Rate of Technology Obsolescence, Demand for Speed of Patent Protection and Efficiency of Patent System

Research Proposal for applying the NBER Innovation Policy Post-Doctoral Fellowship

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1 INTRODUCTION

Cross-country evidences have revealed big differences in the time needed for new technologies to dominate existing ones in different technology classes (Comin and Hobijn 2004). Based on USPTO and EPO patent datasets, I find consistent heterogeneity in terms of renewal decisions for patents in different technology fields[2] (Figure 1). While the renewal decisions for patents reflect the patents' private values to the patentees (Schankerman and Pakes 1987; Schankerman 1998), to some extent, the systematic differences of renewal decisions across technology fields also reflect the rate of technology obsolescence, i.e. the reciprocal of the time interval between the emergence of one technology and the emergence of a new technology that eventually dominates the previous one.

Conditioning on filing patents to protect innovations, firms might have diverse demands for speed of patent protection based on the heterogeneity in the rate of technology obsolescence. A patent system, therefore, is likely to enhance its efficiency by providing patent protections that meet such demands. Previous literatures on the optimality of patent design have primarily focused on maximizing social welfare by choosing the optimal patent length and breadth [3] . Previous studies have also pointed out that a uniform patent system provides distorted R&D incentives to firms and causes misallocation of resources across industries (Cornelli and Schankerman 1998; O'Donoghue and Zweimüller 2004). Firm-level surveys (Levin et al. 1987; Cohen, Nelson, and Walsh 2000) have revealed the relative unimportance and inefficiency of patent as a mechanism of recouping investment to R&D, while other mechanisms, such as secrecy and lead time, are more favored by firms. The aim of this research is to discuss the possibility of increasing a patent system's efficiency by empirically examining the relationship between a firm's demand for speed of patent protection and the rate of technology obsolescence.

The potential contribution of this research is three-folded. First, previous theoretic literatures have primarily discussed the optimality of patent system through design of appropriate patent length and patent breadth (Nordhaus 1969; Gilbert and Shapiro 1990, Klemperer 1990; Green and Scotchmer 1995; O'donoghue, Scotchmer, and Thisse; O'Donoghue 1998, etc.). This research introduces another measure of patent right, the speed of patent protection, and tries to understand how the interactions of length, breadth and speed could possibly enhance the efficiency of patent system as well as social welfare from a theoretical perspective. Second, we define the rate of technology obsolescence by the percentage of abandoned patents applied in the same year and technology field. We can then measure the technology obsolescence index according to this definition and investigate the impact of rate of technology obsolescence on firms' demand for speed of patent protection. To our knowledge, no previous studies have conducted similar quantitative analysis. Third, USPTO recently launched the "three-track examination" [4] .Our study offers early insights on the likely response of inventors with the "three-track" system at USPTO, pointing to an interesting research agenda in the future when the data are accumulated sufficiently at USPTO.

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[2]The technology classification used here is defined in Hall, Jaffe, and Trajtenberg (2001). The definition categorizes patents into 6 big technology fields Chemical, Computer and Communications, Drugs and Medical, Electrical and Electronics, Mechanics and Others based on 3-digit United States Patent Classification (USPC). Since the EPO patents are classified using International Classification Code, we use the IPC-USPC concordance table to transfer IPC into USPC and assign each EPO patent into the HJT patent classification.

[3]See e.g. Gallini and Scotchmer (2002) for an excellent literature review for the optimal design of patent system.

[4]The program allows applicants, willing to pay additional special fees ($4,950 for large entities and $2,550 for small entities) to request for prioritized examination that guarantees a final decision within twelve months of the filing date (Track 1). Applicants can also request a delayed examination for up to 30 months (Track 3), or the standard examination (Track 2).

2 Research Design and Data

To quantitatively investigate the relationship between demand for speed of patent protection (SPG for short) and the rate of technology obsolescence, we plan to use the following data and methods to create measures for the key economic variables.

To measure firms' demand for speed of patent protection, we exploit a unique feature provided by SIPO, the State Intellectual and Patent Office of China. Contrary to USPTO and EPO, SIPO provides two major types of patent protection for product innovations: invention patents (henceforth *IPat*) and utility models (*henceforth UM*). Compared to *IPat*, *UM* requires approximately only one-fifth the time of examination, hence is granted significantly faster[5]. The difference in examination length offers us a rare opportunity to observe patent applicants' demand for SPG based on their choice of *IPat* or *UM*, in China.

It should be noticed that the short examination delay of *UM* is at the cost of no substantial examination[6]. Previous studies have pointed out that *UM* in general, serves as stimulus to domestic inventive activities and protects minor innovations (Bosworth and Yang 2000). The evidences suggest, in China, patent applicants in general choose *UM* because they do not have inventions that are innovative enough to be granted *IPat*. To control for this potential bias while maintaining the feasibility of our data to test the hypotheses, we choose data to include SIPO-USPTO and SIPO-EPO patent dyads. This selection has two advantages. First, the USPTO and EPO employ a uniform and rigorous patent examination standard. In addition, the patentability standards at USPTO and EPO are presumably higher or equal to the patentability standard for *IPat* at SIPO[7] . The uniform patent examination standard at USPTO and EPO could mitigate the concerns caused by heterogeneity in patent quality. In this sample, patent applicants' choices of *IPat*/*UM* should primarily reflect their concerns for SPG rather than patentability. Second, patent application fees at USPTO and EPO are much higher than those at SIPO[8]. This high threshold in terms of upfront cost shall guarantee the innovations are of *ex-ante* significant private values.

To measure the rate of technology obsolescence, we use technology-cohort level number of patents abandoned after a given period (e.g. 4 years after patent grant) divided by the total number of patents in the same technology-cohort as the index[9]. Although renewal decisions for individual patent reflect primarily the value of the patent to the patentee, an aggregate measure at the technological level should approximately reflect the rate of technology obsolescence. This is because when the incumbent innovation's competitive advantage diminishes due to emergence of better innovation, the private value of the associated patent will also decrease, increasing the probability of earlier patent abandonment. It should be noticed that the allocations of R&D resources by industries are generally different for different countries. Hence, the measure of rate of technology obsolescence should be calculated using patents filed in the same country. Since the dataset include patent dyads filed at SIPO-USPTO and SIPO-EPO, to calculate the rate of technology obsolescence, we can use all patents filed at USPTO, all *IPat* filed at SIPO or all patents filed at EPO that are designated, but not limited to a single European country, such as Germany, France or Great Britain.

3 Economics Analysis

We propose four interesting research questions that are worth investigating:

[5]Utility models are granted, on average, 6 months after application. Invention patent are granted about 30 months after application. Author's own calculation based on SIPO patent dataset 2010.

[6]Grant of utility model only requires preliminary check of formality. See e.g. *Patent Law of the People's Republic of China 2008*.

[7]The grant of *IPat* at SIPO requires substantial examination of novelty, non-obviousness and practicability. See e.g. *Patent Law of the People's Republic of China 2008.*

[8]The application fee at USPTO for non provisional patent is over 6 times of that for *IPat* , approximately 12 times of that for *UM*, at SIPO.

[9]Another method of calculating technology cycle is proposed by Bilir (2013), who uses mean forward citation lag at cohort-technology level. See Section 3 for a slightly more detailed discussion.

First, we propose to provide a comprehensive theory of optimal patent design that takes into consideration the speed of patent protection as well as patent length and breadth. Previous theoretical literatures on this subject implicitly assume that firms can secure patent right as fast as they need (Nordhaus 1969; Gilbert and Shapiro 1990, Klemperer 1990; Green and Scotchmer 1995; O'donoghue, Scotchmer, and Thisse; O'Donoghue 1998, etc.). So a more comprehensive theoretical model including SPG will nest the previous models as special cases where the SPG was assumed to be infinite. It is possible that the welfare implications derived from this model will be quite different from those derived from previous ones. A theoretical analysis based on this model could provide insight for possible efficiency-enhancing policy implications for the current patent system.

Second, by constructing the measure for the rate of technology obsolescence at the technology-cohort level, I can conduct quantitative comparisons of cross-sectional and time series differences in this rate of obsolescence. The within-technology time-series comparison will reveal the trends of technology progress over time. In addition, cross-country comparisons will help me understand the differences in technological progresses in different countries. Since SIPO and EPO patents are classified by International Patent Classification (IPC) while the USPTO patents are classified by United States Patent Classification (USPC), a full-fledged cross-country comparison is possible by using the IPC-USPC concordance. Bilir (2013) has proposed to use mean forward citation lag as the measure of the rate of technology obsolescence. While the "citation lag" measure has the advantage that it exploits relative information throughout patents' lifetime, it also has the disadvantage from truncation problem as significant portion of citations appear after 5 years of patent grant (Hall, Jaffe, and Trajtenberg 2001). In addition, citing a previous patent is more consistent with the understanding that the previous patent is "narrowing" the scope of the current patent rather than the innovations protected by the previous patent is invented around by the innovations under the current patent. Conceptually therefore, it seems the "renewal" measure proposed in this research is more closely related with the rate of technology obsolescence. Since our measures are different, one natural question is to compare the "renewal" measure with the "citation lag" measure and investigate which is better at describing differences in technology obsolescence.

Third, the main research question is to analyze the causal impact of technology obsolescence on demand for SPG, in China. To empirically identify the relationship, we can exploit the variations of patent applicants' choices of *IPat* (*UM*) and the variations of rates of technology obsolescence at technology-cohort level. Robustness check can be conducted by changing the definition of technology obsolescence using patent data from different countries. If our hypothesis is true, i.e. the rate of technology obsolescence has an causal effect on demand for SPG, then consistent results should be found in both samples of SIPO-EPO and SIPO-USPTO patent dyads as well as using different definitions of technology obsolescences. We can then construct the obsolescence rate elasticity of SPG using estimates of reduced form regressions. We can further explore how efficient the current patent regimes are based on this elasticity. If the elasticity is indeed significant, then a policy implication is to provide a menu of differentiated patent protection in terms of patent examination speed.

Fourth, the patent dyad datasets allow us to conduct interesting comparisons of patenting behaviors as well as patent values for same innovations at different patent offices. A natural hypothesis is, for the same innovation, whether patent applicants follow similar strategies when they file patent applications at different patent offices. More specifically, if patent applicants would like to have fast patent grant in China, would they also, on average, prefer fast patent grant in U.S and Europe? If so, since *UM* is not available at USPTO or EPO, what strategies would they employ in order to speed up the patent grant? We can investigate this question by comparing the differences in terms of USPTO (EPO) patent prosecution behaviors for innovations filed for Chinese *IPat* to behaviors for innovations filed for Chinese *UM* as priorities. At USPTO, in order to speed up patent grant, applicants can choose not to file for continuing patent applications (Graham and Mowrey 2004), respond faster to examination reports (Popp, Juhl, and Johnson 2003), etc. At EPO, applicants can request for early processing for the patent application. In addition, for the same innovation, if the SIPO patent is filed earlier than the USPTO (EPO) patent, we can also observe the filing lags between the SIPO and USPTO (EPO) filing dates, another measure of how fast applicants would want their patents to be granted. As for comparison of the patent values for the same innovation in different countries, we can compare the renewal decisions of patents in different countries protecting the same innovations. These comparisons add to our understanding of the relative efficiency of patent application processes under different patent systems.

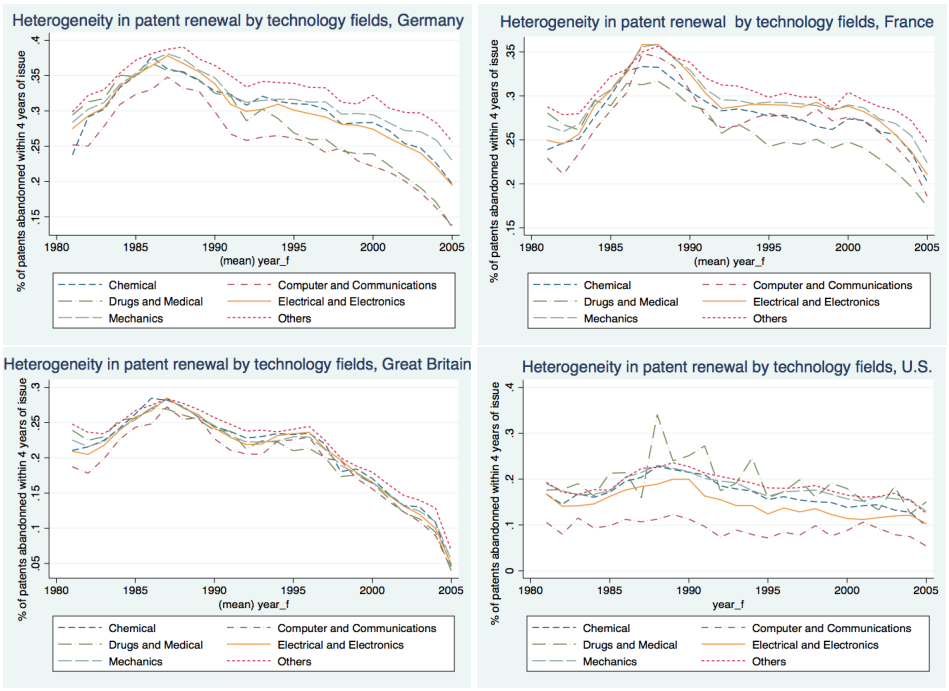

Figure 1: Heterogeneity in Patent Renewal Behaviors by Technology Fields: Germany, France, Great Britain and U.S.

note: 1. Data source USPTO patent dataset and EPO Worldwide Patent Statistical Database April 2011. 2. The technology classification used here is defined in Hall, Jaffe, and Trajtenberg (2001). The definition categorizes patents into 6 big technology fields Chemical, Computer and Communications, Drugs and Medical, Electrical and Electronics, Mechanics and Others based on 3-digit United States Patent Classification (USPC). Since the EPO patents are classified using International Classification Code, we use the IPC-USPC concordance table to transfer IPC into USPC and assign each EPO patent into the HJT patent classification.

References

[1] Bilir, L. K. (2013). "Patent Laws, Product Lifecycle Lengths, and Multinational Activity". In: *American Economics Review forthcoming*.

[2] Bosworth, D. and Yang, D. (2000). "Intellectual property law, technology flow and licensing opportunities in the People's Republic of China". In: *International Business Review* 9.4, pp. 453–477.

[3] Cohen, W. M., Nelson, R. R., and Walsh, J. P. (2000). *Protecting their intellectual assets: Appropriability conditions and why US manufacturing firms patent (or not)*. Tech. rep. National Bureau of Economic Research.

[4] Comin, D. and Hobijn, B. (2004). "Cross-country technology adoption: making the theories face the facts". In: *Journal of Monetary Economics* 51.1, pp. 39–83.

[5] Cornelli, F. and Schankerman, M. (1999). "Patent renewals and R&D incentives". In: *The RAND Journal of Economics*, pp. 197–213.

[6] Gallini, N. and Scotchmer, S. (2002). "Intellectual Property: when is it the best incentive system?" In: *Innovation Policy and the Economy, Volume 2*. MIT Press, pp. 51–78.

[7] Gilbert, R. and Shapiro, C. (1990). "Optimal patent length and breadth". In: *The RAND Journal of Economics*, pp. 106–112.

[8] Graham, S. J. and Mowrey, D. C. (2004). "Submarines in Software? Continuations in US Software Patenting in the 1980s and 1990s". In: *Economics of Innovation and New Technology* 13.5, pp. 443–456.

[9] Green, J. R. and Scotchmer, S. (1995). "On the division of profit in sequential innovation". In: *The RAND Journal of Economics*, pp. 20–33.

[10] Hall, B. H., Jaffe, A. B., and Trajtenberg, M. (2001). *The NBER patent citation data file: Lessons, insights and methodological tools*. Tech. rep. National Bureau of Economic Research.

[11] Klemperer, P. (1990). "How broad should the scope of patent protection be?" In: *The RAND Journal of Economics*, pp. 113–130.

[12] Levin, R. C., Klevorick, A. K., Nelson, R. R., Winter, S. G., Gilbert, R., and Griliches, Z. (1987). "Appropriating the returns from industrial research and development". In: *Brookings papers on economic activity* 1987.3, pp. 783–831.

[13] Nordhaus, W. D. (1969). *Invention, growth, and welfare: A theoretical treatment of technological change*. MIT Press Cambridge, MA.

[14] O'Donoghue, T. (1998). "A patentability requirement for sequential innovation". In: *The RAND Journal of Economics*, pp. 654–679.

[15] O'donoghue, T., Scotchmer, S., and Thisse, J.-F. (1998). "Patent breadth, patent life, and the pace of technological progress". In: *Journal of Economics & Management Strategy* 7.1, pp. 1–32.

[16] O'Donoghue, T. and Zweimüller, J. (2004). "Patents in a model of endogenous growth". In: *Journal of Economic Growth* 9.1, pp. 81–123.

[17] Popp, D., Juhl, T., and Johnson, D. K. (2003). *Time in purgatory: Determinants of the grant lag for US patent applications*. Tech. rep. National Bureau of Economic Research.

[18] Schankerman, M. (1998). "How valuable is patent protection? Estimates by technology field". In: *the RAND Journal of Economics*, pp. 77–107.

[19] Schankerman, M. and Pakes, A. (1987). *Estimates of the Value of Patent Rights in European Countries During thePost-1950 Period*.