trend. The average expiration rate of patents granted from 1994 to 2001 is 15.10%. The patent expiration rate shows a broadly decreasing trend. The rate is highest (16.82%) in 1998, then decreases sharply from 1998 to 2001. The proportion of expired patents is lowest (13.57%) in 2000. In summary, the overall numbers of granted patents and expired patents increased, but the rate of patent expiration showed a decreasing trend.

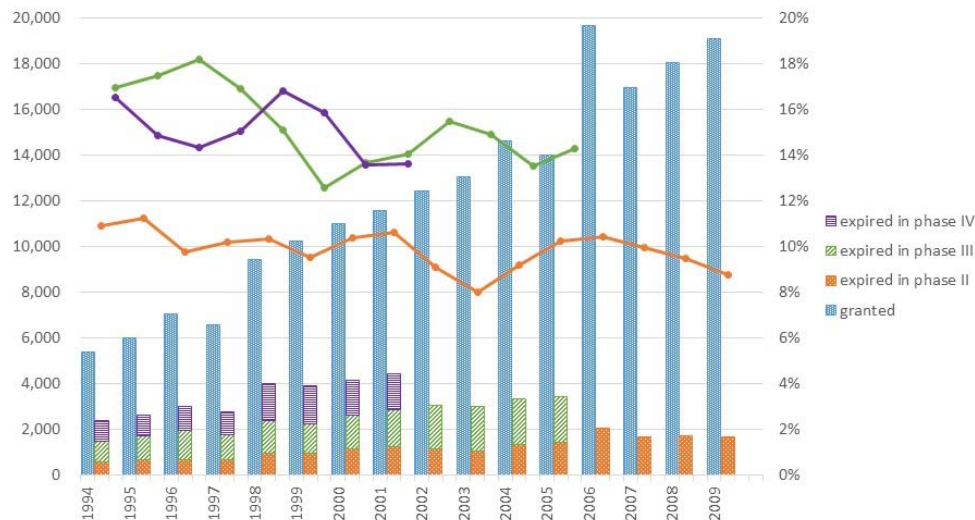


Figure 2. Patent expiration rates in three phases

B. Trends in expired patents in communication technology, by type of owner

Six types of patent owner are indicated in the USPTO database: US corporation, US government, US individual, foreign corporation, foreign government, and foreign individual. Figure 3 shows the trends in patent counts and share among the six types of patentee. It shows that the number of patents granted to US corporations and foreign corporations increased over the period 1994–2008 but the numbers of other types of patentee remained almost the same. The proportion of patents granted to foreign corporations increased the most but the proportion granted to US corporations also increased somewhat. The share of patents granted to US individuals declined.

The figure shows that corporations formed the largest class of owners of US patents, and the majority were US corporations. However, the number of patents granted to foreign corporations increased markedly, which means that there were more and more foreign corporations filing patents with the USPTO, and the share of patents granted to foreign corporations grew closer to the share granted to US corporations. In contrast, there was little change in the number of patents granted to US individuals, but their share grew progressively smaller.

Figure 4 shows the number and percentage of patents expiring annually in Phases II, III, and IV for the six types of patentee. When the proportion of expired patents is more than five percent, it is shown in Figure 4.

In Phase II, as shown on the left side of Figure 4 (a), patent expirations showed an increasing trend. There is a spike for patents granted in 2006 that expired in 2010. Until 1999, more patents of foreign corporations expired than did those of US corporations, and foreign corporation was the type of patentee with the highest number of patent expirations. The right side of Figure 4 (a) shows the rate of patent expiration for those types of owner whose expired patents

account for more than five percent of expired patents. The expiration rate is highest for US individuals.

Nearly 20% of patents granted to US individuals expired in Phase II. In particular, in 1997 and 1998 20% of patents granted to US individuals expired in the fifth year due to non-payment of maintenance fees.

The average expiration rate of patents granted to foreign corporations was about 10%. The expiration rate was less than 10% in 1994 but exceeded 10% from 2001 to 2008, which is above the average expiration rate of Phase II. Thus almost 10% of patents granted to foreign corporations expired in Phase II, and the expiration rate tended to increase year by year.

The patent expiration rates of US corporations were below the expiration rates of patent of foreign corporations after 1999. The average patent expiration rate of US corporations was about 7% and showed a slightly decreasing trend. This indicates that the maintenance rate of patents granted to US corporations slightly increased in Phase II.

The patent expiration rate for US corporations shows a decreasing trend. After 1998, the expiration rate remained at about 10%. The expiration rate for US corporations in Phase III was slightly higher than that in Phase II and was below the average rate.

The left side of Figure 4 (c) shows the number of patents that expired in Phase IV. The overall number of patents expiring annually can be broadly divided into two steps, with about 1,000 expiring each year from 1994 to 1997 and about 1,500 from 1998 to 2001.

The number of expired patents of foreign corporations can also be broadly divided into two steps. More patents of foreign corporations expired than did those of US corporations, and foreign corporations were the type of patentee with the largest number of patent expirations in Phase III.

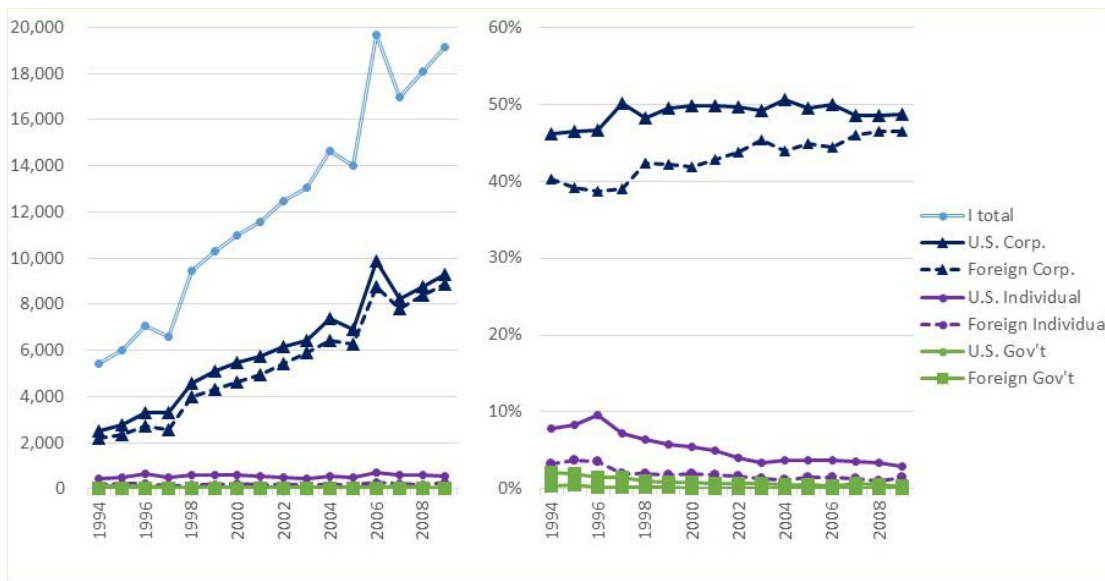


Figure 3. Categories of patent ownership in communication technology patents

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The right side of Figure 4 (c) shows different trends than those in Phases II and III. The expiration rate of patents granted to foreign corporation replaces that for US individuals, to become the highest rate for any type of patentee. About 20% of patents granted to foreign corporations expired 12 years after grant of patent. However, the expiration rate for US individuals remained within 10–15%.

The expiration rate of patents granted to US corporations shows a slightly decreasing trend in Phase IV and remains under 10% after 2000. Compared to the expiration rates of patents granted to US corporations in Phases II and III, the expiration rate in Phase IV is slightly increased but remains below the average expiration rate.

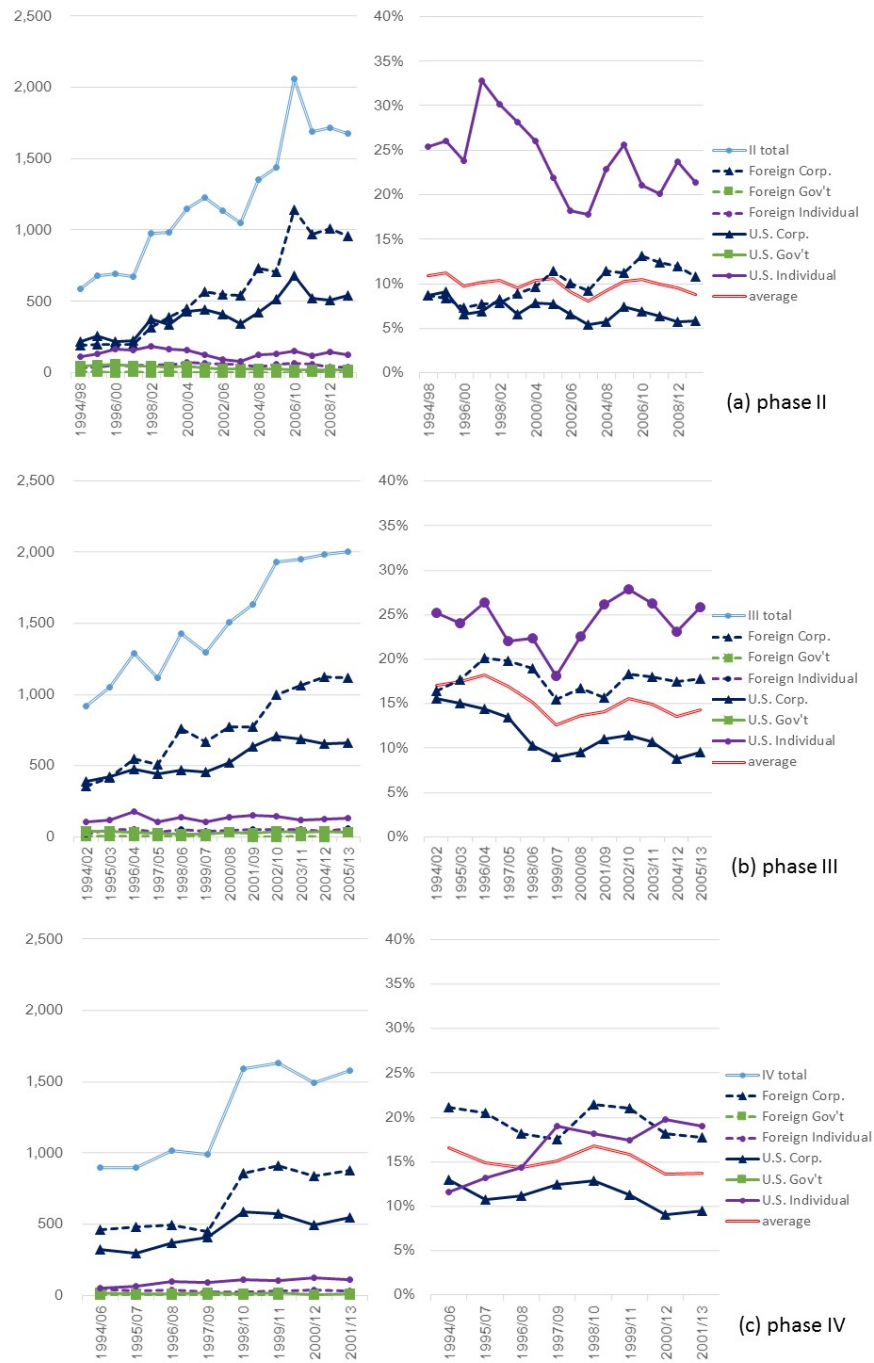


Figure 4. Expiration trends by category of patent ownership

C. Patent expiration rates of the top ranking patent holding countries in communication technology

Figure 5 shows the top ranking countries owning US patents in communication technology, ordered according to their total patent expiration rates through Phases II, III, and IV. The figures in parentheses after the country names indicate the numbers of granted patents from 1994 to 2009. The bar graph compares the total expiration rates and the expiration rates per phase in Phases II to IV. We can see that the total patent expiration rates of Japan and Netherlands were more than 50%, and those of the USA, Canada, and Sweden were less than 30%. The total expiration rates of other countries were between 40% and 50%.

In Phase II, the countries with the highest expiration rates were, in descending order, the Netherlands (19.49%), France (15.31%), Taiwan (14.71%), the UK (13.38%), Germany (13.17%), Japan (10.55%), and Finland (10.43%). The expiration rates of other countries were below 10%. In Phase III, except for Sweden (6.51%), the expiration rates of all countries were more than 10%. The expiration rate of Japan was the highest (20.41%), followed by Germany (17.60%), the Netherlands (17.28%), France (16.97%), and the UK (16.27%). Countries' expiration rates in Phase IV can be separated into three groups. The countries with expiration rates of more than 20% were South Korea (25.49%), Japan (23.15%), and Finland (21.02%). Those with expiration rates between 10% and 20% were Germany (17.07%), the Netherlands (15.45%), Taiwan (14.35%), France (13.78%), UK (13.16%) and USA (11.26%). Countries with expiration rates of less than 10% were Canada (8.72%), and Sweden (5.05%).

Furthermore, we can see that Sweden has a relatively high number of patents but its expiration rates in Phases II, III, and IV were quite low. This may show that Swedish patentees attach much weight to patent protection and their patents may have higher value. The situation for the Netherlands is the opposite. We can see that the Netherlands have the least patents among the countries shown, but the expiration rates in

Phase II, III, and IV were all higher than 15%. More than 50% of Netherlands-held patents expired before the end of the full term of patent protection.

The expiration rates of patents owned by patentees from Japan, South Korea, and Finland show similar trends, being lower in Phase II, higher in Phase III, and higher still in Phase IV. The patent expiration rates of patents owned by patentees from Germany and the USA are lower in Phase II, become higher in Phase III and remain at a similar level in Phase IV. The patent expiration rates of patents owned by patentees from France, Taiwan, the UK, Canada, and Sweden are higher in Phase III but lower in both Phase II and Phase IV.

D. Patent expiration rates of top patentees in communication technology

We further analyzed the numbers of expired patents and the patent expiration rates in Phases II to IV of top-ranking patentees in communication technology. The list of top-ranking patentees was compiled by finding the top 10 patentees, by number of patents held, in each of the four phases of the patent life cycle during the sample period. When combined together, these rankings produced a list of 16 patentees. Figure 6 shows the patent ownership of these 16 top-ranking patentees, their total patent expiration rates, and their expiration rates in Phases II, III, and IV. The figures in parentheses following the names of patentees indicate the number of patents granted from 1994 to 2009. Patentees are ranked top to bottom according to their total expiration rates. We can see that the total patent expiration rates of the US Navy, Toshiba, and Mitsubishi are all more than 70%. This means that less than 30% of patents of these patentees remain in force throughout the patent life cycle. The total expiration rates of Fujitsu and NEC are between 50% and 60%. The total expiration rates of Matsushita, Hitachi, IBM, Sony, Samsung and Siemens are between 40% and 50%. The total expiration rates of Nokia, Alcatel, and Canon are between 30% and 50%. The total expiration rates of Motorola and AT&T are less than 30%.

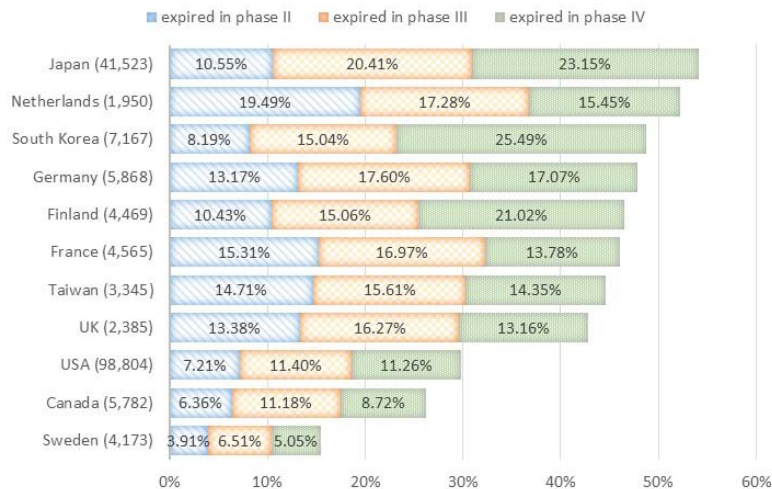


Figure 5. Patent expiration rates of top ranking countries

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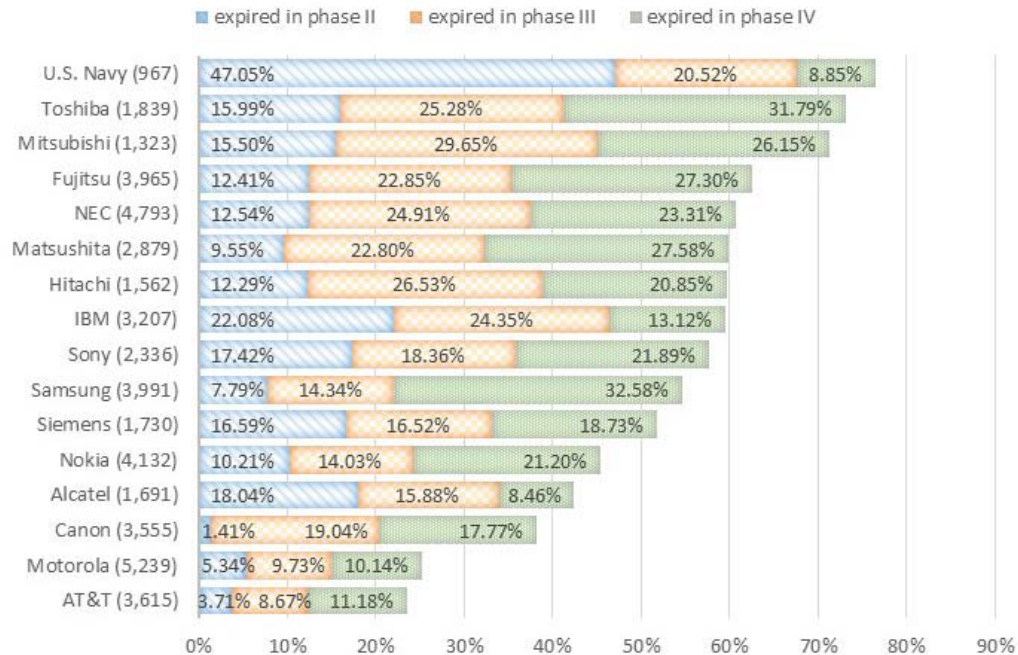


Figure 6. Patent expiration rates of top-ranking patentees

In Phase II, the patent expiration rate of the US Navy is the highest (47.05%). The other patentees with the highest expiration rates, in descending order, are as follows: IBM (22.08%), Alcatel (18.04%), Sony (17.42%), Siemens (16.59%), Toshiba (15.99%), and Mitsubishi (15.50%). The expiration rates of other patentees are below 15%. In Phase III, except for Motorola (9.73%) and AT&T (8.67%), the expiration rates of the other patent owners are more than 10%. The expiration rate of Mitsubishi is the highest (29.65%). Next are Hitachi (26.53%), Toshiba (25.28%), NEC (24.91%), IBM (24.35%), Fujitsu (22.85%), Matsushita (22.80%), and the US Navy (20.52%). The expiration rates of the other owners are between 10% and 20%. In Phase IV, except for the US Navy (8.85%) and Alcatel (8.46%), the patent expiration rates of other patentees are more than 10%. The expiration rate of Samsung is the highest (32.58%). The patentee with the second highest expiration rate is Toshiba (31.79%). Matsushita (27.58%), Fujitsu (27.30%), Mitsubishi (26.15%), NEC (23.31%), Sony (21.89%), Nokia (21.20%), and Hitachi (20.85%) are all between 20% and 30%. The expiration rates of the other patentees are between 10% and 20%.

Except for the US Navy, which is the only government patentee, the other patentees are corporations. Almost half (47.05%) of patents granted to the US Navy expired after four years, and about 60% had expired after eight years. Less than 25% of patents granted to the US Navy remained effective throughout the full patent life cycle. This may show that US Navy is very cautious with regard to patent renewal and stops renewing most patents in the early years. The expiration rates of Alcatel in Phases II, III, and IV show a

decreasing trend similar to that of US Navy, but the total expiration rate of Alcatel is less than 45%.

The patent expiration rates of Toshiba, Fujitsu, Matsushita, Samsung, Nokia, and AT&T show increasing trends in Phases II, III, and IV. The patent expiration rates of Mitsubishi, NEC, Canon, and Motorola are lower in Phase II, then become higher in Phase III and remain at a similar level in Phase IV. The patent expiration rate of Hitachi is higher in Phase III but lower in Phases II and IV. The patent expiration rate of IBM is almost the same in Phases II and III but lower in Phase IV. The patent expiration rates of Sony and Siemens are almost the same in Phases II and III but higher in Phase IV.

IV. CONCLUSIONS & DISCUSSION

This research uses data from the USPTO database to study the expiration of US patents in communication technology between 1994 and 2009. The results show that the expiration rates in Phase II, III, and IV are 9.90%, 15.28%, and 15.10% respectively. Although the number of expired patents increased over the period studied, the proportion of patents expiring decreased slightly in all three phases.

Almost half of US patents are granted to US corporations and more than 40% to foreign corporations. The numbers granted to both these types of patentee increased annually. Although US corporations hold the greatest number of patents granted by the USPTO, the proportion of patents from foreign corporations has been increasing rapidly. In Phases II and III, patents granted to US individuals have the highest expiration rates. But in Phase IV the expiration rate of patents granted to foreign corporations exceeds that of US

individuals. And the expiration rate of patents granted to US corporations is lower than the average expiration rate. These findings indicate that US individuals tend to give up maintaining their patents in Phases II and III, while foreign corporations tend to give up maintaining their patents in phase IV. However, US corporations try the hardest to maintain their granted patents.

The total patent expiration rates of Japan and the Netherlands are more than 50%. The total expiration rates of the USA, Canada, and Sweden are less than 30%. The total expiration rates of other countries are between 40% and 50%. Japan has a high number of granted patents and high expiration rates especially in Phase III and IV. Sweden has a relatively high number of patents but the expiration rates in Phases II, III, and IV are quite low. This may show that Swedish patentees attach much importance to patent protection and that their patents may have higher value. The opposite applies to the Netherlands. The Netherlands has fewer patents, but the expiration rates in Phases II, III, and IV are higher than 15%. More than 50% of Netherlands patents expired before the end of the full term of patent protection.

Looking at the patentees, half of 16 top-ranking patentees are from Japan. The total expiration rates of seven of these eight Japanese patentees are higher than 50%. They tend to let their patents expire in Phases III and IV. The US Navy, the only non-corporate patentee among these top-ranking patentees, tends to give up maintaining almost half of its granted patents in Phase II.

Increases and decreases in expiration rates may be caused by corporate policy, patent maintenance fees, economic trends, corporate mergers and acquisitions, etc. It may require further discussion with other data to fully understand the reasons that affect patent expiration.

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