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ESMT Working Paper

PATENT EXAMINATION AT THE STATE INTELLECTUAL PROPERTY OFFICE IN CHINA

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Abstract

Patent examination at the State Intellectual Property Office in China⁺

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The number of patent applications filed at the Chinese State Intellectual Property Office SIPO grew tremendously over the last decades and the SIPO has become the world's third largest patent office by 2009. In this paper, we provide an overview of the institutional background of patent examination in China. Moreover, we empirically analyze the determinants of the grant lags applicants have to expect at the SIPO. The multivariate duration analysis is based on the population of 443,533 patent applications filed at the SIPO between 1990 and 2002. The average grant lag is 4.71 years with considerable variation across 30 different technology areas. Interestingly, we find that Chinese applicants are able to achieve faster patent grants than their non-Chinese counterparts (even after controlling for various other determinants of grant lags). This might be an indication of a differential treatment of Chinese applicants which would be in violation of Art. 3 (National Treatment) and Art. 4 (Most-favored Nation Treatment) of TRIPS that has been signed by China in 2001.

Keywords: patent system, patent examination, State Intellectual Property Office China, duration analysis

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1. Introduction

Intellectual property rights (IPRs) play a crucial role in protecting ideas and inventions against unwarranted use of third parties. On the micro level, the existence of IPRs can create incentives for innovative activity as they provide an important mechanism for inventors to recoup the cost of developing innovative work (Scotchmer 2004). On the aggregate level, transparent intellectual property laws promote international trade and foreign direct investments (FDI) (Maskus and Penubarti 1995, Smith 1999, Saggi 2000, Branstetter *et al.*, 2007). Against this backdrop – and as a consequence of the People’s Republic of China’s (PRC) strong efforts to promote innovation and international trade after the proclamation of the Open Door Policy in the late 1970s (Maskus *et al.* 2005) – China introduced a system of intellectual property (IP) laws that meets international requirements as specified in the TRIPS agreement. The State Intellectual Property Office (SIPO) was founded in 1985 and plays a central role in China’s IP system as it is responsible for the assignment and enforcement of patent rights in China.¹ It is by now the world’s third largest patent office behind the United States Patent and Trademark Office USPTO and the Japanese Patent Office JPO (in terms of patent applications filed per year, see World Intellectual Property Organization 2009). In 2009 the number of patents applications almost totaled 250.000 filings (World Intellectual Property Organization 2009, Huang 2009).

Given the growing importance of the Chinese market – China is the second largest economy (measured in GDP) world-wide in 2009 – a profound understanding of the Chinese intellectual property system and its governing procedures at the SIPO becomes of utmost importance for numerous stakeholders. First, recent decisions of Chinese IP authorities have demonstrated a lack of transparency creating uncertainty and raise questions whether international applicants are treated in a non-discriminatory way. For instance, the case of the Viagra patent by Pfizer Inc. is a good example highlighting this point. Three years after the patent for the main Viagra ingredient Sildenafil Citrate was granted, the Re-Examination

¹ While China provides legal rights for the protection of various intellectual property this article focuses on the analysis of the Chinese patent system which has been established to protect patent holders against unwarranted use of their technological inventions.

Board of the SIPO revoked its decision in 2004 and caused a stir in the pharmaceutical industry. Following this case, Glaxo Smith Klein PLC has withdrawn a pending patent application for its diabetes drug Avandia that was challenged by three Chinese drug makers. The second reason to study the Chinese patent system are increasing concerns about the consequences of the tremendous growth in patent application filings on grant lags (the duration between the filing of a patent application and the final grant decision). Around the globe, most major patent offices suffer extended backlogs in the examination of patent applications that translate into suboptimal long response times and thereby cause a serious drag on patent applicants (Popp, Juhl & Johnson 2003, Harhoff and Wagner 2009). So far there is no comprehensive study analyzing this potential consequence of an increasing number of patent applications on pendency times at the SIPO in a comprehensive way.

From a managerial perspective it is important for firms to possess detailed information on administrative procedures at patent offices in order to make informed decisions about their IP filing strategies. Existing studies have scrutinized patent examination procedures at major patent offices in Japan (Kotabe 1992), the United States (Johnson and Popp 2003) and in Europe (Harhoff and Wagner 2009). The latter two studies report significant increases in the duration of patent examination as a consequence of strong growth in application figures. Existing studies of the Chinese patent system, however, highlight the tremendous increase of application figures but do not contain comprehensive evidence on the consequences of the rising volumes of applications on the response times at the SIPO.²

In this paper we aim at providing detailed information on patent examination procedures at the SIPO which are important both for policy makers and for managers responsible for corporate IP strategy. In a first step we present an overview of the institutional background and the legislation governing patent examination at the SIPO. Patentability criteria at the SIPO are compared with the criteria applied at other major patent offices before moving on to a description of the procedural steps of patent examination at the SIPO. The second part of the

² One notable exception is Yang (2008) who examines the time between the filing of patent applications and the decision on the application at the SIPO. However, Yang (2008) is not using patent level data and therefore does not allow getting fine grained results of the determinants of grant lags.

paper then presents empirical evidence on patent examination at the SIPO. Based on a comprehensive dataset covering the population of all patent applications filed at the SIPO between 1990 and 2002 we first present descriptive statistics not only on the development of filing figures and the duration of patent examination over time, but also on various patent indicators describing the changing nature of the examination task. On average, grant lags at the SIPO are 4.71 years which is comparable to grant lags at the EPO but significantly longer than at the USPTO. Descriptive statistics are reported for 30 different technology fields in order to provide more detailed evidence on patenting activities at the SIPO. More importantly, we also scrutinize the determinants of the duration of patent examination at the SIPO employing multivariate duration models. Our results suggest that the examination process at the SIPO follows a routine similar to those of other major patent offices, but also indicate some major differences unique to the SIPO. As in other jurisdictions, we find significant variation in examination times across applicant characteristics as well as across technology fields (even after controlling for the complexity of the examination task itself). More strikingly, we find that Chinese applicants achieve faster patent grants than their counterparts from other Asian and non-Asian countries. While this effect might simply be a consequence of language advantages we also find that Chinese applicants achieve disproportionately faster patent grants in areas of high technological relevance for the PRC. Given the fact that we control for various other determinants of process durations in our multi-variate setting this finding raises questions if and to what extent Chinese applicants are positively discriminated against patent applicants with a non-Chinese background. This is especially important as according to Art. 3 (National Treatment) and Art. 4 (Most-Favored-Nation Treatment) of TRIPS (and Art. 18 of the Chinese patent law) applications from foreign and domestic applicants have to be treated equally.

The remainder of the paper is structured as follows: In Section 2 an overview of the institutional background of this study will be given covering both legislative regulations as well as administrative procedures relevant for the filing and examination of patent applications at the SIPO. The importance of process durations for policy makers and patent applicants are discussed along with their potential determinants in Section 3. The empirical part of the paper starts in Section 4 with a short overview of the data sources that have been used for this study and a definition of the variables used in the analysis. In Section 5, the multivariate framework of the duration analysis (the Cox proportional hazards model) is introduced and results from the analysis of more than 400.000 patent applications at the SIPO

between 1990 and 2002 are presented. Section 6 concludes the paper with a summary and a short outlook on future questions to be addressed.

2. Institutional Background

The PRC joined the World Intellectual Property Organization WIPO in 1980 and consequently paved the way for an IPR system that complies with international standards (Bosworth and Yang 2000). Five years later, in 1985, the PRC also signed the Paris Convention for the Protection of Industrial Property and in 1993 the Patent Cooperation Treaty. In becoming a member of the WTO in 2001, China reached another important milestone and adheres to the TRIPS agreement. Today, the PRC has implemented laws for all relevant IPRs such as patents, trademarks and copyrights (Yang and Clarke 2005). All IPRs are filed at branches such as the Patent Office of the SIPO. These offices are responsible for the acceptance, examination and publication of all IPR related documents. Concerning IPR-related disputes, the PRC has established a system of people's courts that enforce IPR laws. This tiered system is divided into the Supreme, Higher, Intermediate and Basic People's Courts. At the Intermediate People's Court level and above, there are specialized divisions for IPR disputes (Wang 2004).

Chinese patent law was enacted by the Standing Committee of the sixth National Congress in 1984 and is the governing legislation for the protection of technological inventions in China. It went into force in 1985 and was amended three times, in 1992, 2000 and 2008. In Art. 2 of the Implementing Regulations of the Patent Law of the People's Republic of China, an invention is defined as "any new technical solution relating to a product, a process, or improvement thereof."³ According to the patent law, patents can be granted to inventions that fulfill the basic requirements of Art. 22: novelty, inventiveness and

³ References to Chinese patent law were taken from the SIPO website; see

http://www.sipo.gov.cn/sipo_English/laws/lawsregulations/200804/t20080416_380327.html, latest visit on

September 5th, 2009.

practical applicability. With the exception of some minor differences, these standards are largely comparable to the regulations of the USPTO and the EPO.

Before the date of filing of a patent application no identical invention or utility model can have been publicly disclosed in the PRC or in any other country in order to meet the novelty criterion.⁴ During the examination of the novelty of an application, examiners have to follow the principle of individual comparison. This means each document of prior reference is compared with the technical solution of the invention under review. In the case of two or more applications on the same subject matter by different applicants, the patent should be granted to the first applicant; this is commonly known as the first-to-file principle. The requirement of inventiveness applies to an invention if it has prominent substantive features and represents a notable progress, compared with the technology existing before the date of filing (state of the art). In order to prove this criterion all relevant prior art is compared to the technical solution of the current application (Ganea and Pattloch 2005). The third criterion – practical applicability – requires that inventions can be made or used and can produce effective results. “Made or used” refers to the commercial production or utilization of an invention. An invention is not seen as practically applicable if it is non-reproducible or if unique natural conditions are necessary.

According to Art. 3 of the Chinese patent law, the patent administration department under the State Council is responsible for the patent examination throughout the country. It receives and examines patent applications and grants patent rights for inventions. There are three major routes to file a patent at the SIPO. The direct way is to file the patent as a Chinese priority filing. Note that a Chinese priority filing is mandatory for inventions made in the PRC by Chinese individuals and entities. Because China adheres to the Paris Convention for the Protection of Intellectual Property, a second filing option is to extend a foreign application by a subsequent SIPO application within the priority year. There also exists a third option, based on the PCT treaty. An applicant may file an international PCT application at any of the defined receiving offices. This allows the applicant to delay the decision as to which jurisdiction he is seeking patent protection for up to 30 months.

⁴ Note that the standards of novelty are part of the current revision of the patent law.

A patent application has to contain a description of the underlying invention, an abstract and the claims supplemented by technical drawings if necessary. The basic application fee of Renminbi Yuan (RMB) 950 is comparable to the online filing fee of EUR 100 at the EPO. After an application has been filed at the SIPO, the examination procedure follows the procedural steps depicted in Figure 1. During the examination, an applicant may amend an application as long as the amendments are within the scope of the initially submitted documents. The applicant may *withdraw* the application at any time during examination. If the invention fulfills the basic formality requirements, it will be classified according to the International Patent Classification IPC by the patent examiner. Eighteen months after the application was filed the document will be published; however, the publication may take place earlier at the applicant's request.

INCLUDE FIGURE 1 ABOUT HERE

Within three years after the filing date the applicant may request a substantive examination of the filed patent invention. If the applicant fails to do so, the application is deemed to have been withdrawn by the applicant. The fee for requesting substantive examination is RMB 2,500. If the examination finds that the invention is not in line with Chinese patent law, the SIPO has to notify the applicant. The applicant will then have the chance – within a certain time limit – to amend the application and to correct the defects that led to the preliminary decision. If the examiners still judge the amended application to be not in conformity with the law, it will be rejected. In contrast, all applications that meet the legal requirements of patentability will be granted. For successful applications the SIPO issues the patent certificate and registers and publishes the granted patent.

If the application is not rejected or invalidated, the patent right will be effective for up to 20 years after the priority date as long as the applicant pays the renewal fees. These annual renewal fees increase over time, from RMB 900 in the first 3 years to RMB 8,000 during the 16th year.⁵ In the case of a refused application, the applicant may request a re-examination by the SIPO Patent Re-Examination Board or directly file a judicial appeal within a certain time limit. Furthermore, the first administrative or judicial decision can be appealed as the Chinese court system always permits at least two instances of appeal. Once a patent is granted, Chinese patent law allows any party to ask the SIPO Patent Re-Examination Board to invalidate the patent. The Re-Examination Board has the option to maintain the patent as granted, revoke the patent or maintain the patent in an amended form. If the person who requested the invalidation or the patent holder is not satisfied with the decision of the Re-Examination Board to maintain or invalidate the patent in dispute, another judicial proceeding can be initiated (Yasong and Connor 2008).

3. The duration of patent examination

Patent applicants face at least three different sources of uncertainty when filing a patent application (Harhoff and Wagner 2009). First, the outcome of the application procedure itself is uncertain as the patent application might be rejected rather than granted. Second, the legal stability of a granted patent right is uncertain as patent rights might be revoked in post-grant validity challenges (Harhoff and Reitzig 2004, Lemley and Shapiro 2005). Third, the duration of patent examination is unknown to the applicant a priori.

The uncertainty regarding the duration of patent examination often is of particular interest to patent applicants. Only once a final decision on a patent application has been reached by a patent office, the uncertainty regarding whether an application will lead to a patent at all right will be relieved. In addition, the claims (and therefore the protective scope) of a patent are often altered during the process of patent examination in order to comply with

⁵ The annuities at the SIPO are lower compared to the EPO. However, the SIPO fees are increasing more steeply up to the 16th year whereas at the EPO the fees only increase up to the 10th year.

requests from the patent examiner. Only once the patent has been granted, the final delineation of the patent is known to the patent holder and to third parties. Patent applicants therefore often prefer shorter examination times over longer durations since investment decisions that depend on patent protection usually take place only after a decision on the granting of a patent and its ultimate delineation has been reached (Regibeau and Rockett 2010). Moreover, early patent grants are beneficial as patent grants make licensing deals more likely to occur (Gans, Hsu and Stern 2009) and facilitate raising of VC funds for start-up firms (Haeussler, Harhoff and Müller 2010). As a result, the ability to obtain fast patent grants is also considered as a valuable organizational capability in the strategy literature (Reitzig and Puranam 2009).

Against this backdrop, firms need to have a profound understanding of the procedures and the determinants of pendency times in order to optimally plan their patent filing strategies. Existing studies identify various determinants of grant lags at international patent offices. Popp *et al.* (2003) analyze patent data from the USPTO between 1976 and 1996. Their findings show that variation in grant lags is largely driven by cross-technology area variation and is a consequence of lacking resources in technology fields with strong growth rates of patent applications. In their study, applicant characteristics and applicant origin were no major determinants of the duration of patent examination. Also using data on US patents (but only in the domain of genetically modified crops) from 1983 to 1999, Regibeau and Rockett (2010) analyze the relationship between the importance of an invention and grant lags. Their empirical findings suggest that the length of the examination process decreases as the industry advances from the beginning of a new innovation cycle to a more mature phase. Moreover, after controlling for the phase of an industry cycle grant delays decrease when the importance of innovations increases. In a broader setting, the duration of patent examination at the European Patent Office between 1982 and 1998 is studied by Harhoff and Wagner (2009). They analyze various determinants of examination duration and – unlike related studies cited above – also consider examination outcomes different from patent grants, i.e., withdrawals and refusals. In their study, they demonstrate that examination duration is influenced by endogenous applicant behavior and scrutinize what levers can be employed by applicants to influence the duration of examination. For instance, Harhoff and Wagner (2009) show that for valuable applications patent applicants can speed up the patent examination if they expect a patent grant. Contrary, applicants drag out withdrawals and rejections in case of valuable applications. In a comparative study of the USPTO and the JPO for the period between 1963 and 1988, Kotabe (1992) finds that the Japan Patent Office has shorter

pendency periods for applications of domestic applicants, whereas at the USPTO, domestic applicants achieve higher grant ratios. Kotabe (1992) interprets the differences in grant ratios and grant lags of domestic and foreign applicants as an act of discrimination of patent applicants at the patent offices. A similar argument has been made by Jensen et al. (2006) who compares patent grant decisions at the EPO, JPO and the USPTO and find inconsistencies across the three offices.⁶

Despite the growing importance of the SIPO there is little evidence on the determinants of the duration of patent examination in China. A notable exception is Yang (2008) who compares the duration of patent examination at the USPTO and the SIPO for the years 1985 to 2002. Employing a simple lagged regression approach she finds that the SIPO positively discriminates domestic applicants over foreign applicants in the sense that Chinese applicants achieve faster grant decisions at the SIPO. While this finding is remarkable in itself it should be noted that Yang's (2008) data contain information on grant lags and the nationality of the applicants only and therefore does not allow controlling for alternative determinants that have been shown to influence examination times in previous literature. Moreover, the lagged regression approach chosen by Yang (2008) does not use grant lags of individual patent applications but only compares the number of applications relative to the number of grants in different cohorts. In this paper, we consider a wider set of explanatory variables that have so far not been explored in existing studies of the SIPO and employ a micro-econometric approach that operates on the patent level. Additional to the question whether domestic (Chinese) applicants achieve faster patent grants than foreign applicants, we are also interested in drawing a more detailed picture of the examination procedure at the SIPO. In particular, we are interested the effect of further applicant characteristics as well as cross-sectoral differences on grant lags.

Regarding applicant characteristics, we expect larger applicants to achieve faster patent grants due to learning and scale effects. This hypothesis is based on by previous evidence in Harhoff and Wagner (2009). Many multinational corporations have specialized IP departments in the PRC, which contribute to a better understanding of the Chinese IPR

⁶ For a critical comment see Katznelson (2007).

system giving them an advantage over smaller applicants.⁷ In addition to experience and scale effects, it is equally important to consider how important the Chinese market is for an applicant. Applicants with a clear focus on the Chinese market can be expected to possess superior skills in managing the application process at the SIPO and should therefore be able to achieve faster patent grants.

In addition to applicant characteristics, it is an important question to what extent variation in grant lags can be explained by structural differences across different technology areas. Structural differences can arise for various reasons: Previous findings from Johnson and Popp (2003) and Harhoff and Wagner (2009) suggest that sectoral differences regarding the workload situation of examiners have a considerable impact on the duration of patent examination. For this reason we distinguish 30 different technological fields according to the OST-INPI technology classification (OECD 1994). We expect fields with strong growth of application figures to be characterized by longer examination lags since patent offices often have problems in increasing their workforce fast enough to cope with increasing workload. A further source of cross-sectoral variation in China might be due to different levels of prioritization of different technology sectors by governmental plans. In fact, the Chinese Communist Party sets the basic course for the country's economic development within recurring five-year plans including national science-, research- and technology-related targets. For the period between 2006 and 2011 the Chinese government has stipulated detailed high-tech projects in advanced computing, biomedicine, satellite application and other technology areas typically related to high patent activities. While these measures mainly affect local R&D activities, the Chinese government also takes influence on the technology transfer of foreign companies to the PRC. The Catalogue of Industries for Guiding Foreign Investment classifies foreign investment activities into encouraged, permitted and restricted activities areas. As a consequence, different levels of technology are deployed by foreign firms to their affiliates. We therefore expect that patents in technology areas that are of special interest to the Chinese economy will be processed more quickly by the SIPO than in less important studies.

⁷ Siemens is a striking example of this practice. See

http://w1.siemens.com/innovation/en/publikationen/publications_pof/pof_spring_2002/patent_site.htm, latest visit on July 12th, 2009, for more information.

Previous literature argued that patent examination is characterized by significant differences due to the country of origin of patent applicants (which is interpreted as discrimination, see Jensen et al. 2006). In our multivariate study, we will scrutinize whether Chinese applicants are positively discriminated in the sense that they achieve faster patent grants than their non-Chinese counter-parts.

4. Data Description

a. Data sources and variable definitions

Our empirical study is based on PATSTAT which is a worldwide patent database provided by the EPO.⁸ The dataset used for this study contains information for patent families based on the April 2008 version of PATSTAT which contains a total of 443,533 patent applications at the SIPO between 1990 and 2002.⁹ For those patent applications two groups of patent families were extracted and additionally analyzed: (i) SIPO patent applications with equivalent filings at the USPTO and (ii) SIPO patents with equivalent filings at the EPO. Identifying USPTO and EPO equivalents allows us to augment the initial data with patent indicators such as patent citations and references (see below) which are not reported for SIPO applications within PATSTAT or other databases. We will include those measures in the empirical analyses as (imperfect) proxies for the characteristics of the SIPO applications. Out of all 443,533 SIPO applications there are 190,429 filings with USPTO equivalents, the group

⁸ While there is a multitude of data sources on patent applications filed at the SIPO we chose to use PATSTAT for this study as it seems to be the most comprehensive database available at the moment for Chinese patents. For more information on PATSTAT see <http://www.epo.org/patents/patent-information/raw-data/test/product-14-24.html>, latest visit September 3rd, 2010.

⁹ As we include the number of citations a patent receives within 5 years after its application we have to limit our observation period to the years before 2003. Moreover, the restriction to those years reduces the number of applications still pending a grant decision in our sample.

of SIPO applications with EPO equivalents comprises 188,388 observations. Based on this data we compute variables on the level of the individual patent, on the applicant level and on the level of the technology area a patent application falls into.

Dependent variable

Grant lag. Grant lag is defined as the duration in years between the date of filing at the SIPO and the final decision to grant a patent on the respective application. In PATSTAT the publication of the grant decision can be identified¹⁰ and we are therefore able to compute grant lags on a reliable basis.¹¹ It should be noted that for patents without a grant decision prior to April 2008 we cannot distinguish applications that are still under examination from applications where examination ended by a rejection of the examiner or a withdrawal from the applicant.

Independent variables

Applicant characteristics

Size (Global annual patent applications per applicant). Experience and economies of scale also apply to patenting activities. As a measure of size, the number of global patent applications per applicant is computed on an annual basis based on all patent families contained in PATSTAT for a given applicant. It can be assumed that the marginal learning

¹⁰ The SIPO classifies patent documents as Unexamined Patent Publication (A – Gōngkāi), Examined Patent Publication before 1993 (B – Shěnding Gōnggào) and Granted Patent Publication since 1993 (C – Shòuquán Gōnggào).

¹¹ Unfortunately, it is not possible to infer whether a patent application has been withdrawn by the applicant or rejected by the examiner. Similar to the studies of the USPTO (Popp, Juhl and Johnson 2003, Regibeau and Rockett 2010), it is impossible to distinguish whether a patent application is still pending or whether it has already been withdrawn or rejected. Reducing the observation period to the years before 2003 allows us to reduce the rate of pending cases in the sample.

effect of additional patent applications per year is a decreasing function. Therefore, the number of global annual patent applications per applicant is taken in log form.

Applicant's China focus. We define the China focus of an applicant's patenting activities as the number of patent applications filed in China in a certain year relative to all patent applications filed within the same year. We assume that a higher China focus of an applicant's patenting activities leads to shorter grant lags as these applicants can be assumed to have more experience in dealing with the SIPO.

Country of origin. We control for the country of origin of patent applicants. In particular, we distinguish most important Asian applicants from the remaining applicants (predominantly from the US and Europe) by including dummy variables for Chinese, Japanese and Korean applicants into the regression analyses treating non-Asian applicants as our reference group.

Variables characterizing technology areas

Revealed Technological Advantage RTA. Technology areas are of varying importance for nations. Soete and Wyatt (1983) propose the Revealed Technological Advantage index (RTA) as a measure of a nation's advantage regarding its patenting activities relative to other nations.¹² Based on their work we define China's Revealed Technological Advantage (RTA_CN) in technology area i and year t as

$$RTA_CN_{it} = \frac{\frac{PAT_CN_{it}}{\sum_i PAT_CN_{it}}}{\frac{PAT_{it}}{\sum_i PAT_{it}}} \quad (1)$$

¹² The RTA index has been applied frequently in the management and economic literature (see, e.g., Patel and Pavitt 1987, Paci and Usai 2000 and Cantwell and Iammarino 2000).

where PAT_CN_{it} is the number of patents grants to Chinese applicants in technology area i in year t and PAT_{it} is the number of all patent grants at the SIPO. RTA_CN being larger than one indicates that China has a relative technological advantage over other nations in a given technology area i since a larger share of patents granted to Chinese applicants falls in that area than on average.

Growth of applications in a technology area. Harhoff and Wagner (2009) demonstrate that the duration of patent examination is an increasing function of the workload (number of pending patent applications per patent examiner) at the patent office. Unfortunately, we do not have detailed information on the number of patent examiners at the SIPO over time. In order to capture workload effects on the duration of patent examination we compute the annual growth rate of patent applications filed in a technology area distinguishing 30 fields. Since the number of examiners should be rather inflexible in the short run, the growth rates of applications can be expected to be directly related to the workload situation at the SIPO. We expect higher growth rates of application filings to be associated with longer durations of patent examination.

Patent characteristics for all SIPO patent applications in our sample

Family size. According to the Paris Convention for the Protection of Industrial Property, applicants can use their priority patent applications to file further applications in other countries within the priority year. We compute the family size of a patent as the number of states in which an application was filed. For the two subgroups of SIPO patent applications with equivalents in the US or at the EPO, the minimum family size is greater than one. Harhoff *et al.* (2003) pointed out that family size is one indicator of the monetary value of patent rights.

PCT application. A dummy variable indicates whether a patent family contains an international patent application. Harhoff and Wagner (2009) find that grant lags for patents originating from PCT applications are significantly longer than those for non-PCT applications for institutional reasons.

Number of International Patent Classification (IPC) assignments. The IPC classification scheme is used by the SIPO to classify each patent application into one or more technology areas. Lerner (1994) applied the total number of IPC subclasses a patent is assigned to as a proxy for the breadth of patent protection and found that patent value is

higher if a patent is classified by more IPC classes. We use the number of different 4-digit IPC subclasses a patent has been assigned to as a measure of patent scope and complexity.

Additional information available only for SIPO patents having USPTO or EPO equivalents

References to patent literature/ non-patent literature. During the process of patent examination the patent examiner includes references to older patents and to non-patent literature that contain the state of the art relevant to determine the novelty of an invention (Harhoff, Hoisl and Webb 2006). For the subsamples of SIPO applications with USPTO or EPO equivalents we include the number of references contained in their USPTO/ EPO equivalents as a proxy for the complexity of the examination task the patent examiner at the SIPO faces. We include both the number of references to previous patents and the number of references to previous non-patent literature. In both cases, it can be expected that a larger number of backward references requires more time and effort from the examiner and should therefore be related to longer pendency times (Popp *et al.*, 2003, Harhoff and Wagner 2009).

Forward citations. Along with information on patent and non-patent literature references, it is of also of interest how frequently a patent is cited by other patents. Numerous studies established a close link between the number of citations a patent receives and the commercial value of the underlying invention (Trajtenberg 1990, Harhoff et al. 2003). Since early applications have the opportunity to be cited more often, the number of EPO and USPTO forward citations in this study is limited to citations made within five years of the application date.

b. Descriptive Statistics

Before providing results from the multivariate analysis of grant lags at the SIPO, we present descriptive statistics regarding filing trends at the SIPO between 1990 and 2002. As shown in Figure 2, the number of patent applications and grants increased steadily in recent years with a steep incline of the application figure after China's joining of the WTO in 2001.

INCLUDE FIGURE 2 HERE

INCLUDE FIGURE 3 HERE

Between 1990 and 2002, the average grant rate for all SIPO patent applications has been 52.7% of all applications. However, as Figure 3 clearly demonstrates there is considerable variation in the grant ratio among applicants from different nations which is in line with previous findings from Yang (2008). The comparison of the most important four foreign countries at the SIPO demonstrates that Japanese and South Korean applicants show considerably higher grant rates relative to applicants from the US, Germany or other non-Chinese countries.¹³ Interestingly, the grant rate for Chinese applicants increased from only 23% in 1990 to more than 50% in 2002. It should be noted though, that a separate analysis for SIPO patents that were also filed at the EPO or USPTO shows clearly higher grant ratios at the SIPO (between 60% and 90% for different years).

Figure 4 presents the distribution of grant lags for SIPO patent applications that have been granted by April 2008. There are significant but only small differences in grant lags

¹³ More than 96.5% of the applications at the SIPO between 1990 and 2002 were filed by Chinese, Japanese, South Korean, US, German or other European applicants.

compared to the subgroups of SIPO patents with USPTO/ EPO equivalents.¹⁴ For example, while all SIPO patents have an average grant lag of 4.71 years, the US and EP subgroups show only slightly longer examination periods of 5.08 and 5.20 years, respectively. This can be explained by a higher share of foreign applicants in the two subsamples as only a small number of foreign applicants file their priority applications in China without equivalent filings at the USPTO/ EPO.

INCLUDE FIGURE 4 HERE

Differences across technology areas are listed in Table 1. The total of number of patent applications between 1990 and 2002 varies from around 1,000 applications in Nuclear Engineering or Space Technology and Weapons to more than 30,000 applications in areas such as Electrical Machinery or Pharmaceuticals and Cosmetics. Interestingly, these figures coincide with areas of the Chinese economy that have been declared as areas of high importance or are restricted due by governmental guidelines. This interpretation is supported by the Revealed Technological Advantage index. (Note that indices being larger than 1 indicate a relative advantage of Chinese applicants in those areas relative to non-Chinese applicants.) The last two columns of Table 1 present the Revealed Technological Advantage as defined above and a matching of the 30 OST-INPI technology areas with the revised Catalogue of Industries for Guiding Foreign Investment 2004. The areas Agriculture and Food Chemistry as well as Agriculture and Food Processing, for instance, exhibit the highest RTA values of all industries. This is in line with findings of Maskus (2004) and shows that a strong effort of the Chinese government trying to control agricultural industries in order to

¹⁴ Descriptive statistics for the two subsets of SIPO applications with USPTO/ EPO equivalents are not reported here but can be obtained from the authors upon request.

secure food supply and to maintain a certain level of competition. Further interesting characteristics for the Agriculture and Food Chemistry industry can be found in the very low grant ratio of 34.14% and a very short average grant lag of 4.3 years for inventions in the realm of patentable subject matter. Also the area of Space Technology and Weapons (being classified as a restricted industry by the investment catalogue) is an area with an RTA index above 1.00 while only containing 950 patent applications. In contrast, encouraged industries with low RTA values and high applications volumes such as Semiconductors and Electric Machinery and Electrical Engineering show high grant ratios and grant lags close to the average of 4.7 years. This might be a result of strong patenting activities of multinational enterprises such as NEC, Toshiba, Samsung or Sharp in the semiconductor industry following a structured IPR process.

Turning to the grant lags we find large variation across technology fields. For instance, within the area of Materials and Metallurgy we observe shortest grant lags, with an average of 4.25 years, while filings in Biotechnology are granted only after 5.24 years. It is noteworthy that there is a significant negative correlation (-0,21) between the duration of patent examination and the Revealed Technological Advantage of Chinese applicants indicating that patent examination takes less time in areas where Chinese applicants have a relative advantage. In the multivariate analysis of the subsequent section we try to disentangle whether this is simply a consequence of a high share of Chinese applicants (who achieve faster patent) of whether examination in those areas requires less time also after controlling for the origin of the applicants.

INSERT TABLE 1 HERE

Table 2 reports most important trends of patenting activities at the SIPO on an annual basis. Strikingly, the grant ratio over time exhibits the shape of an inverted U-curve. Starting in 1990, grant ratios increased up to the mid-1990s and decreased slightly afterwards. The examination times are characterized by a similar development. Beginning with an average

grant lag of 5 years, the examination time for granted patents extends to 6 years in the mid-1990s and decreases to about 4 years in 2002.¹⁵

Moreover, a closer look at patent applications at the SIPO reveals similar patterns that have been observed at other patent offices, too. In particular, the share of PCT applications rose continuously from 7.16% in 1990 to more than 30% in 2002. A similar development has been reported for the EPO in Harhoff and Wagner (2009). Not surprisingly, there has been a strong increase after 1993 when China signed the PCT treaty and made it easier for applicants to transfer PCT applications to the SIPO. In 2002, more than 30% of all SIPO patents and more than 60% of patents within the US and EP groups had a PCT filing within their patent family. The number of IPC assignments has been quite stable over time with an average of 4.99 different IPC classes on patent applications. The average yearly number of global patent applications by an applicant increased steadily after 1993 and exhibited a steeper increase after 2001 reflecting a general surge in patenting activities after that year around the globe.

INSERT TABLE 2 HERE

¹⁵ The decrease in grant lags for SIPO patents might also be caused by the censoring of data. A shortening of the observation period from 1990 to 2000, however, shows no considerable change in the findings in this study.

5. Duration Analysis

a. Model Specification

Duration analysis is a commonly used statistical method for modeling the time until a certain event occurs. It has been applied to study the duration of patent examination in a recent study by Harhoff and Wagner (2009). In duration models the survival function can be written as

$$S(t) = \Pr(T \geq t) \quad (2)$$

where T denotes a non-negative random variable representing the time until an event occurs. While the survival function describes how the risk for a certain event changes over time, the hazard function measures the instantaneous failure rate, also called the age-specific failure rate. This rate represents the probability of an event at time t conditional on “survival,” or no occurrence of an event up to that time

$$\lambda(t) = \lim_{\Delta t \rightarrow 0} \frac{1}{\Delta t} \Pr(t \leq T < t + \Delta t | T \geq t) \quad (3)$$

Since we are not interested in merely computing the survivor function, but in analyzing the relation between survival times and a set of covariates, we introduce explanatory variables in a linear model where the hazard rate $\lambda_i(t)$ for observation i is given by

$$\lambda_i(t) = \exp(h(t) + \beta_1 z_{i1} + \dots + \beta_p z_{ip}) \quad (4)$$

where the variables z_1, \dots, z_p are covariates. In this case, however, it would be necessary to specify a baseline hazard rate $h(t)$ as the point of reference if all covariates equal zero. Cox (1972) introduced the proportional hazard model in which the hazard rate $\lambda_i(t, z)$ of observation i is given by

$$\lambda_i(t, z) = \lambda_0(t) \exp(\beta_1 z_{i1} + \dots + \beta_p z_{ip}) \quad (5)$$

with $\lambda_0(t)$ being an unspecified function and the covariates z_1, \dots, z_p entering linearly. In cases where there is only one binary covariate vector z_1 , the hazard rate is $\lambda_0(t)$ if $z_1 = 0$. When $z_1 = 1$ the hazard rate equals

$$\lambda(t, z_1) = \frac{\lambda_0(t) \exp(\beta_1)}{\lambda_0(t)} \quad (6)$$

Dividing the hazard rate by $\lambda_0(t)$ results in the exponentiated coefficient β_1 . Accordingly, the hazard rate arises from the comparison of observations with $z_1 = 1$ to those with $z_1 = 0$. With continuous covariates, the hazard rate represents the change in the age-specific failure rate associated with a one-unit increase of this variable. When more than one covariate is incorporated into a model, the hazard rate β_i measures the risk of failure across time for observations that differ on z_i (Kalbfleisch and Prentice, 1980). The Cox's proportional hazard model will be applied in the multivariate analysis of SIPO patent grant lags in this study.

Moreover, it should be noted that due to the data restrictions described above we only observe the duration of patent examination for patents that have finally been granted by the SIPO. For patents with no grant decision prior to April 2008 we are not able to distinguish whether examination is still going on or whether the examination already has been terminated by a withdrawal or by a rejection of the application. Therefore, we have to exclude all observations without a grant decision from the survival analysis as it is not possible to know whether and when non-granted applications left the risk pool.¹⁶ It is not unlikely that granted patents are systematically different from patents that are not-granted which might introduce bias to the estimates in the proportional hazards model. In order to validate the findings from the survival analysis we also report findings from a Heckman selection model where the first stage is the selection whether we observe a patent grant or not and the second stage contains

¹⁶ If we observed withdrawals and rejections we could treat those applications either as censored cases or estimated competing risks models to determine the influence of the independent variables on the duration of examination leading to the different outcomes (grant, withdrawal, rejection).

the duration of patent examination as a second stage as a robustness test of our duration analysis (Heckman 1979).¹⁷

b. Results and discussion

In the following section, we present the results from the multivariate Cox proportional hazard models and the Heckman selection robustness checks. For both models, the estimations were carried out for all SIPO patent applications and the two subsets of SIPO patents with USPTO/ EPO equivalents for the period from 1991 to 2002. Patent applications from 1990 has been excluded from the regressions as we compute the growth rate of applications filed in a given technology area starting only from 1990 on. For the subsets, we estimate the same model specifications as for the population of all SIPO patents but additionally estimate a further model that also includes further patent characteristics. In a first step, we estimate a simple specification containing only base effects of the explanatory variables. In a second step, we scrutinize whether there is discrimination across applicants from different countries in areas that are of particular relevance to China. In order to do so, we interact the Revealed Technological Advantage with the country dummy variables. Further, all regressions contain dummy variables for the application year and the 30 technology areas. For reasons of brevity we do not report the estimation results for those dummy variables here.¹⁸

Table 3, presents the coefficients from Cox proportional hazard regressions. Coefficients being larger than zero increase the hazard rate and are therefore associated with shorter examination periods and vice versa. Column (1) and (2) contain results for the population of

¹⁷ Note that the second stage of the selection model is an OLS-type regression which assumes a normally distributed dependent variable. Strictly speaking, the duration of patent examination is not normally distributed as it is by definition non-negative. However, apart from this conceptual violation of the normality assumptions Figure 2 suggests that the normal distribution is a good first approximation for the observed duration data.

¹⁸ Additional information for the estimation results of the technological area and year dummies are available upon request.

patent applications at the SIPO between 1991 and 2002. Most of the estimates are highly significant and carry the expected signs. Regarding applicant characteristics we find that larger applicants achieve faster patent grants than smaller applicants which is in line with findings by Harhoff and Wagner (2009). Moreover, applicants that have a stronger focus of their patenting activities on China also achieve faster patent grants which confirms our expectation discussed in Section 3. Column (1) of Table 3 reveals that Asian applicants achieve significantly faster patent grants at the SIPO than applicants from the reference group (mainly US and European applicants). It is noteworthy that Chinese applicants can expect by far the fastest examination of their applications followed by Korean applicants. The fact that Chinese applications are processed fastest by the SIPO opens up the question to what extent Chinese applicants receive preferential treatment by the SIPO. Since we are controlling for other determinants of the duration of patent examination we cannot rule out the hypothesis that Chinese applicants are in fact positively discriminated against applicants from other nations – a finding that bears relevance as preferential treatment based on nationality would be in violation of Art. 3 (National Treatment) and Art. 4 (most-favored nation treatment) of TRIPS that has been signed by China in 2001.¹⁹

Turning to characteristics of technology fields, our results confirm the expectation that higher growth of patent applications is associated with longer examination lags. Moreover, Column (1) also shows that the duration of patent examination in areas with high RTA indices is shorter than in other areas. A more detailed analysis of the effect of the RTA index on examination durations shows that the acceleration of examination is mainly driven by Asian applicants (see Column 2): Once we interact the dummy variables for Asian applicants with the RTA-index we find that Asian applicants enjoy faster procedures in areas characterized by

¹⁹ Ideally, a further test should be conducted to scrutinize whether this finding is due the applicant's country of origin or whether patents listing at least on Chinese inventor that have been filed by non-Chinese applicants are characterized by similar durations. However, our sample of 443,533 patent applications contains only 510 patent applications with at least one Chinese inventor that have been filed by non-Chinese applicants (compared to 178,144 applications with Chinese inventors filed by Chinese applicants). Therefore, we refrain from an econometric test.

high RTA indices over applicants from the reference group. Again, Chinese applicants have the largest advantage. At the same time, the base effect of the RTA index vanishes once controlling for interaction effects indicating that SIPO does not prioritize certain areas but that acceleration seems to be mainly driven by the applicant's nationality. Interestingly, once controlling for the interaction effects between RTA and country dummy variables we find that Korean and Japanese applicants achieve faster grants only in areas of high RTA indices but not in general. Only Chinese applications are systematically processed faster across all areas faster than applications filed by applicants from other nations. Note that those findings have been obtained controlling for important patent characteristics that influence grant lags. We find that PCT applications are characterized by significantly longer examination times which can be explained by institutional characteristics of the PCT application path (Harhoff and Wagner 2009). Moreover, the higher the number of IPC classes on an application the longer the duration of patent examination. We argue that those applications are more complex to examine as they require a broader prior art search. The effect of family size reduces duration significantly but only to a negligible magnitude.

As explained above, publicly available data sources do not provide information on the number of references contained in SIPO patent documents. Nevertheless, it is a well-established fact that the number of references is a significant determinant of grant lags as a higher number of references reflects a time-consuming search for prior art. In order to control for this fact, we additionally provide estimation results for subsets of SIPO patents where we include the number of references and forward citations from their EPO/ US equivalents as a proxy for the complexity of the examination task. Columns (3) – (5) contain results for the subset of SIPO patents with EP equivalents and Columns (6) to (8) results for SIPO patents with US equivalents. Adding further controls for the complexity of patent examination does not change most of the findings described above. The effects of the patent characteristics remain largely unchanged with the exception of the effect of family size which loses its significance (but has already been small in magnitude in the full sample). Technology area effects such as the growth rate of application filings and the RTA index remain stable. Regarding country effects we find some variation for the different subsamples. For patents with EP equivalents, we find only small changes compared to the results from the overall sample (see Column 5): Chinese applicants enjoy fastest patent grants followed by Korean applicants. However, differing from the findings from all SIPO applications, Korean applicants achieve even faster patent grants than their Chinese or Japanese counterparts in fields of high importance to the Chinese innovation landscape. Regarding the subsample of

SIPO patents with US equivalents, we also find differences to all SIPO patents only regarding the effect of applicants' nationalities: While Chinese applicants enjoy fastest patents grants across all fields (see base effect of Chinese applicant in Column 8), they do not achieve faster grants in areas with higher RTA indexes. Compared to the reference group Korean applicants in turn achieve faster grants in all areas and achieve additional acceleration of their examinations in important areas.

Table 4 contains the result from the second stage of a Heckman selection model (Heckman 1979) that we estimate as a robustness test. The first stage of this model is a probit regression explaining for what patents a grant decision is observed while in the second stage the duration of patent examination is regressed on our explanatory variables. Identification in the first stage is based on family size.²⁰ Since this regression is a standard linear regression estimated coefficients larger than zero indicate longer grant lags and vice versa. The results presented in Table 4 largely confirm our findings from the Cox proportional hazards model. The duration of patent examination is significantly increased in areas of strong application growth and low RTA indices. On the patent level, we observe that PCT applications require more time to reach a grant decision and that examination is longer for patents with a higher number of references and a higher number of IPC classes. Also the pattern of examination times for different nationalities are comparable in the selection in the selection models: Chinese applicants achieve fastest patent grants overall and Korean applicants manage to shorten the duration of patent examination in fields of high RTA indexes more than applicants from other nations. Based on those results, we are confident that the results derived from the duration models are not prone to selection effects from the exclusion of patents with no grant decision in the observation period.

²⁰ Note that the effect of family size on the duration of patent examination is limited. However, as the results from the selection models show it is a significant determinant of the selection. We do not report the results from the first stage of the Heckman models but we are happy to provide them upon request.

6. Conclusion

The People's Republic of China experienced rapid economic development over the past decades. Along with the fast economic growth China established a transparent system of IP laws and joined related international treaties such as TRIPS and PCT. Patent applicants from all over the world seek patent protection in China and as a consequence the number of patent applications at the SIPO has risen tremendously. In 2007, almost 250,000 applications for patent inventions were filed at the SIPO making it the third largest patent office in the world. In this article we presented a short overview on the most important features of the regulations governing the process of patent filing and examination in China. It has been shown that those procedures largely resemble international standards and do not create structural barriers for international applicants. However, as our empirical study demonstrated Chinese applicants achieve faster patent grants than other applicants.

The analysis of the population of all SIPO patent applications filed between 1990 and 2002 revealed interesting insights on the determinants of the duration of the examination of patent applications leading to a patent grant. Most interestingly, we find that Chinese applicants achieve faster patent grants when compared to applicants from other countries, in particular to non-Asian applicants. While this effect might be due to a language advantage of domestic applicants, it might also be a sign of positive discrimination of Chinese applicants. Finding that the speed advantage of domestic applicants is more pronounced in areas that are of high importance to the Chinese economy does not alleviate this concern. While we are unable to ultimately answer the question whether discrimination of applicants is taking place, further research is warranted. This is particularly important since according to Art. 3 (National Treatment) and Art. 4 (Most-Favored-Nation Treatment) of TRIPS (and Art. 18 of the Chinese patent law) applications from foreign and domestic applicants have to be treated equally – a regulation that seems to be contrasted by our findings.

Our findings also bear relevance to practitioners and managers responsible for IP filing strategies. For the first time, we provide descriptive statistics on patent grant delays in China based on the population of all patent filings from more than a decade of SIPO's operation. The insights we derive from these data bear relevance for IP managers as they are now able to better plan their filing strategies taking into account average pendency rates. In addition to these descriptive statistics, we also present more fine-grained information on the determinants of the grant delays applicants have to expect. For instance, we quantify the time advantage of applicants that are more experienced in dealing the SIPO and are therefore able to achieve

faster patent grants. Also, applications filed by applicants with a clear focus on the Chinese market as well as by applicants that have filed a high number of applications at the SIPO are characterized by shorter duration of patent examination. Taken together, these findings imply that having experience in dealing with the SIPO can significantly reduce the grant lags to be expected. For firms having no or little experience in dealing with Chinese patent authorities it might therefore pay-off to contract an external law firm that is experienced in dealing with the SIPO.

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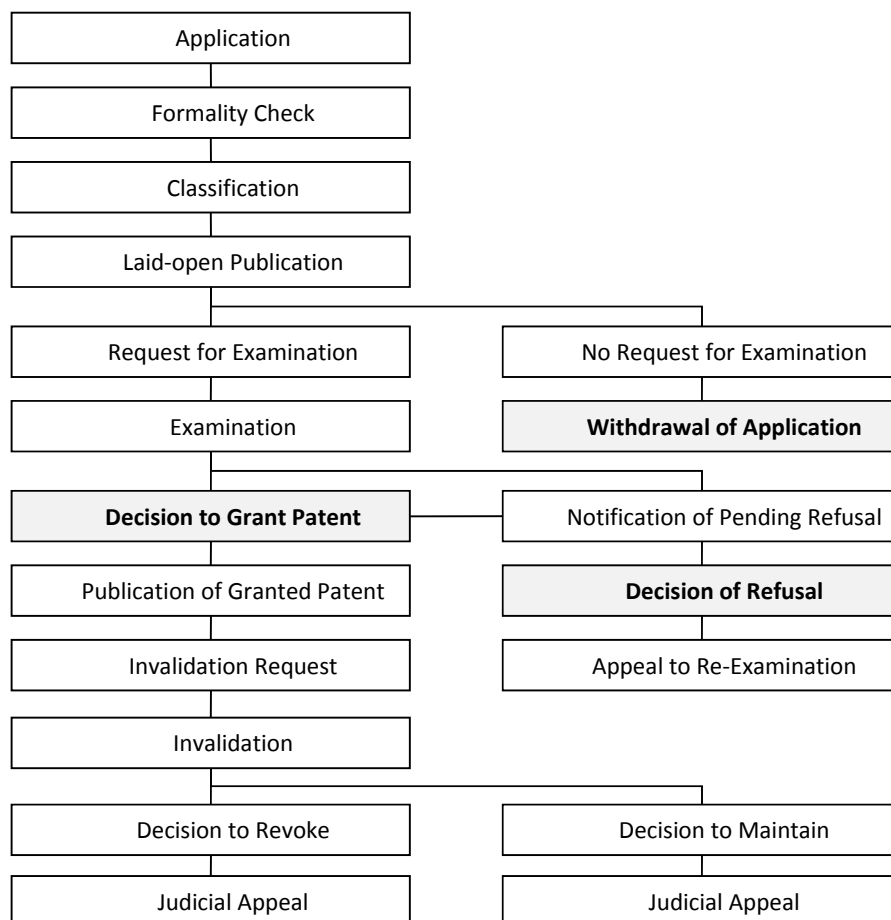


Figure 1: Patent examination process at the SIPO from 2001 onwards.²¹ Final outcomes of the examination procedure are shaded in grey.

²¹ According to Yasong and Connor (2008) and EPO: <http://www.epo.org/patents/patent-information/east-asian/helpdesk/china/grant.html>, latest visit on December 19th, 2008. In addition to the described examination path, applicants may withdraw their application any time before a patent is granted.

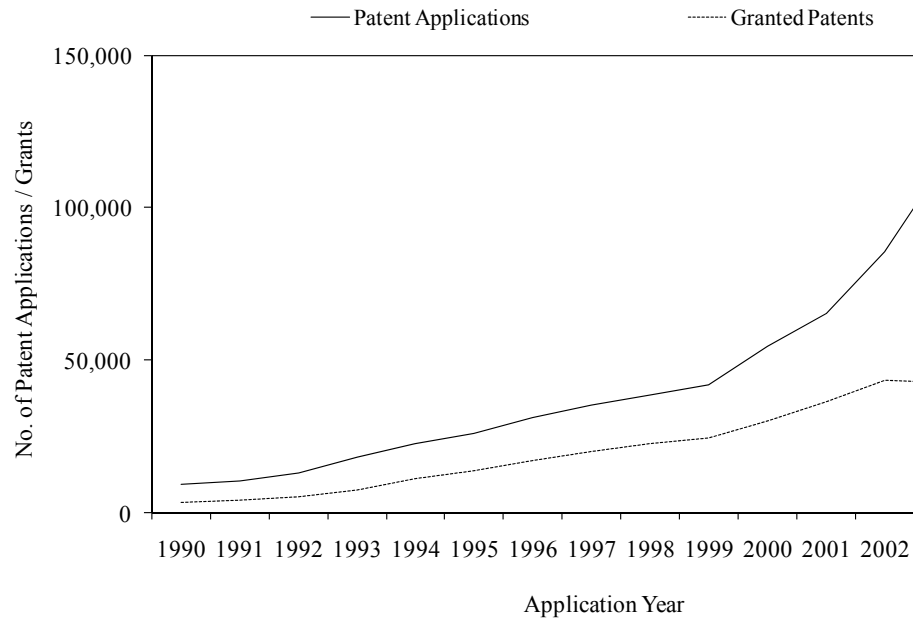


Figure 2: SIPO patent applications and grants (1990-2002).

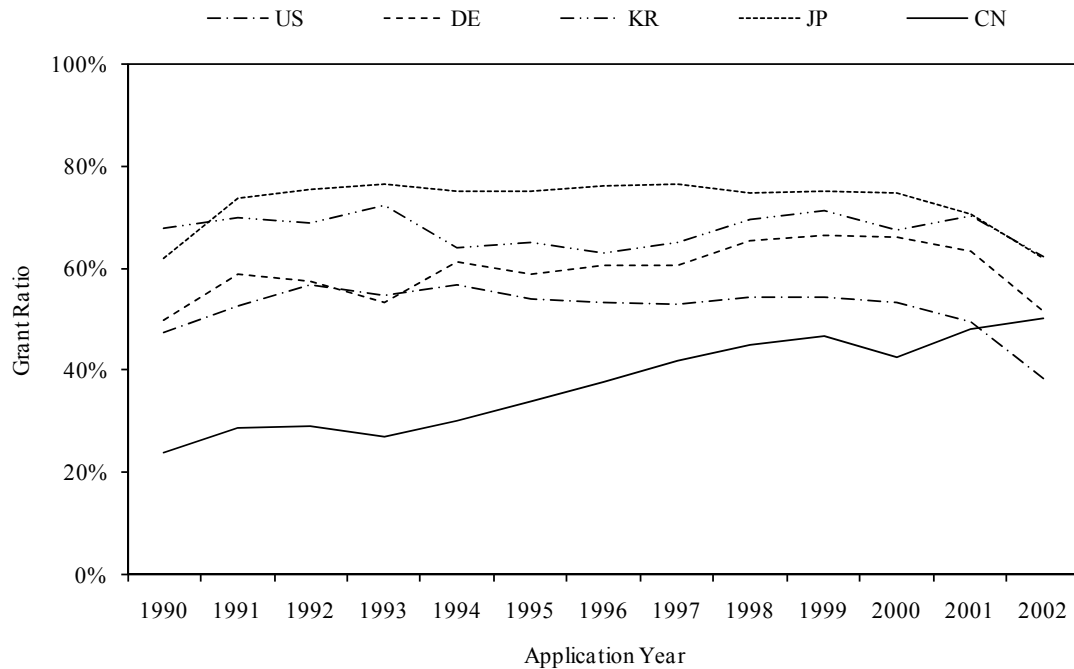


Figure 3: Grant ratios according to applicant's origin (all SIPO applications).

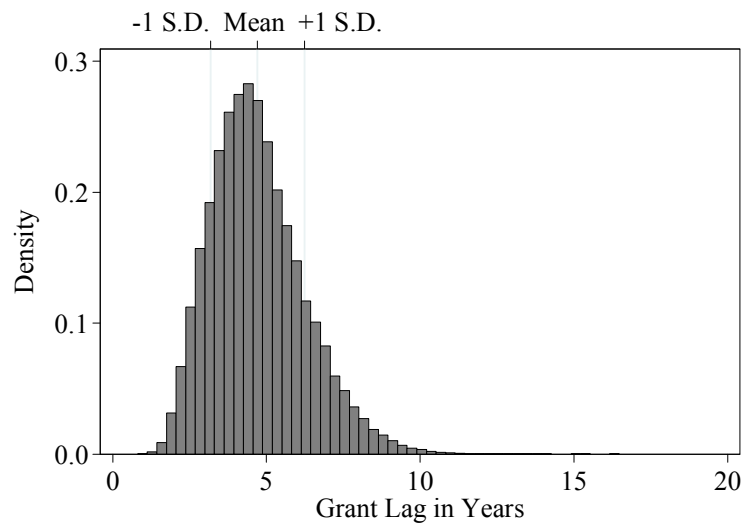


Figure 4: Probability density function of SIPO patent grant lags.²²

²² Due to the right-censoring of SIPO patent grants within this dataset, patents with a longer examination time up to 10 years were typically filed in the early 1990s.

Area Name	No. of Patent Applications*	No. of Granted Patents*	Grant Ratio %	Min. Grant Lag in Years	Average Grant Lag in Years	Max. Grant Lag in Years	Chinese RTA Index	FDI Catalogue 2004**
Electr. Machinery, Electrical Energy	30,323	18,612	61.38	1.14	4.75	13.77	0.62	E
Audiovisual Technology	17,402	10,942	62.88	1.21	5.03	12.63	0.41	N/A
Telecommunications	37,354	21,368	57.20	1.09	4.93	12.72	0.49	E/R/P
Information Technology	23,929	12,383	51.75	1.09	4.95	15.19	0.73	(E)
Semiconductors	10,924	7,315	66.96	1.34	4.70	11.72	0.55	(E)
Optics	12,985	7,885	60.73	1.43	4.78	12.20	0.49	E
Analysis, Measurement, Control Tech.	19,385	10,297	53.12	1.05	4.83	12.67	0.80	(E)
Medical Technology	13,532	5,993	44.29	1.33	5.22	15.33	0.97	E/R/P
Nuclear Engineering	1,000	617	61.76	1.66	4.91	11.06	0.59	E
Organic Fine Chemistry	22,577	12,439	55.09	1.21	4.98	13.37	0.89	E
Macromolecular Chem., Polymers	17,568	10,365	59.00	1.11	4.82	12.40	0.78	N/A
Pharmaceuticals, Cosmetics	30,312	14,721	48.57	1.21	4.86	13.17	1.13	E/R/P
Biotechnology	9,376	3,584	38.23	1.21	5.24	13.37	1.21	N/A
Agriculture, Food Chem.	17,527	5,984	34.14	1.22	4.30	11.18	1.86	E/R/P
Chem. & Petrol Ind., Basic Mat. Chem.	20,645	9,989	48.38	1.16	4.75	13.02	1.02	E/R
Surface Technology, Coating	8,066	4,741	58.78	1.19	4.78	12.84	0.76	E
Materials, Metallurgy	17,666	10,196	57.72	1.05	4.25	11.33	1.21	N/A
Chemical Engineering	13,068	8,261	63.21	1.17	4.63	12.36	0.87	E/R
Mat. Proc., Textiles, Paper	18,042	9,991	55.38	1.05	4.73	16.47	0.78	E/R
Handling, Printing	14,021	8,978	64.03	1.05	4.63	12.96	0.57	R
Agricultural & Food Proc.	4,666	2,044	43.80	1.41	4.49	12.98	1.41	E/R/P
Environmental Technology	4,580	2,284	49.86	1.22	4.52	11.23	1.20	E
Machine Tools	9,161	5,497	60.00	1.20	4.53	11.49	0.85	E
Engines, Pumps, Turbines	9,451	5,177	54.77	1.16	4.64	13.13	0.83	E
Thermal Proc. & Apparatus	8,968	4,656	51.92	1.22	4.87	13.67	1.00	E
Mechanical Elements	8,810	5,163	58.60	1.18	4.53	12.84	0.72	E
Transport	10,209	5,118	50.13	1.03	4.60	12.82	0.83	E
Space Technology, Weapons	950	416	43.79	1.57	4.65	10.97	1.10	P
Consumer Goods & Equipment	19,463	8,999	46.24	1.20	4.83	13.84	0.95	N/A
Civil Eng., Building, Mining	11,574	5,359	46.30	1.07	4.58	12.23	1.23	R
All SIPO Patent Applications	443,533	239,373	54.97	1.03	4.71	16.47		

* The number of patent applications and grants are weighted by the number of technology areas (one patent can fall into several technological areas).

** Classification of industries according to the revised Catalogue of Industries for Guiding Foreign Investment 2004 - E: encouraged; R: restricted; P: prohibited; N/A: not applicable. One industry can fall into several areas. As indicated by classification in brackets (e.g., (E)), some industries could only be roughly matched with the investment catalogue.

Table 1: Grant ratios and lags across technological areas (all SIPO applications 1990-2002).

Application Year	No. of Patent Applications	No. of Granted Patents	Grant Ratio %	Average Grant Lag in Years	Family Size	Share of PCT Applications %	No. of IPC Classes	Average Global Patent Applications per Applicant	Average SIPO Patent Applications per Applicant
1990	9,227	3,378	36.61	4.77	4.39	4.84	4.46	7.16	6.16
1991	9,968	4,079	40.92	4.64	3.99	7.35	4.19	6.69	5.73
1992	12,597	5,148	40.87	4.89	3.49	8.18	3.96	6.60	5.85
1993	17,264	7,447	43.14	5.47	3.78	12.40	4.33	11.78	9.79
1994	21,872	11,156	51.01	5.93	4.56	22.58	4.98	22.05	17.63
1995	25,477	13,846	54.35	6.05	4.74	27.02	5.17	39.06	32.45
1996	30,400	17,152	56.42	5.85	4.64	29.09	4.97	56.00	48.09
1997	34,381	20,178	58.69	5.47	4.68	30.85	4.94	81.52	69.69
1998	37,920	22,477	59.27	5.16	4.74	34.86	5.08	92.36	80.03
1999	41,400	24,561	59.33	4.76	4.75	37.82	5.34	83.53	70.59
2000	53,962	30,151	55.87	4.32	4.21	33.71	5.44	113.17	100.25
2001	64,477	36,498	56.61	4.00	3.86	33.34	5.18	122.98	98.90
2002	84,588	43,302	51.19	3.62	3.21	31.41	4.75	157.10	131.83
Total	443,533	239,373	54.97	4.71	4.14	29.48	4.99	91.71	77.36

Table 2: Yearly patent indicators of all SIPO patent applications (1990-2002).

Duration until patent grant	SIPO patents		SIPO patents with EP equivalents			SIPO patents with US equivalents		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Applicant characteristics</i>								
Korean applicant (0/1)	0.251** [0.011]	0.044 [0.027]	0.278** [0.022]	-0.029 [0.055]	-0.002 [0.055]	0.228** [0.014]	-0.01 [0.037]	-0.037 [0.037]
Japanese applicant (0/1)	0.100** [0.006]	-0.003 [0.014]	0.050** [0.008]	-0.099** [0.021]	-0.081** [0.021]	0.073** [0.008]	-0.067** [0.019]	-0.077** [0.019]
Chinese applicant (0/1)	0.920** [0.009]	0.623** [0.018]	0.579** [0.048]	0.381** [0.132]	0.346** [0.131]	0.708** [0.037]	0.715** [0.103]	0.697** [0.103]
Yearly applications (log)	0.021** [0.001]	0.021** [0.001]	0.017** [0.002]	0.018** [0.002]	0.014** [0.002]	0.016** [0.002]	0.018** [0.002]	0.016** [0.002]
China focus	0.056** [0.012]	0.062** [0.012]	0.021 [0.016]	0.030+ [0.016]	0.027+ [0.016]	0.041** [0.015]	0.049** [0.015]	0.050** [0.015]
<i>Technology area characteristics</i>								
Revealed Technological Advantage RTA	0.177** [0.012]	-0.006 [0.013]	0.073** [0.018]	0.01 [0.019]	0.014 [0.019]	0.075** [0.018]	-0.003 [0.019]	-0.012 [0.019]
Growth rate of application filings	-0.237** [0.012]	-0.232** [0.012]	-0.166** [0.022]	-0.164** [0.022]	-0.157** [0.022]	-0.138** [0.019]	-0.136** [0.019]	-0.126** [0.019]
Chinese applicant x RTA		0.352** [0.018]		0.246 [0.151]	0.322* [0.148]		-0.001 [0.123]	-0.007 [0.122]
Korean applicant x RTA		0.300** [0.039]		0.440** [0.075]	0.422** [0.076]		0.358** [0.056]	0.360** [0.056]
Japanes applicant x RTA		0.138** [0.018]		0.202** [0.026]	0.211** [0.027]		0.193** [0.024]	0.185** [0.024]
<i>Patent characteristics</i>								
Family size	0.004** [0.001]	0.006** [0.001]	-0.002* [0.001]	-0.001 [0.001]	0 [0.001]	0 [0.001]	0.001 [0.001]	0.003** [0.001]
PCT application (0/1)	-0.253** [0.006]	-0.254** [0.006]	-0.300** [0.008]	-0.306** [0.008]	-0.265** [0.008]	-0.322** [0.007]	-0.327** [0.007]	-0.317** [0.007]
No. of IPC classes	-0.008** [0.000]	-0.008** [0.000]	-0.010** [0.001]	-0.010** [0.001]	-0.007** [0.001]	-0.009** [0.001]	-0.009** [0.001]	-0.007** [0.001]
References to patent literature					-0.018** [0.001]			-0.004** [0.000]
References to non-patent literature					-0.056** [0.002]			-0.008** [0.000]
Forward citations within 5 years					-0.021** [0.001]			-0.006** [0.000]
Chi-squared	91,907	91,404	54,922	54,861	55,251	60,021	60,050	60,976
Observations	235,995	235,995	116,021	116,021	116,021	127,372	127,372	127,372.00

Table 3: Estimation results of a Cox proportional hazards model for SIPO patent applications from 1991-2002. Note: Standard errors of coefficient estimates are reported in brackets. Significance levels are denoted as follows: ** 1%, * 5%, + 10%.

Duration until patent grant	SIPO patents		SIPO patents with EP equivalents			SIPO patents with US equivalents		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Applicant characteristics</i>								
Korean applicant (0/1)	-0.023 [0.015]	0.136** [0.035]	-0.386** [0.022]	-0.087 [0.056]	-0.109* [0.056]	-0.344** [0.015]	-0.147** [0.035]	-0.115** [0.035]
Japanese applicant (0/1)	0.247** [0.009]	0.267** [0.020]	-0.169** [0.011]	0.004 [0.023]	-0.021 [0.023]	-0.186** [0.010]	-0.050* [0.021]	-0.039+ [0.021]
Chinese applicant (0/1)	-0.988** [0.010]	-0.850** [0.020]	-0.883** [0.039]	-0.618** [0.115]	-0.617** [0.115]	-0.952** [0.028]	-0.807** [0.080]	-0.786** [0.079]
Yearly applications (log)	-0.002 [0.002]	-0.002 [0.002]	-0.017** [0.002]	-0.018** [0.002]	-0.015** [0.002]	-0.016** [0.002]	-0.017** [0.002]	-0.016** [0.002]
China focus	0.094** [0.018]	0.092** [0.018]	-0.012 [0.017]	-0.021 [0.017]	-0.022 [0.017]	-0.030+ [0.017]	-0.036* [0.017]	-0.038* [0.017]
<i>Technology area characteristics</i>								
Revealed Technological Advantage RTA	-0.408** [0.013]	-0.325** [0.018]	-0.073** [0.019]	-0.005 [0.020]	-0.008 [0.020]	-0.100** [0.018]	-0.027 [0.020]	-0.012 [0.020]
Growth rate of application filings	0.307** [0.015]	0.305** [0.015]	0.220** [0.021]	0.219** [0.021]	0.209** [0.021]	0.211** [0.019]	0.209** [0.019]	0.194** [0.019]
Chinese applicant x RTA		-0.165** [0.020]		-0.327* [0.131]	-0.360** [0.130]		-0.188* [0.093]	-0.184* [0.092]
Korean applicant x RTA		-0.236** [0.048]		-0.422** [0.074]	-0.416** [0.074]		-0.292** [0.049]	-0.305** [0.049]
Japanes applicant x RTA		-0.027 [0.025]		-0.237** [0.028]	-0.246** [0.028]		-0.191** [0.026]	-0.188** [0.026]
<i>Patent characteristics</i>								
PCT application (0/1)	0.259** [0.008]	0.259** [0.008]	0.379** [0.008]	0.385** [0.008]	0.343** [0.008]	0.396** [0.007]	0.401** [0.007]	0.389** [0.007]
No. of IPC classes	0.009** [0.001]	0.009** [0.001]	0.012** [0.001]	0.012** [0.001]	0.008** [0.001]	0.010** [0.001]	0.010** [0.001]	0.008** [0.001]
References to patent literature					0.017** [0.001]			0.003** [0.000]
References to non-patent literature					0.065** [0.002]			0.010** [0.001]
Forward citations within 5 years					0.025** [0.001]			0.008** [0.000]
Constant	3.199** [0.025]	3.146** [0.026]	4.391** [0.036]	4.359** [0.036]	4.305** [0.036]	4.395** [0.033]	4.360** [0.033]	4.330** [0.032]
Observations	434306	434306	185327	185327	185327	187816	187816	187816

Table 4: Estimation results from the second stage of a Heckman selection model (duration of patent examination) for SIPO patent applications from 1991-2002 conditional on a patent grant taking place (first stage). Note: Standard errors of coefficient estimates are reported in brackets. Significance levels are denoted as follows: ** 1%, * 5%, + 10%.

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