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The Factors Related to the Minimum and Maximum Survival of Patents against Challenges to Validity

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Abstract

In order to shed new light on the methodology of empirical studies on factors relating to patent validity, this study uses criteria based on the difference of the scope of protection at the time of grant and after the challenge as the dependent variable, and includes some new and recently studied independent variables related to the patent application and prosecution. Thus, 267 Japanese patents with application dates between October 2001 and December 2004 which were subsequently challenged in invalidation trials were categorized into three outcomes; (1) “complete survival”, (2) “partial survival” and (3)“complete loss”. Groups (1)+(2) and (3), or groups (1) and (2)+(3) were compared using logistic regression analysis to identify factors relating to the minimum and maximum survival of patents, respectively. The results showed a different set of variables significantly correlating with the minimum and maximum survival, indicating differences in the qualitative impacts of the variables on patent validity. Policy implications are also considered.

Keywords: patent validity; patent specification; patent prosecution; invalidation trials

1. Introduction

The validity of patents is the cornerstone of the patent system, allowing it to properly protect new and inventive inventions, and to promote knowledge-driven innovation. Although there are arguments that strengthening the examination process is not cost effective and it would be better to strengthen the litigation process for the few patents whose validity have been challenged (Lemley 2001), there is rising fear that the uncertainty of patent validity may decrease the incentives for development, deter entry of smaller firms, discourage “cumulative” invention and slow the pace of innovation or investment in the commercialization of new technologies (Hall et al. 2003; Jaffe & Lerner 2004; Hall & Ziedonis 2007; Scellato et al. 2011; Mann & Underweiser 2012, Nakamura 2013). Thus, there is a need to continue efforts to improve the quality of patent applications and patent prosecution.

A growing number of empirical studies focus on the factors relating to the outcomes of U.S. litigations, European Patent Office (EPO) oppositions, or Japan Patent Office (JPO) invalidation trials (Allison & Lemley 1998; Cockburn et al. 2002; Graham et al. 2002; Niiyama 2007; Nagata and Watanabe 2008; Scellato et al. 2011; Mann & Underweiser 2012; Kobayashi 2013; Nagaoka & Yamauchi 2013; Nakamura 2013). Most of these studies use regression analysis with dependent factors focusing on the text of judgment in the decisions on patent validity, in which the outcome would be binary: valid or invalid. Some of these studies also focus on oppositions resulting in amendments, where the possibility of an amendment is analyzed by logistic regression.

This study takes a different approach to the dependent variable, and focuses on the difference of the scope of protection at the time of grant and after the decision. From this perspective, the outcome is not necessarily dichotomous. In some jurisdictions, not all the claims may necessarily be the subject of decision, and in a small number of cases, not all the claims may be invalidated (a "partially valid" decision). Furthermore, in invalidation trials and objections, it is possible to make post-grant amendments[1], changing the scope of protection.

Focusing on the scope of protection is important because it is straightforward. The survival of the individual claims is the main concern in patents. From the patent holder's view, the survival of some claims is better than survival of no claims. From the opponent's view, the invalidation of some claims is better than invalidation of no claims.

Thus, to incorporate this intermediate outcome, this study classifies the outcome into three groups; "complete loss", "complete survival", and "partial survival" of the patented claims. Figure 1 describes the relationship between the outcomes based on the text of judgment and changes in scope of claims in invalidation trials at the JPO. From this Figure, it can be understood that the three outcomes here have been somewhat mixed in prior studies.

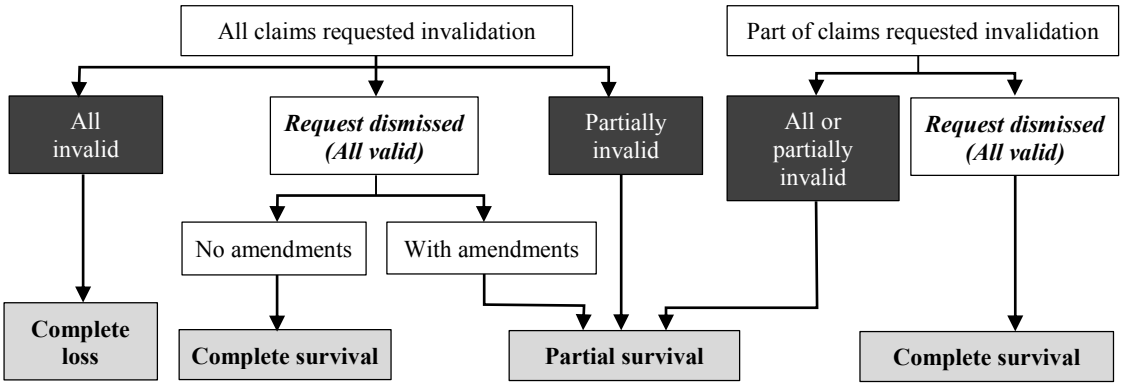

Figure 1: Schematic illustration of the outcomes of invalidation trials at the JPO

[1] In the Japanese system, "correction" is the legal term, but the term "amendment" will be used in this paper for comprehensibility and comparability among different systems. Post-grant amendments are frequent. For example, in the 129 "partially survived" cases in this study, 110 had post-grant amendments.

The grouping method in this study has an advantage over previous methods. By using the intermediate characteristics of the "partial survival" outcome, we can hope to identify factors that relate to the minimum and maximum survival of patents, and make a comparison of these factors.

Figure 2 gives a simplified illustration of the idea. If we compare the sum of the "complete survival" and "partial survival" cases with the "complete loss" cases, we may hope to find factors that relate to the difference between minimum survival and loss of patents. Similarly, if we compare the sum of the "complete loss" and "partial survival" cases with the "complete survival" cases, we may hope to find factors that relate to the difference between the maximum survival of patents and otherwise.

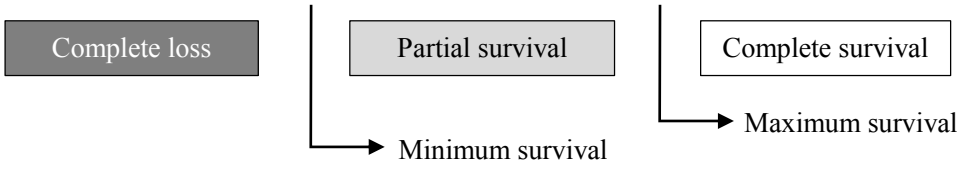

Figure 2: The minimum and maximum survival of patents

Thus, this study focuses on new dependent variables, but the study also includes new independent variables relating to the patent drafting and prosecution, to enhance deeper understanding. Some of the variables focus on the role of the outside patent attorney, differences in whether an examiner or an appeals board granted the patent, the amount of specification describing prior art or the patented invention, and time from application to first action, etc.

The research design combining new dependent and independent factors allows a detailed comparison of the factors that relate to the minimum and maximum survival of patents, and understand the qualitative as well as the quantitative impact of the various factors that affect patent validity.

The remainder of this paper is organized as follows. The next section gives background information on the patent system in Japan, section 3 describes the research design, and section 4 describes data collection methods. Section 5 reviews the results, and section 6 concludes and tries to identify areas of future research.

2. Background Information on the Japanese Patent System

2.1 Patent Prosecution in Japan

Figure 3 shows a schematic illustration of the patent prosecution process at the JPO. The process can be characterized by (1) an examination request period, (2) accelerated examination

procedures, (3) outsourcing of prior art search, and (4) pre-board examination.

The examination request period is a three year period[2] after the application to the JPO for requesting substantive examination. After the examination request is filed, the examination process starts and the first office action from the examiner will be made within approximately a year (Japan Patent Office 2014).

Accelerated examination can be requested with or after an examination request, but before the first action. When examination is accelerated, the first action will be made in approximately two months (Japan Patent Office 2014). Accelerated examination is free of charge and can be requested if the applicant is an individual, small or medium-size enterprise, a university or a public research institute, or if the application meets one of several requirements (such as being applied for a patent in a foreign country, or is being prepared for manufacture, etc.).

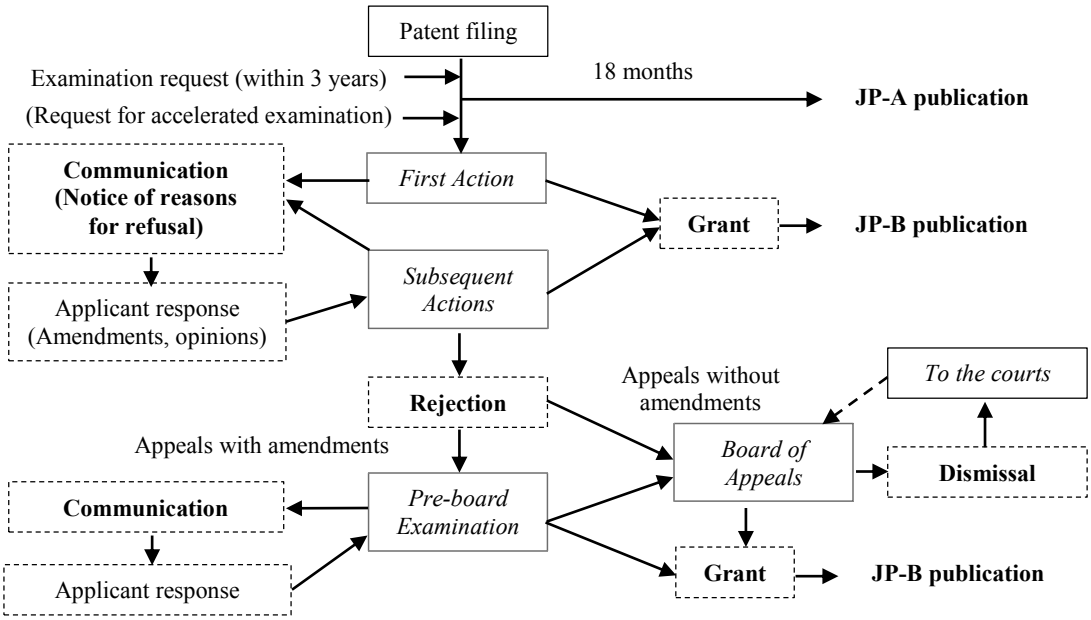

Figure 3: Patent prosecution process in Japan

Prior art search is necessary to find documents mainly to examine the novelty and inventive step of the application, which are the major requirements in the examination process. Prior art search which may be done by the examiner, or outsourced to registered external search organizations with qualified search staff[3].

Pre - board or "*zenchi*" examination[4] takes place when the applicant amends the claims when making appeals to the Board of Appeals after final rejection. Appeals without amendments will be sent directly to the Board of Appeals. Appeals with amendments will be sent back to the ex-

[2] The period was 7 years for applications before September 2001.
[3] Prior art search for approximately 70% of the applications is outsourced.
[4] The official name that appears in the JPO Annual Report is "reconsideration by examiners before appeal proceedings".

aminer for reconsideration to grant, send a further communication, or send the case to the Board. The Board may send yet another communication (not shown in the figure), or may make a decision to grant the application or dismiss the appeal. Upon dismissal, the applicant may make appeals to the Intellectual Property High Court, and Supreme Court. Until 2003, the Japanese patent system also had a post-grant opposition system, in which the Board of Appeals would review the granted patent through an *ex-parte* procedure[5].

2.2 Invalidation Trial procedures

An invalidation trial can be requested by any third party[6] to the Board of Appeals, where the case will be fought between the patent holder and his opponent. After the decision on validity has been made by the Board, appeals can be made to the IP High Court. The patent holder may request amendments to the Board during the trial, or even after the trial, as long as a decision to invalidate the patent has not yet been made final. In the case an amendment is requested for cases appealed to the courts, the court will usually send the case back to the Board to reconsider the case. When the case is finally decided in the courts, the decision would cancel the Board decision and send the case back to the Board, or would dismiss the request. When the Board of Appeals decision has been cancelled, the Board cannot make decisions which contradict the judgments of the courts, but have to the powers to make the official decision of validity. The case will go back and forth between the board and the court until the parties both decide not to make further appeals to the court. The board decision then becomes final, and the decision will be published.

3. Research Design

3.1 Logistic Regression Analysis

Logistic regression analysis is used to analyze the relationship between a set of independent explanatory variables and a dependent variable, in this case representing the outcome of an invalidation trial, expressed in binary (0 or 1) numbers. In other words, the following equation will be estimated:

$$P(v_i = 1) = \text{logit}^{-1} (\alpha + \boldsymbol{\beta}\mathbf{X}\mathbf{i} + \varepsilon)$$

(Where v_i is the dependent variable representing the outcome of an invalidation trial, expressed

[5] A similar opposition system will be re-introduced shortly as a result of a recent amendment of the Patent Law in 2014.

[6] When the opposition system is re-introduced, request for invalidation trials will be limited to interested parties.

in binary (0 or 1) numbers, **β** is a vector of all the coefficients, X_i is a vector of all the independent variables, and ε is the residual error.)

The alternative hypothesis is that the variables will relate to the validity of patents. The model explains the effect that each independent variable has on the likelihood that the dependent variable will be take the value 1.

All statistical calculations including the logistic regression analysis was conducted using R version 3.1.2 (2014-10-31) "*Pumpkin Helmet*" (R Core Team 2014) with packages "*Epicalc*" (Chongsuvivatwong 2012) for log-likelihood, "*BaylorEdPsych*" (Beaujean 2012) for pseudo-R squares, and "*car*" (Fox & Weisberg 2011) for the variance inflation factor (VIF).

3.2 Dependent Variables

The dependent variables assigned to the outcomes in each logistic regression analysis are summarized in Table 1. Analysis (1) compares the sum of the "complete survival" and "partial survival" cases with the "complete loss" cases to find factors that relate to the difference between minimum survival and loss of patents. Analysis (2) compares the sum of the "complete loss" and "partial survival" cases with the "complete survival" cases, to find factors that relate to the difference between the maximum survival of patents and otherwise.

To further explore factors identified in analysis (2), analysis (3) will compare the "complete survival" and "partial survival" cases.

Table 1: Summary of the analyses and dependent variables

	Complete Loss	Partial survival	Complete survival
Analysis (1)	Variable = 0	Variable = 1	
Analysis (2)	Variable = 0		Variable = 1
Analysis (3)		Variable = 0	Variable = 1

Assuming that the patent holder and its opponent make rational decisions, the factors relating to the minimum survival of patents may have a more critical impact than factors relating only to the maximum survival of patents. Having the wrong combination of the former factors would lead to complete loss of the claims, where the wrong combination of the latter factors would only lead to a loss of the broader claims. Thus, if the former and latter factors differ, we would be able to obtain two categories of factors having different impacts on patent validity.

The assumption that the patent holder and the opponent both make a certain level of rational decisions is based on the following ideas. The patent holder would usually prefer survival of all the claims. However, if the patent holder decides that the claims are too broad to survive the challenge, an amendment will be made to narrow the claims to the extent that the holder be-

lieves will assure survival of the patent. On the other hand, the opponent would usually prefer to invalidate all the claims, but if the opponent decides that some claims are very difficult to destroy, those claims may not be challenged in the first place.

This assumption may not be so irrational when we consider that the invalidation trials and related systems are adversary systems that also require cost, in which the subject of decisions and the level of courts are decided by the parties, affecting the results of the decisions. Especially in the Japanese system, invalidation trial cases (and thus the scope of protection) settle when the patent holder decides not to make further requests for amendments, and *both parties* decide not to make further appeals to the courts.

3.3 Selection of Independent Variables

3.3.1 Basic Approach

A brief description of the independent variables is shown in Table 2.

Mann and Underweiser (2012) analyzed the validity of the patent as a function of three distinct sets of inputs: the invention, effort by the applicant, and effort by the examiner. This study focused on U.S. patents and included variables related to the prosecution history data, such as the number of classes and subclasses searched, filings of IDSs, time from application to issuance, time from first action to issuance, number of communications from the examiner, counterpart applications in the E.U. and Japan, along with variables related to text-based features, and variables describing the facial characteristics of patents, such as the number of claims, classes, references in the patent, continuations, etc.

This study applies a similar basic approach on independent variables to Japanese patents, but aims to expand its scope by introducing a different set of variables, some new and some recently studied for Japanese patents. These variables focus on (1) the characteristics of the decision maker, (2) the characteristics of the drafter of the specification, (3) the involvement of the third party, and (4) the amount of description in the specification on the prior art and the present invention. Other variables on (5) patent families, (6) time-related variables, and (7) added search classifications and commercial databases used in search are also explained below in section 3.3.2 to 3.3.8. Dummy variables for application year and technical field (IPC section level) were also added as controls.

Table 2: Brief description of the independent variables analyzed in this study

Variable	Brief Description
Div	Dummy variable: 1 = divisional applications, 0 = other
Nat_pri	Dummy variable: 1 = national priority claims, 0 = other

Foreign	Dummy variable: 1 = foreign drafted specifications, 0 = other
Leg_person_int	Dummy variable: 1 = specifications drafted internally by legal persons, 0 = other
Nat_person	Dummy variable: 1 = specifications drafted by natural persons (individuals), 0 = other
Acc_exam	Dummy variable: 1 = accelerated examination, 0 = other
Search_out	Dummy variable: 1 = search outsourced, 0 = other
Pre_board_Gr	Dummy variable: 1 = granted in pre-board examination stage, 0 = other
App_grant_Opp	Dummy variable: 1 = cases challenged in oppositions or granted by the appeals pre-board, 0 = other
Infringe_lawsuit	Dummy variable: 1 = cases with related infringement lawsuits, 0 = other
Fam_IP5	Number of offices in the IP5 (USPTO, SIPO, KIPO and EPO (or any of the German, French, or U.K. offices)) covered by the same patent family
Num_classif	Number of International Patent Classifications (IPCs) at the main group (5 - 7 letter; e.g. "A61K39") level
Fw_cit	Number of subsequent Japanese applications in which the patent was cited
zCl1_len	Number of letters in claim 1 of the original patented claims, normalized using patents of the "basic" data set with matching IPCs at the subclass (4 letter; e.g., "A61K") level
zNum_claims	Number of claims in the original patented claims, normalized using patents of the "basic" data set with matching IPCs at the subclass (4 letter) level
zDesc_all	Number of letters in the description of the specification normalized using patents of the "basic" data set with matching IPCs at the subclass (4 letter) level
zDesc_for	Number of letters in the former half of the description of the specification, normalized using patents of the "basic" data set with matching IPCs at the subclass (4 letter) level
zDesc_lat	Number of letters in the latter half of the description of the specification, normalized using patents of the "basic" data set with matching IPCs at the subclass (4 letter) level
Desc_for_ratio	"*zDesc_for*" divided by "*zDesc_lat*"
log_Ap_to_FA	The natural logarithm of the number of months from first application to first action
log_Exam_exper	The natural logarithm of the number of years of examiner experience of the first action examiner (or assistant examiner) at the time of the first action
App_cit_pdom	Number of domestic patent documents cited by the applicant
App_Cit_Pfor	Number of foreign patent documents cited by the applicant

App_cit_nonp	Number of non-patent documents cited by the applicant
Add_search_ Classif	Number of IPC groups additionally searched by the examiner (groups smaller than the main group (5-7 letter) level were counted as the number of main groups)
Num_com_db	Number of commercial databases used in search (different databases offered by the same company and are normally used in the same search are counted as one)
Add_cit_pdom	Number of domestic patent documents citations added by the examiner
Add_cit_pfor	Number of foreign patent documents citations added by the examiner
Add_cit_nonp	Number of non-patent documents citations added by the examiner
Num_comm	Number of communications (notice of rejections and final rejections, including notices of rejections in the appeals stage) before grant
Third_P_inf	Number of third party submissions of information before patent grant

3.3.2 Characteristics of the Decision Makers

In prior studies on the relationship between the characteristics of the decision maker and patent validity, Cockburn et al. (2002) focused on the effect of patent examiner characteristics in addition to historical statistics, and Allison and Lemley (1998) focused on the characteristics of the fact finder: a jury, a judge ruling on a pre-trial motion, or a judge granting judgment as a matter of law.

In Japanese patent prosecution, the decision makers are the examiners and the Boards of Appeal. In order to consider the human factors at the entrance and exit of the patent granting process, I added a variable on the length of experience of the first action examiner, and dummy variables for the final decision maker (the examiner in the examination stage or the pre-board examination stage, or the Board of Appeals in the appeals stage or in opposition proceedings). It may be worthy to note that the examiners are randomly assigned to applications, and that the examination divisions in the JPO have a similar distribution in the experiences of examiners. Since this study focuses mainly on factors affecting the patent prosecution process, decision makers in the invalidation trial and subsequent court cases will not be included.

Patents granted by the Board of Appeals may be expected to have a higher validity than those granted by the examiner, since the Board consists of three or five trial examiners who have longer experience than examiners in the examination departments, and since the chief trial examiner has the authority to investigate issues not considered in the previous examination prosecution. However, Nakamura (2013) obtained mixed results on the effect of the Board of Appeals decisions on patent validity. According to this study, patents that passed through opposition procedures had a higher validity rate compared to patents that did not, whereas patents granted by

the Board in appeals against the examiner's rejection did not show any significant effect.
Variables indicating by whom prior art was searched is also included in this study. Nakamura (2013) reported that patents in which prior art search was outsourced had increased possibility to be determined valid in invalidation trials.

3.3.3 The Characteristics of the Drafter of the Specification

The idea of variables related to the human characteristics is further extended to the drafter of the specification. In relation to the applicant characteristics, prior studies focused on applicant size based on the amount of sales (Nakamura et al. 2011) or the amount of patent applications (Nakamura 2013) in a certain year have been considered in relation to invalidation trials. However, a closer view on the drafters of the specification may be even straightforward.
Patent specification drafting, in many cases, is the co-work of researchers, patent staff and other coordinators. If we assume that the flow of information does not differ whether the players belong to different firms, then logically, specifications completed in outside patent firms would not differ in quality compared to specifications drafted internally. But if being in the same company means closer communication and sharing deeper information on the technology being developed, such as secret know-how and the hidden goal of the development process, etc. (which may sound more realistic), then the internally drafted specification may have an advantage over the externally drafted specification.
In order to make a comparison, I classified the applicant and representative characteristics (or rather, the origin of the specification) into four groups, namely: (1) foreign, (2) legal persons (corporations, etc.) using outside representatives, (3) legal persons internally drafting the specification, and (4) natural persons (individuals). The dummy variables for groups (1), (3) and (4) were included in the model, and group (2), which is the most common, was used as the control group. Since specifications from foreign countries are considered to be drafted according to the domestic practice and customs of the origin, which may differ from those in Japan, patents with foreign origin were classified into a separate group. Specifications by individual applicants were also classified in a separate group since the drafting and decision making processes of individuals and corporations may differ.

3.3.4 Involvement of the Third Party

I have included a variable on the number of third party submissions before patent grant. There had been studies on "Peer-to-patent" schemes which invite third party contribution to improve patent quality (Noveck 2006; Bestor & Hamp 2010). The Japanese patent system has a relevant scheme in which the third party can voluntarily submit information relating to the patentability

of applications before or after its grant. The system is intended to provide materials for improving quality of patent examination and future invalidation trials. Nakamura (2012) found that the patent applications receiving third party submissions before patent grant had grant rates 10-15 points lower than applications not receiving submissions, and concluded that third party submissions before grant increases the validity of patents. However, Nakamura (2013) was unable to confirm the results using invalidation trial results both for submissions before and after patent grant.

I have also included a dummy variable for infringement lawsuits of the patent. This is expected to allow further consideration of the effect of the third party at a later stage.

3.3.5 The Length of Description on the Prior Art and the Present Invention

The detailed description of the invention in a patent specification can be divided into the former and latter halves: the former half includes the description on prior art and the problem to be solved by the present invention, the latter half includes the solution to the problem with a detailed description of the invention, examples, and in some cases data on specific embodiments of the invention. Niiyama (2007) used the ratio between the length of the former half and the whole detailed description as a variable in an ordered probit analysis of invalidation trial results, but did not find any significant effect.

However, I believe that the ratio of the former (or the latter) half is not as important as the length of the halves. The reason for this is because if the applicant thoroughly considered the prior art and carefully distinguished the problem to be solved by the claimed invention, it would be assumed that the *length* of description in the former half would be longer than the description written by applicants who do otherwise. In the same manner, it would be assumed that the *length* of description in the latter half would be longer for the applicants who focus on a detailed description of the claimed invention than those who do not. Thus, a comparison of the lengths of the former (or latter) halves of specifications among patents with different outcomes may be a more adequate variable.

3.3.6 Patent Families

The prior literature focuses on patent families among the Trilateral Offices (the EPO, the JPO, and the USPTO) as a variable representing the value of the patent and possible increase in patent quality through the prosecution of the same patent in different Offices (Guellec & van Pottelsberghe de la Potterie 2000; Graham et al. 2002; Mann & Underweiser 2012; Nakamura 2013). Considering the increase of importance of the South Korean (KIPO) and Chinese (SIPO) Offices in the share of patent applications, in which the five offices above receive about 80 per-

cent of the world's patent applications, I have broadened the area of counting patent families to include filings to these offices. I have also broadened the definition of a European filing to include filings to other major offices than the EPO, and counted filings to any of the French, German, and U.K., Offices as filings to the European region in general.

3.3.7 Time-Related Variables

Several prior studies have considered time-relevant variables in relation to patent validity. Mann & Underweiser (2012) considered the time from first action to issue as a variable expressing the vigorousness of the prosecution, but did not find a significant correlation to patent validity. Graham et al. (2002) found that amendment is more likely in an EPO opposition case when accelerated examination was requested.

Kobayashi (2013) found a positive correlation between the time from application to examination request and validity, between the time from first publication to registration and validity, and a negative correlation between accelerated examination and validity. Nagaoka & Yamauchi (2013) reported that the shorter the length of time from application to first action was for a patent, the higher the possibility of invalidation. Nakamura (2013) hypothesized that the shortness of time from filing to first action would create a difficulty in finding citations for new technologies, but the results of the ordered logit regression analysis did not show a significant relation between validity and the time from application to examination request, or the use of accelerated examination. On the other hand, the results suggested a negative relation between the number of communications and validity.

In the Japanese system, the total prosecution time may be explained by two factors: the time from first filing to first action, and the time from first action to grant. The former is controlled by the applicant's timing of examination request, request for accelerated examination, and the patent office backlog. The latter is a function of the number of communications. To avoid overlaps of variables, the time from first filing to first action and the number of communications were studied in this paper.

3.3.8 Added Search Classifications and Commercial Databases Used in Search

Mann & Underweiser (2012) discussed the possibility that rigorous examination would lead to a higher patent quality. Along this line, and also from the assumption that applicant citations increase with patent value, the prior literature has focused on applicant citations and examiner citations (Sampat, 2005; Niiyama, 2007; Nagata & Watanabe, 2008; van Zeebroeck & van Pottelsberghe de la Potterie 2011a; Mann & Underweiser, 2012; Cotropia et al., 2013). Since the Japanese JP-B publications for granted patents include data on the classifications and commer-

cial databases used in search, the classifications and databases added in search were incorporated in this study.

3.4 The Possibility that the Patent will be Rejected Before Finally Being Granted

To further understand the relation between examiner experience, the use of outside patent attorneys and the possibility that the patent will be rejected before finally being granted, a supplementary analysis (4) was conducted using the set of disputed patents and random samples from the patents which were applied for in the same period but not challenged. Factors related to the patent application and the patent prosecution before first action were used as independent variables, and a dummy variable representing the occurrence of rejection (rejected cases takes the variable "1") was used as the dependent variable.

4. Data Collection

4.1 Data Set

In order to avoid the influence of the change in length of examination request period in October 2001, and to avoid the influence of any mid-term trends in patent application patterns, patents having the application date between October 2001 and December 2004 and which have been granted before April 2014 were used (further referred to as the "basic" data set). Divisional applications between October 2001 and December 2004, were limited to those having effective filing dates (in most cases the filing date of the parent application) in the same period to maintain consistency. The "basic" data set was identified using the CKSWeb patent database (Chuo Kogaku Shuppan K.K., https://web-service.cks.co.jp/Bd/CWSF001.aspx). By searching for patents with Board of Appeal trial numbers to search the JPO IP Digital Library (IPDL, http://www.ipdl.inpit.go.jp/homepg.ipdl), a total of 267 patents were found which the invalidation trials were concluded and the final decision was published before April 2014 (further referred as the "concluded" data set).

4.2 Dependent Variables

By comparing the original patented claims with the scope of protection after the invalidation trial decisions, the 267 patents in the "concluded" data set were classified into "complete survival", "partial survival", and "complete loss" cases. For patents which were challenged in two or more invalidation trials, the claims after the most recent trial with a final conclusion were compared to the original patented claims.

4.3 Data on Patent Prosecution History and Patent Application

Bibliographical data of the patents, International Patent Classification (IPC) codes, patent prosecution history, opposition case numbers, backward citations[7], specification text, and applicant and representative (patent attorney name) listed on the JP-A publications, and information on IPC classifications and commercial databases searched by the examiner listed on the JP-B publications were obtained from the CKSWeb database.

Applicant and patent attorney names on the JP-A publications were used to classify the specifications drafted in Japan into those by natural persons, by legal persons (corporations, etc.) drafting the specifications internally or by using outside patent attorneys. To determine whether the patent attorneys were internal or external, the IPDL was used to search the head attorney and find the applications represented by that attorney in the same year. If the applications were all from the same applicant (or any corporation within the same corporate group) as the patent being considered, the attorney was considered to be an internal one, and otherwise and external attorney. The "Benrishi-navi" database (http://www.benrishi-navi.com/) provided by the Japan Patent Attorneys Association was also used to supplement the decision.

The specification text was used to identify applicant citations, explicitly indicated according to the revision of the law in 2002, or appearing in the paragraphs under the "Prior Art" and "Problem to be Solved" headings. The former half of the specification was identified by a macro on Microsoft (R) Excel, using the headings such as "Solution to the Problem", "Disclosure of the Present Invention", "Composition of the Present Invention", so on, and their possible variations along with different type of brackets to locate the position where the latter half begins. The patents in the "basic" data set were also analyzed in order to obtain the mean and standard deviation of the length of both halves of the specifications in various IPC subclasses for normalization calculations as explained below in section 4.5.

The data on first action examiner (or assistant examiner) name was obtained from IPDL or at the JPO, either as data appearing on the JP-B publications or the first notice of refusal. The first action examiner (or assistant examiner) was checked with the list of staff and new recruits at JPO on newsletters published by the JPO, the technical staff society or related groups, which can be found in the JPO library, and the recruitment dates and the first action dates were used to calculate the amount of examiner experience at the time of the first action.

Patent family data and forward citations[8] were checked on the ESPACE patent database of the EPO (http://www.epo.org/searching/free/espacenet.html).

4.4 Data on Court Cases

[7] These are documents cited in the notices of refusal and granted patent publication.

[8] In this study, the number of Japanese applications (and not the number of times) the patents in the sample group were cited for, either in notices for refusal, in the granted patent publication, or both.

The Westlaw Japan database (Shin-Nihon Houki Shuppan K.K. and Thomson Reuters, http://www.westlawjapan.com/english/) and the Court Judgment database on the IP High Court website (http://www.ip.courts.go.jp/index.html) were used to search infringement law suits related to the patents in the sample group.

4.5 Normalization of Data

Some of the numerical data, namely the length of the first claim, the number of claims, the length of the description, and the length of description divided by number of claims, may differ greatly depending on the technical field. To enable comparison of these variables, the data was normalized by using the mean and standard deviation calculated for patents in the "basic" data set with matching main IPCs at the subclass (4 letters) level.

5. Result and Discussion

5.1 Summary of the Variables

The basic statistical data on the variables in relation to the different outcomes are described in Table 3.

Table 3: Basic statistical data on the variables

	Total (n=267)				**Complete loss (n=75)**				**Partial survival (n=129)**				**Complete survival (n=63)**			
	mean	sd	min	max	mean	sd	min	max	mean	sd	min	max	mean	sd	min	max
Div	0.02	0.14	0	1	0.01	0.12	0	1	0.02	0.12	0	1	0.03	0.18	0	1
Nat_pri	0.22	0.42	0	1	0.24	0.43	0	1	0.22	0.41	0	1	0.21	0.41	0	1
Foreign	0.05	0.22	0	1	0.01	0.12	0	1	0.09	0.28	0	1	0.03	0.18	0	1
Leg_person_int	0.11	0.32	0	1	0.07	0.25	0	1	0.15	0.36	0	1	0.10	0.30	0	1
Nat_person	0.06	0.24	0	1	0.01	0.12	0	1	0.06	0.24	0	1	0.11	0.32	0	1
Search_out	0.39	0.49	0	1	0.44	0.50	0	1	0.36	0.48	0	1	0.41	0.50	0	1
Pre_board_Gr	0.10	0.30	0	1	0.11	0.31	0	1	0.11	0.31	0	1	0.08	0.27	0	1
App_grant_Opp	0.05	0.22	0	1	0.01	0.12	0	1	0.05	0.23	0	1	0.10	0.30	0	1
Infringe_lawsuit	0.11	0.31	0	1	0.07	0.25	0	1	0.07	0.26	0	1	0.24	0.43	0	1
Fam_IP5	0.72	1.29	0.00	4.00	0.65	1.25	0.00	4.00	0.72	1.26	0.00	4.00	0.78	1.42	0.00	4.00
Num_classif	2.19	1.54	1.00	11.00	2.39	1.41	1.00	6.00	2.19	1.72	1.00	11.00	1.97	1.27	1.00	6.00
Fw_cit	2.52	2.89	0.00	17.00	2.44	2.62	0.00	12.00	2.63	3.01	0.00	17.00	2.40	2.97	0.00	13.00
zCl1_len	-2.21	0.56	-3.50	-0.81	-2.22	0.55	-3.50	-0.81	-2.17	0.57	-3.45	-0.89	-2.28	0.55	-3.43	-1.27
zNum_claims	0.14	1.37	-1.09	10.19	-0.08	0.94	-1.09	3.43	0.36	1.70	-1.01	10.19	-0.07	0.91	-1.01	3.90
Desc_for_ratio	0.15	0.09	0.02	0.45	0.17	0.09	0.02	0.44	0.14	0.08	0.02	0.45	0.16	0.09	0.03	0.44

	Total (n=267)				Complete loss (n=75)				Partial survival (n=129)				Complete survival (n=63)			
zDesc_all	0.04	0.92	-1.42	5.18	-0.22	0.65	-1.42	2.06	0.20	1.05	-1.28	5.18	0.02	0.83	-1.33	2.97
zDesc_for	0.05	1.12	-1.32	9.81	-0.10	0.58	-1.18	1.95	0.10	1.22	-1.28	9.81	0.12	1.38	-1.32	8.92
zDesc_lat	0.04	0.91	-1.34	5.26	-0.22	0.65	-1.33	2.16	0.20	1.06	-1.34	5.26	-0.00	0.78	-1.29	3.09
log_Ap_to_FA	3.58	0.73	0.55	4.44	3.40	0.86	0.55	4.37	3.65	0.63	1.57	4.44	3.64	0.73	0.68	4.43
log_Exam_exper	2.32	0.88	-1.61	3.67	2.50	0.71	0.59	3.57	2.27	0.87	-1.08	3.67	2.19	1.07	-1.61	3.60
App_cit_pdom	1.60	2.94	0.00	29.00	1.47	2.23	0.00	14.00	1.81	3.56	0.00	29.00	1.35	2.20	0.00	14.00
App_cit_pfor	0.23	1.07	0.00	11.00	0.23	1.30	0.00	11.00	0.23	0.78	0.00	5.00	0.24	1.29	0.00	10.00
App_cit_nonp	0.23	1.89	0.00	30.00	0.12	0.40	0.00	2.00	0.36	2.69	0.00	30.00	0.10	0.39	0.00	2.00
Add_search_classif	0.29	0.68	0.00	5.00	0.24	0.57	0.00	3.00	0.32	0.77	0.00	5.00	0.30	0.61	0.00	3.00
Num_com_db	0.18	0.59	0.00	4.00	0.12	0.43	0.00	3.00	0.18	0.63	0.00	4.00	0.25	0.67	0.00	3.00
Add_cit_pdom	4.19	3.01	0.00	20.00	4.43	3.34	0.00	20.00	4.11	3.11	0.00	15.00	4.10	2.33	0.00	12.00
Add_cit_pfor	0.19	0.61	0.00	4.00	0.19	0.54	0.00	3.00	0.22	0.66	0.00	4.00	0.14	0.56	0.00	3.00
Add_cit_nonp	0.16	0.65	0.00	6.00	0.17	0.53	0.00	3.00	0.15	0.60	0.00	4.00	0.17	0.85	0.00	6.00
Num_comm	1.44	1.08	0.00	7.00	1.41	1.04	0.00	7.00	1.48	1.10	0.00	6.00	1.38	1.08	0.00	5.00
Third_P_inf	0.33	0.89	0.00	8.00	0.16	0.49	0.00	3.00	0.33	0.81	0.00	4.00	0.52	1.29	0.00	8.00

5.2 Logistic Regression Models

Table 4 to 6 summarizes the regression models for analysis (1) to (3). Models 1-1 and 2-1 are models based on some of the major variables studied in the prior literature, and models 1-2, 2-2, and 3-1 includes all of the new variables. Models 1-3, 2-3, 3-2 and 3-3 deletes some of the variables with low statistical significance. Table 7 summarizes the regression models for analysis (4) on the possibility that the patent will be rejected before finally being granted.

Table 4: Regression models for analysis (1): "complete survival" and "partial survival" cases versus "complete loss" cases

	Model 1-1			Model 1-2			Model 1-3			
	Estimate	s.e.	VIF	Estimate	s.e.	VIF	Estimate		s.e.	VIF
(Intercept)	-0.329	(1.339)		0.947	(1.554)		1.186		(1.206)	
Div	-0.200	(1.276)	1.12	0.068	(1.416)	1.19				
Nat_pri	-0.358	(0.423)	1.42	-0.553	(0.474)	1.55	-0.737	.	(0.425)	1.29
Foreign	1.855	(1.298)	1.45	3.016	* (1.375)	1.60	1.779		(1.154)	1.13
Leg_person_int				1.498	* (0.633)	1.26	1.290	*	(0.597)	1.13
Nat_person				3.077	* (1.313)	1.18	3.085	*	(1.277)	1.14
Search_out				-0.011	(0.415)	1.71				
Pre_board_Gr				-0.244	(0.616)	1.40				

App_grant_Opp				2.804	*	(1.287)	1.27	2.653	*	(1.214)	1.19
Infringe_lawsuit				0.605		(0.634)	1.21				
Fam_IP5	-0.008		(0.146)	1.46	-0.089		(0.18)	1.81			
Num_classif	-0.288	*	(0.122)	1.51	-0.360	**	(0.136)	1.59	-0.354	**	(0.127)	1.45
Fw_cit	-0.020		(0.057)	1.24	0.004		(0.065)	1.40			
zCl1_len	-0.180		(0.365)	1.79	-0.142		(0.398)	1.87			
zNum_claims	-0.057		(0.222)	1.74	-0.104		(0.248)	1.95			
zDesc_all	0.865	**	(0.298)	1.92							
zDesc_for					0.261		(0.21)	1.22	0.186		(0.186)	1.14
zDesc_lat					0.928	**	(0.322)	1.84	0.879	***	(0.265)	1.34
Desc_for_ratio	1.023		(2.166)	1.62							
log_Ap_to_FA	0.516	*	(0.216)	1.29	0.574	*	(0.261)	1.58	0.558	*	(0.235)	1.31
log_Exam_exper					-0.492	*	(0.218)	1.21	-0.450	*	(0.209)	1.12
App_cit_pdom	0.019		(0.071)	1.36	0.036		(0.099)	1.62			
App_cit_pfor	-0.161		(0.162)	1.70	-0.139		(0.168)	1.77			
App_cit_nonp	-0.051		(0.146)	1.25	-0.029		(0.163)	1.25			
Add_search_classif	0.123		(0.251)	1.23	0.224		(0.273)	1.34			
Num_com_db	0.483		(0.382)	1.61	0.623		(0.424)	1.73	0.499		(0.351)	1.26
Add_cit_pdom	-0.039		(0.054)	1.21	-0.063		(0.058)	1.36	-0.054		(0.055)	1.18
Add_cit_pfor	-0.065		(0.287)	1.30	-0.264		(0.33)	1.47			
Add_cit_nonp	0.232		(0.318)	1.55	0.479		(0.357)	1.74	0.415		(0.341)	1.51
Num_comm	-0.041		(0.162)	1.38	-0.388	.	(0.211)	1.81	-0.356	.	(0.187)	1.51
Third_P_inf					0.437		(0.305)	1.22	0.436		(0.288)	1.15
IPC controls	yes				yes				yes			
Application year controls	yes				yes				yes			
No. of observations	267				267				267			
Log-likelihood	-137.6				-121.5				-124.2			
AIC	337.3				320.9				300.4			
McFadden R^2	0.132				0.234				0.217			
Nagelkerke R^2	0.209				0.349				0.326			
Correctly Classified	0.723				0.760				0.742			

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1

Table 5: Regression models for analysis (2): "complete survival" cases versus "complete loss" and "partial survival" cases

	Model 2-1			Model 2-2			Model 2-3			
	Estimate	s.e.	VIF	Estimate	s.e.	VIF	Estimate		s.e.	VIF
(Intercept)	-2.316	(1.546)		-2.040	(1.833)		-2.165	*	(0.849)	
Div	1.757	(1.175)	1.34	2.639	. (1.376)	1.64	2.570	*	(1.221)	1.33
Nat_pri	-0.414	(0.466)	1.44	-0.471	(0.497)	1.45				

Foreign	-0.761		(1.081)	1.73	-0.092		(1.172)	1.85				
Leg_person_int					0.325		(0.651)	1.33				
Nat_person					2.181	**	(0.726)	1.45	2.038	**	(0.696)	1.37
Search_out					0.646		(0.436)	1.61	0.708	.	(0.392)	1.32
Pre_board_Gr					-0.847		(0.781)	1.69	-0.963		(0.71)	1.39
App_grant_Opp					0.723		(0.932)	1.85				
Infringe_lawsuit					1.768	**	(0.593)	1.51	1.672	**	(0.536)	1.27
Fam_IP5	0.326	*	(0.156)	1.66	0.428	*	(0.188)	2.01	0.381	*	(0.162)	1.58
Num_classif	-0.273	.	(0.14)	1.42	-0.437	**	(0.161)	1.70	-0.452	**	(0.154)	1.54
Fw_cit	-0.056		(0.063)	1.30	-0.021		(0.071)	1.44				
zCl1_len	0.105		(0.361)	1.60	0.156		(0.403)	1.65				
zNum_claims	-0.337		(0.241)	1.92	-0.371		(0.281)	2.12	-0.369		(0.224)	1.32
zDesc_all	0.326		(0.245)	2.08								
zDesc_for					0.402	*	(0.171)	1.53	0.424	**	(0.163)	1.38
zDesc_lat					0.143		(0.27)	2.24				
Desc_for_ratio	1.738		(2.206)	1.55								
log_Ap_to_FA	0.356		(0.262)	1.19	0.286		(0.338)	1.57				
log_Exam_exper					-0.179		(0.209)	1.23				
App_cit_pdom	-0.037		(0.082)	1.32	-0.120		(0.077)	1.64	-0.106		(0.071)	1.39
App_cit_pfor	0.101		(0.195)	1.75	0.067		(0.192)	1.73				
App_cit_nonp	-0.590		(0.623)	1.89	-0.241		(0.589)	1.97				
Add_search_classif	-0.205		(0.26)	1.28	-0.197		(0.288)	1.41				
Num_com_db	0.797	*	(0.369)	1.94	1.105	**	(0.405)	2.31	1.110	**	(0.339)	1.75
Add_cit_pdom	-0.012		(0.061)	1.21	-0.045		(0.072)	1.33				
Add_cit_pfor	-0.218		(0.361)	1.37	-0.233		(0.388)	1.47				
Add_cit_nonp	0.150		(0.306)	1.69	0.248		(0.334)	1.95				
Num_comm	-0.129		(0.174)	1.29	-0.466	.	(0.255)	2.33	-0.415	*	(0.2)	1.49
Third_P_inf					0.798	**	(0.266)	1.74	0.849	***	(0.245)	1.49
IPC controls	yes				yes				yes			
Application year controls	yes				yes				yes			
No. of observations	267				267				267			
Log-likelihood	-125.3				-108.4				-110.9			
AIC	312.5				294.8				269.8			
McFadden R^2	0.141				0.257				0.240			
Nagelkerke R^2	0.215				0.368				0.347			
Correctly Classified	0.783				0.835				0.809			

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1

Table 6: Regression models for analysis (3): "complete survival" versus "partial survival" cases

	Model 3-1	Model 3-2	Model 3-3

	Estimate		s.e.	VIF	Estimate		s.e.	VIF	Estimate		s.e.	VIF
(Intercept)	-1.966		(2.005)		-2.648	.	(1.531)		-1.915	*	(0.906)	
Div	2.718	.	(1.598)	1.68	1.560		(1.385)	1.33	2.045		(1.369)	1.34
Nat_pri	-0.223		(0.569)	1.60								
Foreign	-0.809		(1.33)	2.07								
Leg_person_int	-0.307		(0.714)	1.39								
Nat_person	1.507	*	(0.759)	1.45	1.346	.	(0.726)	1.40	1.477	*	(0.719)	1.39
Search_out	0.384		(0.48)	1.57					0.653		(0.437)	1.36
Pre_board_Gr	-0.593		(0.854)	1.71					-0.644		(0.771)	1.39
App_grant_Opp	0.313		(1.141)	2.44								
Infringe_lawsuit	1.955	**	(0.74)	1.70	1.890	**	(0.659)	1.42	1.887	**	(0.646)	1.39
Fam_IP5	0.428	*	(0.212)	2.13	0.298	.	(0.168)	1.43	0.373	*	(0.174)	1.54
Num_classif	-0.356	*	(0.175)	1.91	-0.376	*	(0.166)	1.71	-0.383	*	(0.163)	1.68
Fw_cit	-0.055		(0.078)	1.47								
zCl1_len	0.436		(0.478)	1.93								
zNum_claims	-0.470		(0.336)	2.44	-0.586	*	(0.268)	1.55	-0.466	.	(0.246)	1.30
zDesc_for	0.351	.	(0.183)	1.63	0.348	*	(0.177)	1.37	0.365	*	(0.175)	1.38
zDesc_lat	-0.152		(0.318)	2.60								
log_Ap_to_FA	0.391		(0.371)	1.61	0.257		(0.317)	1.24				
log_Exam_exper	-0.049		(0.221)	1.21								
App_cit_pdom	-0.111		(0.078)	1.59	-0.116		(0.076)	1.36	-0.114		(0.074)	1.31
App_cit_pfor	0.398		(0.258)	2.46	0.429	.	(0.233)	2.07				
App_cit_nonp	-0.073		(0.337)	1.32								
Add_search_classif	-0.259		(0.287)	1.41								
Num_com_db	0.926	*	(0.422)	2.26	0.974	**	(0.367)	1.79	0.989	**	(0.359)	1.71
Add_cit_pdom	-0.032		(0.081)	1.44								
Add_cit_pfor	-0.547		(0.5)	2.04	-0.618		(0.442)	1.75				
Add_cit_nonp	0.137		(0.347)	1.99								
Num_comm	-0.534	.	(0.313)	2.94	-0.520	*	(0.212)	1.48	-0.511	*	(0.218)	1.57
Third_P_inf	0.696	*	(0.293)	1.91	0.623	*	(0.25)	1.39	0.690	**	(0.256)	1.50
IPC controls	yes				yes				yes			
Application year controls	yes				yes				yes			
No. of observations	192				192				192			
Log-likelihood	-86.7				-89.5				-90.2			
AIC	251.4				229.1				228.4			
McFadden R^2	0.286				0.263				0.258			
Nagelkerke R^2	0.424				0.395				0.388			
Correctly Classified	0.786				0.760				0.797			

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1

Table 7: Regression models for the analysis (4): Possibility of rejection for finally granted patents

	Model 4-1 (Basic)				Model 4-2 (Challenged)			
	Estimate		s.e.	VIF	Estimate		s.e.	VIF
(Intercept)	-2.691		(2.966)		1.128		(1.367)	
Nat_pri	1.385	*	(0.543)	1.33	0.950	*	(0.463)	1.28
Foreign	1.166	*	(0.583)	2.20	1.174		(1.074)	1.45
Leg_person_int	**-0.206**		**(0.604)**	**1.15**	**-0.242**		**(0.63)**	**1.12**
Search_out	0.181		(0.425)	1.35	-0.015		(0.454)	1.34
Num_classif	0.050		(0.121)	1.31	0.014		(0.122)	1.17
Fw_cit	-0.013		(0.073)	1.16	0.028		(0.071)	1.18
zCl1_len	-0.423		(0.352)	1.78	0.336		(0.412)	1.59
zNum_claims	-0.074		(0.23)	1.39	-0.654	*	(0.306)	1.97
zDesc_for	-0.001		(0.234)	1.49	0.287	.	(0.171)	1.69
zDesc_lat	0.118		(0.188)	1.42	0.040		(0.295)	1.51
log_Ap_to_FA	-0.106		(0.676)	1.27	-0.402		(0.275)	1.43
log_Exam_exper	**-0.338**	**.**	**(0.195)**	**1.13**	**-0.479**	*	**(0.203)**	**1.20**
App_cit_pdom	-0.071		(0.148)	1.40	0.007		(0.068)	1.63
App_cit_pfor	0.019		(0.074)	1.64	0.034		(0.198)	1.35
App_cit_nonp	-0.059		(0.138)	1.49	0.025		(0.12)	1.14
Third_P_inf	2.324	**	(0.82)	1.12	0.508	*	(0.208)	1.32
IPC controls	yes				yes			
No. of observations	400				267			
Log-likelihood	-110.6				-95.9			
AIC	269.2				239.7			
McFadden R^2	0.135				0.150			
Nagelkerke R^2	0.175				0.209			
Correctly classified	0.913				0.858			

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1

5.3 Factors Related to the Minimum and the Maximum Survival of Patents

The results shown in Tables 4 to 6 show a striking difference in the variables showing high statistical significance. The variables showing statistical significance for analysis (2) were the same as in analysis (3), representing the factors related to the maximum survival of patents. These variables were different from those in analysis (1), representing the factors related to the minimum survival of patents, with the exception of *Nat_person* representing individual applicants, and *Num_classif*, representing the number of classifications. Table 8 summarizes the factors related to these variables with indications of positive (+) and negative (-) effects on patent validity, with the factors common to both in italics.

The results thus strongly support the hypothesis in section 3.1 that the approach taken in this study allows the identification of two categories of factors, each related to the minimum and the maximum survival of patents.

Table 8: The Factors Related to the Minimum and the Maximum Survival of Patents

Factors Relating to Minimum Survival	Factors Relating to Maximum Survival
(+) Internal drafting of applications (by legal persons)	*(+) Natural persons as applicants*
(+) Natural persons as applicants	(+) Infringement lawsuits
(+) Final checking of claims by the Board of Appeals	(+) Patent families in the IP5
(+) Total length of description	(+) Length of description explaining the prior art and problem to be solved
(+) Length of description explaining the patented invention	(+) Number of commercial databases used in search
(+) Length of time from first application to first action	(+) Number of third party submissions of information
(-) Number of patent classifications	*(-) Number of patent classifications*
(-) Length of examiner experience	(-) Number of communications

5.4 Characteristics of the Decision Makers

5.4.1 Examiner Experience (*log_Exam_exper*)

Cockburn et al. (2002) focused on the effect of patent examiner characteristics, and found no strong statistical association between examiner experience or workload at the time a patent is issued and the probability of the CAFC finding it to be invalid if it is subsequently litigated.

This study found different results for the experience of Japanese examiners. The length of examiner experience showed an inverse correlation to minimum patent survival. This result was unexpected, since experience was thought to improve the quality and efficiency of search and examination. Furthermore, in the JPO, assistant examiners are trained by experienced examiners (tutorial examiners) for two to four years, which means that the skills for search and examination are passed on from the older to the younger generation.

In order to understand the relation of examiner experienced and the tendency to grant or reject an application, logistic regression analysis using the “concluded” data set and 400 random unchallenged samples from the “basic” data set was conducted. The results in Table 7 show a weak inverse correlation between examiner experience and the rejection of patents finally granted but not challenged, and a strong correlation between examiner experience and the rejec-

tion of patents subsequently challenged.

A possible explanation for this result is that for controversial cases which require a difficult decision, such as those subsequently challenged, examiners with less experience have a tendency to reject, whereas those with more experience tend to grant. This tendency may not be significant for less controversial cases, such as in the unchallenged patents group.

The results shown in Tables 4 and 7 describe this tendency as a tradeoff between the possibility of obtaining patent rights without the need to file appeals and patent stability, rather than an overall decrease of examination quality associated with the length of examination experience.

5.4.2 The Role of the Board of Appeals (*App_grant_Opp*, *Pre_board_Gr*)

The results suggest a strong positive correlation between the patents finally checked by the Board of Appeals and the minimum survival of patents (Table 4). This finding was different to the findings of Nakamura (2013), who found that opposition procedures positively correlate to a higher validity rate, whereas patents granted by the Board in appeals against the examiner's rejection did not.

The "concluded" data set included mostly patents granted by the Board upon appeals, and only one patent passing opposition procedures, which was subsequently invalidated (complete loss). This may seem that only patents granted by the Board upon appeals have improved validity. However, considering that the appeals procedure and the former opposition procedure are both *ex parte* procedures with the same authority deciding patentability, it seems straightforward to expand the results to patents passing the former opposition procedure. These results also show a striking comparison to patents granted in the pre-Board examination, which also is an appeals case. These patents did not show any significant correlation with patent survival, indicating a similar level of validity to patents granted in the examination stage. Since the major difference between a pre-Board examination grant and patents granted (or maintained) by the Board is the authority granting the patent, the conclusion here is that the Board of Appeals can greatly supplement and improve patent validity, which is exactly their role in the patent system.

5.4.3 The Effect of Search Outsourcing (*Search_out*)

Nakamura (2013) reported that patents in which prior art search was outsourced had increased possibility to be determined valid in invalidation trials. However, I was not able to confirm this correlation for neither the minimum nor maximum survival of patents. The estimated coefficients for the models of minimum and maximum survival were also mixed, indicating that the search outsourcing does not relate to any difference in validity compared to in-house searching.

5.5 Characteristics of the Drafter of the Specification (*Foreign*, *Leg_person_int*, *Nat_person*)

The results shown in Table 4 suggest that legal persons such as corporations drafting patent applications internally have an advantage over legal persons working through outside patent law firms. By combining these results with subsequent informal hearings from several patent attorneys and corporate executives in the IP section, I can present three non-exclusive hypotheses. The first is that corporations draft their most important patent applications internally, in order to control the secrecy of their know-how and their long-range strategies. The second is that the closer communication and understanding of the background arts between inventor and drafter work positively to draft a specification that has stronger defense. The drafter may be able to suggest the most effective comparisons, embodiments, or data which can defend the patent against any challenges. The third is that there is a strong incentive for outside patent attorneys to try to have the widest (and perhaps the riskiest in terms of patentability and validity) claim possible, in order to have an advantage over competing patent attorneys. However, since the results in Table 7 do not show a significant difference between internal specification drafting and outsourcing in terms of the possibility of being rejected before final grant, it seems difficult to support the third hypothesis that outside attorneys draft more daring claims from this analysis. The first and second hypotheses need to be studied in-depth to reach any further conclusion.

As for the patents applied by natural persons, the results show a significant positive correlation to the minimum and maximum survival of patents. Although it is difficult to evaluate the reason at this point, the second explanation on the improvement of minimum survival of patents by legal persons may also apply for individual's applicants, which usually are also the inventors. The reasons for which maximum survival is improved may also be similar, but further analysis is necessary to reach a firm conclusion. Furthermore, since there were only 16 patents applied by natural persons, the sample size was too small to statistically evaluate the role of the patent attorney. Of the 13 patents with patent attorneys, none were complete loss, and 5 were complete survival. Of the 3 patents without patent attorneys, 1 was complete loss and 2 were complete survival. There may be a possibility that the patent attorney improves the validity of patents applied by individuals. In such a case, the role of the patent attorney may be different for the corporation and the individual which have different strengths and capabilities. This possibility can further be extended to different roles of the patent attorneys for clients with different sizes and capabilities, which may create different needs. Further analysis is necessary for a detailed view on what the role of the patent attorney which best improves the quality of patent drafting.

5.6 Third Party (*Third_P_inf*, *Infringe_lawsuit*)

Although the results shown in Table 4 do not show a significant correlation of pre-grant third

party submissions to the minimum survival of patents, there was a very significant positive correlation to the maximum survival (Tables 5 and 6). The documents provided by the third party aim at, above all, the broadest claim. Thus, it seems natural that the resulting claim after examination using the document can defend itself against challenges of the same level. The findings here coincide with the findings of Nakamura (2012).

Cases of infringement lawsuits parallel with the invalidation trials showed a strong correlation with the maximum survival of patents (Tables 5 and 6). Since the patent holder would usually double-check the validity of its patent claims before filing a suit, the variable should indicate the enhanced possibility of survival through the double-checking process. The variable may also represent the patent holder's reluctance in narrowing the claims, which would weaken the powers of the patent.

5.7 Length of Description (*zDesc_all*, *zDesc_ratio*, *zDesc_for*, *zDesc_lat*)

The results shown in Table 4 show a strong positive correlation between the total length of description (*zDesc_all*) and minimum survival of the patent. Models 1-2 and 1-3 show that the length of the latter half (*zDesc_lat*) explaining the patented invention in detail relates positively to the survival of the patent. This may be because a detailed description may serve as a basis for arguments defending patent validity. Furthermore, since the valid group in this analysis includes amended patents, the result may reflect that the longer description becomes a basis allowing a larger possibility for amendments that can avoid any challenges on novelty and inventive step.

The results shown in Tables 4 and 5 show a different aspect of a patent's description and its validity. The results show a significant positive correlation between the length of the former half of the description (*zDesc_for*) and maximum survival of the patent. Since the former half of the description includes consideration of the prior art and its problems, the results imply that applications in which the prior art and problem to be solved is thoroughly considered gives a clear understanding of the strong points of the claimed invention, defending it against challenges to novelty and inventive step. This is an important finding since the variables relating to the number of applicant citations do not show any significant correlation to the minimum and maximum survival of patents. From this comparison it can be said that it is not the number of applicant citations that improve the validity of patents, but the adequacy of the prior art cited and how the claimed invention is explained in relevance to the prior art that contributes to the resistance properties and the adequacy of the language of the broadest claim. Sampat (2005) concluded that patent applicants devote more effort to identifying prior art for more technologically and commercially valuable inventions. The results shown here explain where such applicant's effort contributes to patent validity.

The ratio of the former half of description to the whole specification did not show statistical significance in relation to patent survival as Niiyama (2007) reported previously. Together with the other results, we can say that the length of both former and latter halves are important, with the role of the former being a guide clearly showing the direction of the invention, and the role of the latter being the breadth of the invention's practical application, both working to defend the patent against any anticipated or incidental attack.

5.8 Number of Classifications (*Num_classif*)

The number of classifications showed a negative correlation to both the minimum and maximum survival of patents. This result was opposite to those of Mann & Underweiser (2012) which reported that for U.S. court decisions, the number of classes into which the patent is classified has a significant and positive relation to validity. Their analysis was that the number of classes into which the invention is classified might better be understood as reflecting the success of the applicant and examiner in understanding the entire range of technology over which the invention operates, or that cross-classification of patents might be a proxy for innovation in a cutting-edge area.

Inventions stretching over multiple technologies indicate technical complexity (van Zeebroeck & van Pottelsberghe de la Potterie 2011b). Examination of patents with such inventions pose a difficulty in search and examination, although the examiner may understand the range of technology that the invention stretches over. The results of informal consultations with applicants and examiners imply the difficulty of discovering the motive to combine elements from a certain technology with other elements from a different technology. Going back in the history of the development of the claimed invention may enable one to find a common link or similarities between the two technologies, but this sort of information is not easily found by routine queries in the databases.

Furthermore, the hypothesis that cross-classification of patents might be a proxy for innovation in a cutting-edge area may need more information on the reason the patents were invalidated for. This is because if the patented invention was in a cutting-edge area, there may be different approaches to the technology, meaning that documents other than predicted by the applicant or examiner might be used as a basis for challenge to inventive step. Furthermore, if the technology was in an area of high uncertainty, such as biotechnology and chemicals, the challenges may not be against inventive step, but other reasons such as support and enablement.

5.9 Time-Related Variables (*log_Ap_to_FA*, *Num_comm*)

The results shown in Tables 4 showed a positive correlation between the length of time from

first application to first action and minimum validity of patents. The results shows the importance of the variable, and coincide with the findings of Kobayashi (2013) and Nagaoka & Yamauchi (2013). The explanation for this result is that the examiner's direct and indirect access to documents that explain the background technology, especially documents on the state of the art which suggest links between different technologies, would be limited just after the invention. General documents on the background of an invention would appear only appear after the potential of the invention is sufficiently explored, and even if more specific documents exist, the use of accelerated examination greatly decreases the chances of third party submissions to reach the examiner in time[9].

The results shown in Table 4 also showed a weak correlation between the number of communications and minimum validity, but Tables 5 and 6 show a significant correlation between the variable and maximum validity, especially from the comparison between the "partial survival" cases and the "complete survival" cases. This result implies that the large number of communications arises largely from a divergence of views between the examiner and applicant on claim drafting. It seems that claims drafted in ways that create a difficult decision for the examiner are, in the end, weeded out in the process of invalidation trials.

5.10 Other Variables

The variable of interest here is the number of patent families within the IP5 (*Fam_IP5*), number of commercial databases used in search (*Num_com_db*), both of which showed a significant positive correlation to the maximum survival. Other variables, such as the standardized number of claims (*zNum_claims*), normalized length of claim 1 (*zCl1_len*), and variables related to the number of citations added by the examiner showed no significant correlation to patent validity.

5.10.1 Patent Families

Mann & Underweiser (2012) reported that the number of families suggest an inverse relation to validity, explaining that it reflects different national standards for patent drafting. The results of this study are different. The results fit better to their original hypothesis that patents subjected to the prosecution processes of other patent offices would display a higher quality, both because of the benefits of a parallel examination and search and because of the reputedly high capabilities of those offices. It may also seem, considering that the variable also represents the value of the patent (van Zeebroeck & van Pottelsberghe de la Potterie 2011b; Mann & Underweiser 2012), that a high value of the patent would prompt patent holders to maintain the original scope of

[9] In the cases studied in this paper, most of the third party submissions to applications using accelerated examination arrived later than patent grant.

claims to the extent possible. However, the number of forward citations (*Fw_cit*), another variable considered to represent patent value, showed no significant correlation to the maximum and minimum survival of patents. Thus, the results of this study do not fully support this hypothesis. The results of this study also imply that the technical relevance of a patented invention to future technologies is not necessarily linked to the strength of defense of the patent.

5.10.2 Number of Commercial Databases Used in Search

The use of commercial databases in search is critical for the search of a number of technologies such as biotechnology, chemicals, food products, and for the search of non-patent literature. The results of this study suggest that the use of commercial databases to the extent necessary is effective to find prior art that affects the scope of the broadest claim.

6. Conclusions

This study sheds new light on the methodology of empirical studies on factors relating to the minimum and maximum survival of patents against challenges to validity. Instead of focusing on the text of judgment of decisions, this study used three categories of the outcome based on the difference of the scope of protection at the time of grant and after the challenge as the dependent variable; (1) “complete survival”, (2) “partial survival” and (3)“complete loss”, along with new and recently studied independent variables. The approach enabled identification and classification of the factors relating to patent validity into factors critical to patent survival and factors affecting the scope of the broadest claim. The difference of the factors in each group suggest a qualitative difference in the effect of these factors on patent validity. Thus, this study proposes a new methodology in empirical studies of patent validity.

The methodology described in this paper may also be applicable to other patent systems, such as the new re-examination system in the U.S., and the opposition system in Europe in which patent validity may be challenged. An opposition system will also be introduced in Japan shortly. Studies on the results of the challenges using the methodology can be expected to identify the more important factors that need to be dealt with in order to improve the quality of patent systems.

Considering that the validity of patents becomes visible only through legal challenges on validity, the study also has some implications for patent policy. Although we need to be careful to generalize the results of this study to the population of all granted patents, as will be mentioned below, the results can support ideas on patent policies that has been considered in different backgrounds.

For example, the Japanese patent system will be reintroducing a system for oppositions, in which an *ex-parte* procedure by the Board of Appeals will check the final claims after grant. The results of this study supports this system, since it increases the chances of a final claim check by the Board, which improves patent validity. The finding also could support an expansion of final checking by the Board, for example, by abolishing the pre-Board examination process, and having the Board directly handle all appeals cases[10]. A further suggestion may be to take further measures to improve the consistency of the examiner's decision. The tendency to allow or reject difficult cases according to the length of experience implies that the structure of the training system in the JPO, which gives examiner training at certain intervals in the examiner's career, can be improved. Although it would be difficult to decide on how high an examiner should "raise the bar" without analyzing on the overall effect that it has on economy, a general direction could be to move towards improved consistency of decisions among examiners, the Board of Appeals and the courts.

Furthermore, the based results of this study show the relation of some basic aspects of specification drafting and patent validity, and introduces new areas to be explored. Further studies on the detailed contents of the description, and also the involvement of the patent attorney in relation to the characteristics of the applicant may yield information on drafting practices that could improve the quality of the application, which can be spread in the patent community through outreach activities.

While the overall results are encouraging, we need to acknowledge that the current study has some shortcomings. First of all, we need to consider that the cases discussed in this study as a group, comprise a different category compared to the rest of the granted patent population. Although we now have information for the more important patents, there remains to identify and consider the effects of factors relating to the challenge of patent validity in order to safely expand the results to the unchallenged patent population. Identifying factors related to the validity of unchallenged patents may not be of high importance from the business prospective, but are important when we consider specific policies to improve patent application and patent prosecution.

The prior literature have indicated that patents being challenged in oppositions, re-examinations, invalidation trials or infringement law suits have different characteristics to those that are not.

[10] The objective of the pre-Board examination is to let the examiner have a last consideration of any final amendments, and filter the allowable cases before entering the costly appeals procedures. The same objective could be accomplished by an extra communication if the examiner sees any possibility for a meaningful amendment.

The probability of being challenged increases with patent value, measured in terms of forward citations, number of claims or designated states, third party submissions, and accelerated examination (Graham et al. 2002; Harhoff & Reitzig 2004; Nakamura et al. 2011; Scellato et al. (2011); Mann & Underweiser 2012). If the difference between challenged and unchallenged patents relates only to the factors affected by the value of a patent, this may not be a major problem, since those factors are *affected by* patent value and not the other way around. However, at this point we are not sure of that. Thus, we need to see if the patent application and prosecution patterns affect the possibility of challenges to patent validity, through changes in patent value or through other mechanisms, in order to reach a more accurate conclusion on what changes we need to improve our patent system.

Secondly, with the exception of the existence of parallel infringement law suits, this study focused on factors occurring before patent grant[11]. According to the results of this study, these factors account for less than half of the outcome. Thus, in order to get a clearer view of all the factors relating to challenges against patent validity, there is a need to consider the contents of the decisions, to identify the conclusive argument or citation, and to see if these factors have been thoroughly examined in previous examinations, and if not, the reason why.

This study is, therefore, an introductory attempt to look into the details of the factors relating to patent validity, and more sophisticated attempts, both for particular technical fields and the population of patents, should follow.

[11] Forward citations may occur after grant, but if we consider this as a proxy variable for the inherent value of the technical disclosure of patents, it not would be so strange to say that this is also a variable decided before grant.

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