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The Economics of Pending Patents

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Abstract

We provide a treatment of a number of questions pertaining to pending patents – a subject that has so-far mainly been discussed en-passant in the existing literature. We present the underlying institutional and legal framework that governs pending patents and some basic facts related to them. Then, we focus on the strategic considerations of firms in the earliest stage of the patenting process and the interplay with the patent office. This is followed by considering the perspective of the patent and trademark offices (PTOs), in particular, acknowledging the limited resources that are available to PTOs. Finally, we investigate the potential abuse of pending patents and the role of reputation of patenting firms.

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Keywords: patenting, pending patents, innovation, patent office overload, patent inspection, grant delays.

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1 Introduction

Imagine yourself playing chess with an acquaintance, with whom you are not necessarily friendly, so that the outcome of the game matters to you. Your acquaintance bought the board and pieces, and as a compensation for his investment, you agree that you are not allowed to use your left bishop for the first twenty moves – if you do, your opponent may appeal to a referee who will dole out an expensive punishment to you. The rules are clear: You are at a disadvantage which your opponent has earned through his prior investment. In the course of the first twenty moves of the game, your immobilized figure may become redundant, as the focus of the game has shifted elsewhere, or it may even be removed from the board by a move of your adversary. It will almost definitely burden the progress of your other figures that you are trying to develop. Now picture the same situation with just a slight twist: For the first couple of moves, *you do not know which figure* it is that you are not allowed to touch. Which situation would a strategic player prefer to be in?

The former setting resembles the way the patent system is generally understood by lawmakers, the press and many academics up until now: Patents encourage innovation by awarding a clearly defined (by the claims in the patent document), temporary (twenty years from the date of application) strategic advantage over competitors. The latter, as we argue in this article, is – at least along one dimension – perhaps closer to the kind of strategic situation that firms in industries with patents actually face. In addition to the clearly defined, observable patents that have been granted (and whose infraction firms are mostly able to avoid, if this is determined prudent) there are different types of pending patents in the market: some of which are completely invisible (at least up until 18 months from application), all of which are generally unchallengeable – yet they still exert influence from their inception, which becomes even stronger if a patent is later awarded.

In this article, we provide a treatment of a number of questions pertaining to pending patents – a subject that has so-far mainly been discussed en-passant in the existing literature. We proceed as follows: First, we briefly present the underlying institutional and legal framework that governs pending patents and introduce the necessary terminology for our pursuits. As a next step, we focus on the strategic considerations of firms in the earliest stage of the patenting process and the interplay with the patent office. We also explicitly focus on the perspective of the patent and trademark offices (PTOs): we consider different mechanisms how to allocate available resources, while keeping track of the aims that the PTO must bear in mind. Finally we ask the provocative question, why we do not observe (even) more abuse of patent applications aimed at obtaining pending patents and point to potential answers.

In the spirit of a survey article, for each of the topics indicate the relevant literature that we rely on as we go along, though we do not aim to be complete and the selection, therefore, is idiosyncratic.[4] Further, we attempt to point out subjects and questions that in our eyes are deserving of a closer look, empirically or

4 For a comprehensive survey on recent research in the area of patenting in general, see, e.g., Hall and Harhoff (2011).

theoretically.

2 Institutional framework

The rules governing the patent system have been subject to significant changes in the last decades, whether with regard to patentable subject matter – consider the controversies regarding (and finally introduction of) the patentability of software code[5] or business methods[6] – the disclosure of patent applications which we will discuss in some detail below, or, most recently, the switch from a first-to-invent to a first-to-file system in the US.[7] The latter constitutes a further step towards harmonizing the major patent regimes, the so-called "Triad" of Europe, Japan and the United States.[8]

In this section, we discuss some relevant features of the existing institutional frame- works that are particularly pertinent to pending patents: patent grant delays (and patent protection), patent grant rates, the disclosure duties regarding the information included in the patent application and the expected gains during the pending phase.

2.1 How long are patents pending?

Internationally, patents generally grant 20 years of protection for the included claims. The "clock" starts at the priority date, i.e. the initial date of application,[9] while protection – with important exceptions[10] – sets in at the time that the patent is granted. This clearly makes grant delays, the time between an application and the decision by the PTO, a potentially important issue: A five-year grant delay, for example, reduces the duration

5 Following the 1981 *Diamond* decision, the US PTO has let this become more common practice subsequently.

6 According to the United States Court of Appeals for the Federal Circuit *State Street* decision in 1998, business methods can be protected by a patent if a) practical applications are involved and b) it produces a useful, tangible result. This decision revoked the previous notion that business methods were specifically to be excluded from patentable subject matter.

7 The so called *America Invents Act* was approved by the Senate on September 8, 2011. This is not to be confused with the *American Inventors Protection Act* of 1999.

8 For more details on this process, see Straus and Klunker (2007); for a discussion on the controversy regarding the switch to the first-to-file system in the US, see "Fighting Backlog in Patents, Senate Approves Overhaul" (Edward Wyatt), New York Times September 9, 2011, page B4. For a discussion of the results of patent reforms prior to 2000 in the US, see Gallini (2002).

9 In the US, this has replaced a rule of 17 years of protection from the year of the patent grant in the course of the Uruguay round WTO negotiations in 1995, see e.g. Johnson and Popp (2003) and Maskus (2006).

10 Once the application is filed, this precludes other parties from successfully applying for a patent on the same subject matter. In some jurisdictions, such as Europe (EPO applications) and Germany (§§30,140 German Patent Law), once the application is published it grants protection contingent on the patent being granted later on. For more details on the US, see section 2.2 below.

of full patent protection to 15 years. Add to this the fact that patent applications must be made public 18 months after the priority date (if the application is upheld by the applicant),[11] which, in addition, creates time-windows during which ideas are in the public realm without much protection. The first issue we address as a basis for our further discussion is the duration of grant lags within different patent regimes.

Much happens between the original filing of an application for a patent and the decision of the PTO whether or not to grant the individual claims outlined therein. A naive first approach to quantify this would be to look at the average time that elapses (though we will see in a minute that considering averages is not that helpful). A number of studies have computed this kind of figure: Hall and Harhoff (2004) found that the average time of pendency for patents at the US PTO was around 24 months in 2002 (up from 18 months in 1990), which can be related to a yearly increase of the number of patent applications of about 5 per cent since the seventies. As the capacities of the PTO have not increased analogously, they estimate that the average workload of each examiner, measured by cases per year, increased by more than 20 per cent in the five years until 2002. In their sample, Popp, Juhl, and Johnson (2004) find an average lag of around 27 months for US patents, analyzing data on all applications for utility patents in the US between 1976 and 1996. King (2003) reports an increase in the average pending duration between 1988 to 1999 from 20 months to around 25 months. Note that therefore the 1995 reform replacing the 17-year term from granting to a 20-year term from application would on average increase the duration of patent protection in the US.[12] As discussed below, it is more complicated (and potentially more valuable) patents which require longer inspection and whose protection may therefore be shorter after the reform. For Europe, Harhoff and Wagner (2009) find a substantially longer average decision lag of 52 months at the EPO, for applications filed between 1978 until 1998.

What happens during this interval at the PTOs? We outline the processes very briefly below.[13] In the US, the following steps take place:

1. Upon reception, the completeness of the application is ascertained (if the application is deemed incomplete, it is returned to the applicant who has a chance to resolve remaining issues) and the priority date is determined. Then the application is assigned a classification. Based on this classification, the file passes through two filters, the Technology Center[14] and subsequently the

11 We further discuss this rule – and its exceptions – in section 2.2 below.

12 For further recent numbers on the net-effect of the introduction of 20-year from application rule, see Dennis Crouch's analysis at http://www.patentlyo.com/patent/2010/12/one-of-the-most-important- attributes-of-a-patent-is-its-term-or-duration-of-enforceability-in-1995-the-us-patent-system-beg.html

13 For a detailed description of the US process, we refer to the excellent Popp, Juhl, and Johnson (2004) and King (2003). For a description of the process in the form of a flow-chart, see www.inventorbasics.com/Patent%20Process.htm.

14 Currently there are 9 Patent Technology Centers at the US PTO, a list of which can be found at

Specialized Art Unit,[15] which further differentiate its classification.

2. As a result, the file is assigned to an individual examiner by the director of the Art Unit and enters the examiner's queue. This point of the process is where the backlog at the patent office accumulates and has accumulated.

3. Once the examiner arrives at the application, she must determine the contents of each claim made, and then commences the prior art search, based on existing local and foreign patents as well as scientific and trade literature, aided by specialized electronic databases. A report, including any problems and conflicts that were discovered, is then issued and presented to the applicant.

4. Upon receiving the report on the prior art search, the applicant has 6 months to respond regarding the issues that have been raised. Note that this process can be repeated: the examiner must reply within 2 months, which grants the applicant a further 6-month window to respond in turn. For this exchange, the examiner must determine whether the amendments are still within the realm of the original application, or whether the process must be started anew.

5. After these correspondences the examiner must decide whether to grant or to reject the patent. In the latter case, the applicant can decide to appeal the decision or file a so-called continuation: The latter can be interpreted as a request for a renewed (complete) examination of the (potentially amended) patent application, which keeps the original filing date. For details on this, see Quillen and Webster (2001) and Quillen, Webster, and Eichmann (2002). Further reasons for continuation is a separation of the original application into multiple patents, or improvements to the original design which require the application to be updated.

Note that both, researchers and the USPTO itself, have suggested introducing tweaks to the current procedure in order to deal with the problems created by backlogs more efficiently by inducing self-selection of applicants. The USPTO has suggested introducing a two-track application process, in which applicants can request a faster treatment over the current procedure. Also, applicants would be able to delay patent examination by up to 30 months, a practice that is used in, e.g., Germany, Korea and Japan.[16] In a similar vein, instead of faster examination, Bar and Atal (2011) suggest to introduce "gold-plated" patent applications, in which applicants with a higher prior of patent quality would be more likely to request a more intense and critical examination through the PTO.

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www.uspto.gov/about/contacts/phone directory/pat tech .

15 Art unit 3783, e.g., covers matters related to "Internal-Combustion-Engines", while 2785 is responsible for "Error Detection/Correction and Fault Detection/Recovery". For a current list of the Patent classes arranged by Art Units, see www.uspto.gov/patents/resources/classification/art/index.jsp.

16 See the 2010 press release for details, at www.uspto.gov/news/pr/2010/10 24.jsp. Currently, the USPTO has an optional deferred examination rule in place, which is, in fact, basically not being applied according to practitioners – see both the post and discussion at http://www.patentlyo.com/patent/2009/01/deferred-examination-pto-to-hold-roundtable-discussion.html.

How should one interpret the puzzling observation that a patent examination at the European Patent Office takes, on average, about twice as long as the US PTO examination? Can this be attributed to the institutional framework of the examination process? The workload for each examiner is rather similar by the numbers, at about 110 cases per examiner and year in the US[17] and about 120 cases examiner and year at the EPO[18] at the end of the periods examined in the studies mentioned above. At both institutions, despite efforts at hiring, examiner workloads have substantially increased over time; but these processes have run almost parallel at both institutions, so that the ratio of examiners to applications has remained very similar and cannot explain the observed difference.[19] If anything, practitioners communicate the impression that the circumstances at the USPTO are substantially less comfortable than at the EPO.

There is no fundamental institutional difference, such as additional inspection steps, between the European and the US system:[20] The process at the EPO is separated into two stages: a prior art search after the application has been filed, followed by the substantive examination of claims if requested by the applicant after she has received the search report. As opposed to the US, the application does not have to include a list of references submitted by the applicant. It appears unlikely though, that this is responsible for the observed differences. Popp, Juhl, and Johnson (2004) include a brief discussion with USPTO examiners resulting in the observation that depending on their quality and length, reference lists provided by applicants can both slightly decrease but also substantially increase the required examination efforts. During the substantive examination, communication between the EPO and the applicant may take place – for each correspondence, the examiner is able to determine how quickly the applicant must answer within the range of 2–6 months. When requesting the substantive examination, the applicant may request accelerated examination, which significantly and substantially reduces the grant lag, as Harhoff and Wagner (2009) find as a result of their survival analysis of more than 200,000 EPO applications. Despite – or perhaps because of – the feasible opportunity to speed things up, an accelerated examination was only requested in about 2 per cent of cases in their huge sample. Strategic factors (and moral hazard) may be at play here: One observes an actual acceleration through the request only for those patent applications that result in a patent being granted. If, on the other hand, the application is withdrawn or rejected, a request for accelerated examination is actually associated with an increased duration of pendency. Assuming that it is more important inventions for which the request is submitted, this could indicate a stronger willingness of applicants to drag out the application

17 See footnote 19 in Hall and Harhoff (2004), referring to 2002.

18 See Harhoff and Wagner (2009) for 1998.

19 For details, see EPO (2009) and USPTO (2009).

20 For a stylized overview of the European patent inspection process, see the figure in Harhoff and Wagner (2009). For detailed descriptions of the examination process, see the EPO guide for applicants at www.epo.org/applying/european/Guide-for-applicants/ and, even more detailed, for examiners at http://www.epo.org/law-practice/legal-texts/guidelines.html.

process for these valuable applications if they realize that it will not come to a successful conclusion.

Various papers study the determinants of patent grant lags: Applications with more claims, from more sophisticated technology fields, and higher "importance" (measured by family size or number of citations) take significantly longer to be examined, effects that generally hold for both jurisdictions – see, e.g. van Zeebroeck (2007), Harhoff and Wagner (2009) for Europe and Popp, Juhl, and Johnson (2004) and Johnson and Popp (2003) for the US. Regibeau and Rockett (2010) provide evidence to the contrary – they hypothesize, based on a theoretical model, that applicants significantly contribute to the delay at the patent office. More valuable patents, in the probability of patenting and the flow profits generated, should pass through the examination process more quickly. Their empirical results bear this prediction out – Regibeau and Rockett (2010) argue that this contrast to the existing literature might be explained by the fact that other papers did not take the so-called innovation-cycles into account: Whenever a ground-breaking new technology is developed, the patent office requires some time to learn how to deal with it adequately, therefore there will be a tendency for new (and important) technologies to be examined for longer periods of time. Controlling for this, they find that more valuable applications have shorter grant-lags.

But what explains the differential – why do EPO applications take so much longer? One possible and rather straightforward explanation is that the examination process is stricter and more rigorous in Europe, which simply takes more time. Strongly differing grant rates that appear to be systematically higher for the US than for Europe, as discussed in the following section, serve as some evidence for this line of argumentation. As we point out in Section 3, this may also provide quite different incentives to applicants to delay the process through strategic use of communication.

One important difference between the US and the European patent regime that may further explain this difference is related to the incentive structures of the patent examiners. First note, that it is non-trivial to determine the quality of the work of patent examiners: If a patent is (falsely) rejected, then there are a number of paths for the applicant (appeal, in some cases continuations) to resolve this issue – most of these are not observable from available data. What is observable, though, is post-grant litigation of patents, in which courts deem granted patents invalid ex post. This subject has been analyzed by Cockburn, Kortum, and Stern (2003) and King (2003). But this process takes a substantial amount of time (multiple years, especially in the case of appeals of the initial judgment), therefore, as Friebel, Koch, Prady, and Seabright (2006) and Schuett (2011) note, it must be seen in connection with the career paths of patent examiners. In its September 2007 report, the US Government Accountability Office (GAO)[21] found that of the 4,818 examiners that were employed at the time, more than 20 per cent were in their first year of tenure, which indicates substantial hiring efforts. But the USPTO employee base is subject to substantial attrition: between 2002 and 2006, one (experienced) examiner departed for every two new hirings. Schuett (2011) points to

21 See http://www.gao.gov/new.items/d071102.pdf.

fundamentally different tenure structures of the European and the US patent offices: While more than a quarter of examiners at the EPO have been at the institution for more than 15 years, the equivalent figure for the US-PTO is at only around 10 per cent. According to the GAO report, only about 50 per cent of examiners in the US could look back at a tenure of longer than 5 years. In most cases, therefore, incentives attached to the quality of decisions in the sense of court re-evaluations of patents will not be feasible for the US and individual examiners will be little inclined to overly consider their reputations. One might hope to address this issue by retaining examiners and thereby extending their average tenure (initiatives to achieve this are underway), but certain institutional details are difficult (if at all possible) to overcome: Patent examiners are highly specialized within their areas of expertise and obtain a valuable inside view into the processes within the PTO. Moreover, as Popp, Juhl, and Johnson (2004) elicited from PTO insiders, at least the first year of tenure must be considered a kind of training period, in which substantial investments into the human capital of new examiners are made. These kinds of expertise are highly prized in the market and industry poaching plays an important role.

There is a second, perhaps more obvious difference between the incentives at the USPTO and the EPO: While the incentive structure at the EPO is flat – at any given pay- level, there is a fixed salary – examiners in the US receive bonuses based on the number of applications that they process each year.[22] By most estimates, see in particular Friebel, Koch, Prady, and Seabright (2006), it takes an examiner about twice as long to reject a patent as it does to grant it:[23] Far more effort must be exerted in drafting the reports and the examiner must expect a substantial increase in correspondence with the applicant as well as the potential for appeals and litigation. This structure, together with the lack of a corrective via a reputation mechanism, as discussed above, makes it doubly attractive for US examiners to quickly issue grants for patents in their queue to accumulate more processed applications – which on average could speed up the process substantially, at the cost of inspection quality.[24]

To summarize the discussion of patent grant lags: Due to a substantial increase in applications over the last two decades, significant grant lags are observed at all major patent offices. As a result, patents spend on average more than 10 per cent (in the US), or even up to 25 per cent (in Europe) of their lifetime in pendency. Different prerogatives and incentive structures probably account for much of the difference in pendency between Europe and the US – with the US focusing on relatively timely processing and the European office stressing the (more time-consuming) detection of undeserving applications – but this issue is

22 For details, see Popp, Juhl, and Johnson (2004).

23 At the EPO, examiners qualify for promotions and raises through a point system – twice as many points are awarded for rejections as for grants, which takes the relative efforts that are required into account.

24 Schuett (2011) points out that the PTO may face a tradeoff between inspection quality and examiners' willingness to truthfully reveal their findings. Incentives that push examiners towards granting patents can be socially desirable in his model.

worth additional empirical analysis. One issue that we have so far not addressed is that applicants may contribute to the pendency durations through action of their own – we discuss different motives and methods for this below in section 3, but first turn to other framework issues.

2.2 Disclosure of applications, protection and grant rates

Let us briefly recount the normal timeline of the patenting process: After the initial application is submitted, the applicant has a 18-month window of time during which she may withdraw the application and thereby keep it secret. Generally, if she wants to uphold the application at this point of time, she has to agree to it being disclosed to the public, i.e. secrets contained within enter the public domain. While this has been common practice in most jurisdictions internationally, it has only become the rule in the US relatively recently with the American Inventors Protection Act of 1999.[25] And there is an exception to this rule: According to 35 U.S.C. 122(b), when filing an application to the US PTO, inventors can request non-publication (until the patent is granted), given that the applicant certifies in her request that the invention in question "has not been and will not be the subject of an application filed in another country". Though this exception has been criticized frequently in the past,[26] it was not repealed during the recent reform, according to our reading of the new legislation.

Disclosure of patent applications involves conflicts of interest: For the inventor, disclosure prior to receiving a patent grant constitutes a serious gamble – it takes away other possible venues of protecting her intellectual property, e.g., as a trade secret, that are no longer feasible once the application is on record and in the public realm.[27] Depending on the expectations of the inventor regarding the quality of protection – in this case this also includes the likelihood that the PTO will grant claims to the extent necessary for the inventor's business, in addition to the later enforceability in court – these other options may become even more appealing. As Anton and Yao (2004) demonstrate in a theoretical model, it may in particular be important inventions for which inventors then opt for secrecy, which reduces the dissemination of knowledge. Focusing specifically on pre-grant patent publication in the context of a cumulative innovation model, Aoki and Spiegel (2009) show that a pre-grant publication can reduce the incentives to patent basic technologies and might also lead to less research as a result, especially if patent protection is imperfect. From a social perspective, this can be desirable in their model, nevertheless, as the increased probability of spillovers given a patent application can lead to more products reaching the market, which increases consumer welfare.

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25 See, for example Popp, Juhl, and Johnson (2004).

26 See, for example Mossinghoff and Kunin (2008) who – apparently falsely – cite removal of this exception as one of the reform steps that should be completely uncontroversial.

27 While trade secrets are typically seen as substitutes for patents, in the case of complex innovations they may actually be complements, see the discussion in Denicolò and Franzoni (2008).

Other controversial issues may have to be taken into account as well. In particular, allowing to keep patent applications secret for indefinite time increases the likelihood of holdup situations arising due to so-called "submarine" patents: Consider that firm *A* has made some technological process and applied for a patent in an area, in which firm *B* is commercially active. As long as *A*'s application is pending and secret, *B* has no possibility to infer that its activities may lead to infringement of *A*'s intellectual property. It may even apply for a patent for technology that it has independently developed later on, since *A*'s application will not appear in prior-art search – not even for the patent-examiner in charge of *B*'s later application. Note that with the mounting patent-backlogs in mind, these kinds of potential redundancies in the activities of patent examiners pose a significant problem in themselves. But the situation for firm *B* can become extremely expensive, once it has sunk the investments for a new product line that potentially infringes *A*'s prospective patent. Because at this point, *A* may choose to let its patent "surface", i.e. pursue its application more seriously and let it enter the public realm, from which a typical holdup problem for *B* arises.

Two features of the patent systems render the problem of submarine patents somewhat mute: patent lifetime starting at application introduces an additional tradeoff which makes the "submarine" strategy less attractive and, more importantly, publication, which limits the potential term under water to 18 months. This is what makes the exception according to which applications can remain secret potentially problematic. Aoki and Spiegel (2009) quote PTO figures stating that the exception was only invoked in about 10 per cent of cases. As more data becomes available and the lifetime of these patents accumulates, it will be important to better understand in which cases this exception is applied: There is a first selection bias due to the fact that no international protection is being sought, which one would expect to make this option interesting in particular for (smaller) entities whose operations are centered in the US. As a further issue, it will be impossible for the econometrician to observe those (secret) applications that are rejected or withdrawn because they never enter the public realm. But there is one important question that can and should be studied: In the medium run, it will be interesting to observe whether and how often secret applications which later are granted as patents are involved in litigation. Two potential forces could be at play that lead to more litigation: On the one hand, secrecy makes it substantially harder to design around the patent, as also proposed, e.g., in Bessen and Meurer (2006). On the other hand, if there are strategic considerations at play in keeping a patent secret, i.e. if the applicant is trying to pursue the submarine strategy, this should further increase the probability of litigation. This kind of investigation would both let us better understand the true significance of the publication exception in US law, as well as the different motivations for patenting in general.

Sometimes advocates raise the specter of the time-window between publication and the granting of the patent, arguing that the idea is completely unprotected during this period. This may at first seem intuitive, but considering that any competitor would have to invest into technological capabilities, production methods and infrastructure as well as human capital, it appears rather unlikely that he would expose himself to holdup, if and when the patent is granted later on. Whether or not the idea is therefore de facto protected between publication and patent-grant, depends on the likelihood, both objective and subjective, that a patent will be granted for the application. We very briefly therefore turn to this subject next.

Official figures typically put grant-rates at around 50 per cent for the EPO and the JPO and substantially higher at around 60 per cent for the US PTO.[28] As Van Pottelsberghe de la Potterie (2010) points out, official statistics typically relate the total number of actions of examiners in a given final year to the number of grants and, therefore, do not paint a completely reliable picture.[29] For this, one would have to take a given generation of patents and study their respective outcomes – just one factor that complicates this that we have discussed in the previous section is that apparent refusals of patents may still be overturned in the process of continuations. As a result, we would expect the official figures to underestimate the true situation; which is precisely the result that e.g. Lazaridis and van Pottelsberghe de la Potterie (2007) arrive at using a cohort approach as discussed: they find that in the 1990s, despite the extraordinary increase in the number of applications, grant rates at the EPO were and remained above 60 per cent.[30] As a result, for any given application that competitors observe, without any further knowledge they should expect it to become a patent in about two-thirds of cases.

A further highly interesting factor is the relative propensity of patent offices to grant patents. We would like to point out the results of one study in particular, with further added relevance due to the introduction of fast post-grant patent reviews through the recent reform in the US. Hall and Harhoff (2004) use the following intuitive approach: They take cohorts of patents already granted in the US and try to match them to applications to the EPO with identical claims. Then they compare this to EPO applications following a granted priority application to another foreign office apart from the US. By comparing the outcomes in a kind of difference-in-difference approach, this is a straight- forward way to analyze the development of the strictness of the US PTO. The results are striking: While in 1979 the EPO was as likely to grant an application based on a granted US vs. a granted international patent, the quality of US patents has decreased significantly since then – in 1995, a US patent was about 15 per cent less likely to be awarded a European patent than an application based on a non-US patent. This strongly indicates a stricter standard being applied at the European than at the US patent office, which corroborates our considerations in the previous section. Hall and Harhoff (2004) link this disparity to the existence of a post-grant review system in Europe, which did not exist for the US at the time, a point also argued by Mossinghoff and Kuo (2002). Immediately after a patent being granted, third parties can initiate a comparatively cheap and fast process to oppose granted patents without invoking an expensive patent trial. A similar method has now been established in the US, therefore it will be interesting to observe the effects on US patent quality.

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28 See, for example, USPTO (2009).

29 Hall and Harhoff (2011) point out a further issue that may systematically skew reported grant rates: If one regime allows patent deferrals, while the other does not, then the longer time-window to let a patent lapse will tend to lead to more withdrawals of patents and therefore lower grant rates.

30 Note that depending on the methodology, the grant rates that researchers arrive at differ substantially. Straus and Klunker (2007), for example, report that about 40% of 2005 patent applications were granted in the US, while the figure for Europe is below 30%. But due to the timing of the study, this conflates grant lags and rejections.

After discussing the duration of pendency as well as disclosure obligations and grant rates, we next turn our attention to a further important dimension with regard to the strategic calculus: the economic value during the pendency of patents.

2.3 The value of pending patents

We have discussed in the previous section how any pending patent application exposes competitors to a certain kind of risk: If they develop products or otherwise engage in activities that infringe upon claims in the application, and a patent is granted later on, the value of the associated investment is destined to take a substantial hit. For a manufacturing firm, the declaration “patent pending” on a product can, thus, grant competitive advantages in the spirit of the chess-match analogy in the introduction: It signals to a competitor that he must tread carefully, and for 18 months (at least, as discussed) he does not even have the opportunity to find out the exact circumstances. Abuse of the terms “patent pending” and “patent applied for” are sanctioned with fines by law, in the US according to 35 U.S.C. 292 – fines are incurred in the case that no patent application was submitted (or the application is no longer pending), but without any regard to the patentability of the subject matter, i.e. the likelihood of patentability. As a placative example: a firm stamping a bread box with “patent pending” is perfectly within its rights, as long as there is a patent application related to the bread (or packaging, or baking method) currently pending at the PTO. On the flip-side, no rights are conveyed to the applicant through this stamp: Any gains derive from inducing competitors (or potential licensees) to behave in a desirable fashion when faced with the pending patent. As we will show below, these gains are substantial.

Let us first consider a licensing-situation between the inventing firm *I*, whose patent application is pending, and a potential licensee *L*. *L* faces the following problem: it can either enter into a licensing agreement and commence the necessary investments for production immediately, or it can let its behavior depend on the outcome of the examination process: if *I*’s application is rejected, then no license is required, and the corresponding fees are avoided – at the disadvantage of either postponing the investments and thereby production start or of investing under additional uncertainty with the possibility of having to bargain with *I* later on in a classical holdup situation. It is not surprising therefore that one observes substantial licensing activity regarding pending patents, with one important group of players in this field being university technology licensing offices as discussed by Henderson, Jaffe, and Trajtenberg (1998). To quantify: Gans, Hsu, and Stern (2008) generate a dataset in which patent and licensing information for technology licensing agreements in the 1990s is combined to study this question. They find that in more than a quarter of cases, the licensing agreements are concluded prior to the corresponding patent being granted. From the perspective of hazard rates though, there is a substantial and significant spike at the date of the patent grant (about a fivefold increase), but considering the complexity of this kind of sophisticated contract, this can be taken as an indication that the parties generally come to an agreement previously, even if formalization takes place only when the patent is granted.

Beside this licensing story, Henkel and Jell (2010) and Harhoff and Wagner (2009) each speculate about further channels how pending patents can create value for firms, potentially even more so than if they have already been granted: A first, direct effect is that the payment of search and renewal fees can be postponed.[31] In the spirit of our motivating analogy, the firm can also use the time during pendency to evaluate the market situation and better judge the value of the idea – the possibility to adapt the application in the course of the process (within boundaries) further enhances this. And finally, the uncertainty created for the competitor creates strategic opportunities, such as extending first-mover advantages and making it harder to design around the patent.

The overall effect also appears in the data, especially in the context of young firms in technology intensive settings: Using data from 269 Israeli technology start-ups, Greenberg (2009) analyzes the impact of pending and granted patents on firm values. The study separates the sample into software and non-software firms; for non-software firms, pending patents on average raise the valuation by between 3.8 and 4.7 million USD, with granted patents leading to a significantly higher raise. The fact that this does not hold for software firms may, on the other hand, indicate the dubious value of software patents. An important factor for the success of young technology firms is the availability of external financing through venture capital companies. Both Häussler, Harhoff, and Müller (2009) and Cockburn and MacGarvie (2009) analyze this question, both find that pending patents are associated with a significantly higher probability to obtain venture capital financing. According to Cockburn and MacGarvie (2009), this effect is even stronger for pending than for already granted patents. This probably reflects a taste for growth potential, which pending applications satisfy even better than granted patents already in the stock of the company.

3 Strategic interaction between applicant and PTO

After outlining the general framework that applies to pending patents, which one could consider the macro-level, we now turn to the micro-level: The actual interactions between the applicant and the examiners. If one were to study the patent application process in detail as a strategic game, it would be surprisingly complex – as we will outline below, the applicant has substantial discretion both with regard to designing the application and the claims included within and with regard to accelerating or dragging out the examination process. This is not our goal. Instead, we wish to briefly outline some of the tradeoffs involved, while pointing both to work that has already been done and to subjects that merit further study in our opinion. We first discuss the most important options available to the applicant, before we briefly turn our focus to the

31 The fee for an application at the EPO currently is between 105 and 203 Euro. The search fee (prior art search) and the inspection fee are significantly higher at between 800 and 1785 Euro and between 1,480 and 1,645 Euros, respectively. The grant fee, which covers the first two years of patent protection, is 830 Euro. After this, renewal fees increase from 420 Euro per year to 1,420 Euro starting from the tenth year, see http://www.epo.org/applying/forms-fees/fees.html. The fee structure in the US is very similar, though fees tend to be somewhat lower overall. For details, see http://www.uspto.gov/web/offices/ac/qs/ope/fee092611.htm.

PTO perspective.

3.1 The applicants' toolbox

In the course of this section, we will focus on two (interrelated) dimensions of discretion that the applicant has: first, discretion regarding the formulation of the application, i.e. the specification and claims; then, we turn our attention towards the different procedural possibilities and choices available to applicants. In both steps, the aim is to try to understand how observable data can be structured and then approached to learn more about the state of the patent system and the quality of applications.

The formulation of patent applications can almost be considered a two-part art-form, consisting of the specification and the claims.[32] What makes the subject so interesting is that the incentives of the inventor and society in general, represented through the PTO, are misaligned. The specification is the clear description of the idea, which is supposed to enable a competent person to understand (and reproduce) the invention. It is (mainly) the specification that catapults the inventor's know-how into the public realm. Therefore, it is in the interest of the public that the specification be phrased as clearly, precisely and completely as possible. On the other hand, the claims encompass the basic rights of the inventor after a patent has been granted: whom she can exclude from which kind of activity in which situation. Ex post, after investments for innovation have been sunk, it appears to be in the interest of society to limit the scope of these claims, while – at least at first glance – the inventor wants them to be as broad as possible; "possible" being defined by whatever can be enforced through courts. The claims and specifications are interrelated, in that the former must derive from the latter.[33] One can easily envision a bargaining process that takes place between the examiner and the applicant as the original application is adjusted and tweaked reacting to the examiner's criticism throughout the process.

Since both sides need to invest effort into the process, one can translate this situation into a problem of moral-hazard in teams. In Prady (2009), an inventor can invest into the clarity of his application, which reduces the effort required by the examiner to inspect the application. This may give low-quality inventors an incentive to try to induce shirking of the examiner by sending "scrambled" signals that require more effort to parse. But our previous discussion implies that an opaquely phrased application does not necessarily indicate a bad patent: Anticipating the examiner's reaction and demands to redact, it can also be a way to extend the period of pending while giving the applicant additional strategic flexibility: Harhoff and Wagner (2009) point out that in the process of redacting, the applicant is also granted the valuable opportunity to adjust her claims to new developments in the competitive setting. It would be a fascinating (though rather involved) exercise

32 For a recent guide to composition, we refer to Slusky (2007).

33 In fact, it may be in the interest of the inventor to formulate a relatively broad specification, as it can function as a fallback position if claims are drawn into doubt in the course of court proceedings.

to systematically compare the original specifications with those in the finally granted patent, taking the duration of the examination (and correspondence) into account. Among other things due to the costs involved, e.g., for legal counseling, one might expect different effects for individuals or small vs. large firms. Further, one might be able to relate a measure of "similarity" of the initial application and the final version to the quality or value of the granted patent.[34]

Apart from the formulation of the application, there are a number of formal instruments available to the applicant to influence the duration of pendency, whose details differ by jurisdiction. In the following, we present a selection of these as well as interesting questions related to observable data for each:

Requests for accelerated examination: Data for the application of this option is currently available for the EPO. As noted above, Harhoff and Wagner (2009) find that it is only used in around 2 per cent of cases, despite the fact that it substantially reduces grant lag. Similar to the discussion concerning the secrecy exception above, it would be highly interesting to better understand who makes use of this instrument, for example by the research intensity or level of competition within the industry, as well as the likelihood that these patents will later be involved in litigation.

Delayed examination: The option to delay examination is available to applicants in a number of jurisdictions either directly or indirectly, among them Germany, Korea and Canada. Henkel and Jell (2010) analyze this issue using data from the German PTO, where applicants can defer the process by up to seven years by postponing the filing of the request for examination. They find that in their sample of patent applications filed between 1986 and 2000, around 50 per cent of applications were delayed by the applicants and for around 20 per cent, the delay even lasted for the maximum possible seven years. In a subsequent survey sent out to inventors, they establish that strategic considerations do play a central role in extending the pending process: In particular, patents with the aim of inducing uncertainty for competitors were likely to be delayed, with different effects by industry.[35]

Patent Cooperation Treaty (PCT) application: A PCT filing provides the applicant a 30-month time-window during which she can apply in each PCT country, i.e. it extends the cutoff regarding the novelty criterion in these countries. If the applicant wishes to seek patent protection in any of these countries, it also tends to substantially expedite the process, as the original examination also includes an international search report.[36] The PCT filing has a second important effect: It tends to delay the examination in the original country, by about a year in Germany according to regression results in Henkel and Jell (2010), significant

34 Measuring the quality and value of patents in general, and individual patents in particular, is a rather thorny issue, see, e.g., Schankerman (1998), Cornelli and Schankerman (1999) or Hall, Jaffe, and Trajtenberg (2005) for different approaches to valuation and discussions of the potential problems.

35 For further, more detailed examinations of the effects of the opportunity to defer applications, see Hall and Harhoff (2011) as well as Thomas (2010).

36 For additional details, we refer to the description in Harhoff and Wagner (2009).

delays are also found by van Zeebroeck (2007) for Europe. If firms are interested in international patent protection, a PCT filing offers easier access to foreign patents, but a delayed grant in the priority country, which may be problematic for important innovations. In the context of delays it would be interesting to investigate whether there are PCT filings that lead to grants in the priority country, without any international filings taking place afterwards. This would be a further potential way to identify delaying tactics.

Filing of provisional patent applications: Since June 1995, 35 U.S.C. 111(b) gives applicants in the US the option to file a "provisional application for patent". This method allows an inventor to (relatively cheaply) establish priority, for example the requirement to file a prior art statement is waived. There is a 12-month pendency period for the provisional application, during which the applicant is allowed to use the term "patent pending". The application can be converted to a standard application, by filing a corresponding patent application, which has the important advantage that its patent term begins only at the filing date of the subsequent "full" application. In other words, filing a provisional application is a way to delay the patenting process by one year, while also extending the duration of patent protection.

As shown in this section, firms and inventors both have the tools to extend the pending period of applications substantially and they also make use of them for different reasons, at least some of which are related to the strategic interaction with competitors – factors that so long were not considered part of the "mission-statement" of the patent system. A further unsettling trend seems to materialize in the data: van Zeebroeck (2007) finds that the longer the inspection process for a patent, the more likely it is that the inventor will let it lapse, *even if it is granted by the EPO*. Together with the findings on the extension of pendency, this raises the specter of firms actually protecting their interests more effectively through pending than through granted patents: With the former being much more difficult to oppose by third parties. This issue should be studied in more detail, as such a development would seriously undermine the efficacy of examination in deterring abuses of the patent system. In the extreme, this might be considered a *de facto* shift from an inspection (granted patents) towards a registration (pending patents) regime.

3.2 The PTO perspective

Longer grant delays affect the aims of the PTO, as well. First turn your attention towards the quality of the match between the application and an examiner. Cockburn, Kortum, and Stern (2003) study the effects of the observable characteristics of patent examiners on the outcomes of litigation that arises after patents being granted, a measure for inspection quality that we have briefly discussed above. They do not find significant effects of examiner experience on the likelihood of a court finding a patent invalid and also the examiner workload does not have a significant effect. What does significantly influence the probability of a patent being invalidated by the courts is the technology field that it originated in. This may indicate matching difficulties in especially faddish fields or in fields in which it is systematically difficult to have adequate examiners. More generally, it suggests that the quality of the match is affected by the flexibility a PTO has when allocating patent applications to examiners. This flexibility is affected by the length of the patent

pending phase.

To illustrate the importance of the length of the patent pending phase, as a brief thought experiment, consider the case of a patent office as a "closed system", in which for each time period as many applications are received as decisions can be made by examiners: The PTO has the capacity to exactly deal with the incoming applications. By extending the inspection period, i.e. the average time each application spends in the queue waiting to be examined, the patent office might then be able to achieve a better match between examiners and applications. The following example illustrates this line of thought: A PTO covers two technological fields, termed *A* and *B*, and employs two specialized examiners, *a* and *b*. In each period, two applications are submitted to the patent office. Each examiner can consider exactly one submission per period. Suppose that each application falls within either field with equal probability and that all draws are independent. Thus, in a given period, with probability 1/4 both applications belong to field *A*, with probability 1/4 both applications belong to field *B*, and with probability 1/2 one application belongs to field *A* and the other to field *B*. First, consider an inspection period of one period, i.e. each period, incoming and outgoing applications must be the same: In this case, whenever two applications from the same field arise, one of them must be treated by a non-specialist. Hence, with probability 1/2 there is a mismatch. On the other hand, if we extend an inspection period to two periods, a mismatch only happens if the two applications that were not investigated in the previous period and the two applications that are submitted in the current period belong to the same field. Thus, if the two applications from the previous period that remain on the desk of the two examiners belong to field *A*, with probability 1/4 there will be a mismatch. Similarly, for remaining applications that belong to field *B*. In order to derive the overall probability of a mismatch, we determine the stationary distribution of the Markov chain with state space *(A, A)*, *(A, B)*, and *(B, B)*, which keeps track of the applications that remain on the desk of the examiners, i.e., we determine the probability these three states occur in the long run. Concerning the transition probabilities, we write the process such that examiners avoid a mismatch whenever possible. In this simple example, the stationary distribution is easily calculated as (1/3, 1/3, 1/3). Hence, with a two-period inspection period, a mismatch occurs with probability (1/4)(1/3) + (1/4)(1/3) = 1/6. Hence, by increasing the inspection period from 1 to 2 periods the probability of a mismatch is reduced by 2/3.

This simple thought experiment points towards some very interesting tradeoffs within a PTO. While longer queues may contribute to improving the matching quality (one could easily extend the example to also cover increasing workloads) they could also lead to (or indicate, which has the equivalent effect) an overload problem as proposed by Jaffe and Lerner (2004). Caillaud and Duchene (2009) theoretically study such a situation, in which a PTO can implement either a strict policy, in which it diligently examines each application and sifts out low-quality patens that should not be granted, or a lax policy, in which the large number of applications force the PTO to spend less time with each and therefore low-quality ideas are patented with higher probability. Each of these policies can be an equilibrium, depending on the beliefs of prospective applicants: If they expect the inspection to be lax, many applications are submitted, which forces the inspection to be lax; if they inspect the inspection to be strict, then fewer applications are submitted,

which grants the PTO the opportunity to diligently examine each application. This demonstrates why a PTO should attempt to not even appear to be suffering from overload. Note that there are different ways of achieving this: Both implementing a stricter inspection policy with the given capacities and increasing the inspection capacity, or, of course, a combination of these measures would be beneficial. Both of these steps are currently being implemented, with the EPO arguably focussing more on the quality/strictness of inspection and the USPTO on inspection capacities and hiring/retaining of qualified examiners. Allowing variability in queues may serve as an information gathering device in this context, as shifts help detect fields in which hiring or qualification measures should be focused (or can be relaxed).

Apart from the situation *within* PTOs, there is also an interesting dynamic between the PTOs of different countries. Some efforts have been undertaken to determine how identical (or at least originally identical)[37] patent applications fare at patent offices in different countries. Similarly to the study by Hall and Harhoff (2004) discussed in the context of relative grant-rates in Section 2.2, Webster, Palangkaraya, and Jensen (2007) construct a sample starting with patents that were granted in the US with priority dates between 1990 and 1995, that could be matched with applications both to the European and to the Japanese Patent Office with identical priority applications, without them being PCT applications. This leaves a sample of about 70,000 US patents. Similar to Hall and Harhoff (2004), they find that a substantial share of patents that were granted in the US are declined by the overseas patent offices. They further show that the treatment by the European and Japanese offices appear to differ systematically depending on the technological field and location of the priority application.

There is a very interesting facet of the data, which lies somewhat outside the scope of Webster, Palangkaraya, and Jensen (2007). The inspection outcomes at the two non-US agencies are not independent, which can easily be derived from the descriptives displayed in their study (with the caveat in place that we do not know the sequence of events): Overall, the frequency of withdrawals at the Japanese Patent Office was 29.6 per cent and at the European Patent Office was 18.5 per cent. Considering only those patents that turned out to be rejected by the other agency, the equivalent withdrawal frequencies are substantially higher, at 52.5 per cent and 23.1 per cent, respectively.[38] Compared to the withdrawal rates of the patents granted by the other institution (22 per cent and 9 per cent, respectively), the jumps are even more prominent, which also allows to control for the effect of time on the probability of withdrawals. Examination outcomes at the EPO, if it was faster, therefore affect the workload of the JPO and vice versa, and this effect holds via the channel of withdrawals, whether or not one institution is informed about the outcome of the other's examination process. If this information is transmitted, take the case of rejections, then the incentive to dither and acquire this information may further increase. Add this effect to the additional information accruing to the applicant

37 Excluding amendments during the application process.

38 The sample includes 2,672 patents that were rejected by the EPO and 10,230 patents rejected by the JPO.

over time discussed above, such as marketability, which may lead to withdrawals as well, and it becomes clear why, e.g., the USPTO might consider introducing deferred patent applications but also why the introduction of provisional patent applications, which are substantially cheaper and can be interpreted as a kind of deferral as discussed above, has been so successful.[39]

4 Abuse of pending patents

As we have documented above, pending patents are seen as valuable. For this reason, a firm may excessively apply with ideas that are not sufficiently novel. In particular, a pending patent may lead competitors not to enter the market or to sign licensing agreements already in the patent pending phase. At first glance this suggests that a long patent pending phase may even contribute towards excessive patenting; but a more careful look at this issue reveals that a firm may not go unpunished if it misuses the patent system and applies with ideas of no or little value, at least if this firm frequently generates new ideas.

The disciplining force is the reputation reputation of (or trust in) firms that comes into play for companies that repeatedly invest in innovative ideas. Koenen and Peitz (2011) provide a theoretical framework to address this issue. They propose an infinite horizon setting in the spirit of Klein and Leffler (1981) and Choi (1998): Each period, with a certain probability strictly smaller than 1, a firm generates an objectively patentable idea. Even when it does not, though, it can submit a patent application to the PTO. After some periods of inspection, the PTO grants patents to good ideas with certainty, while due to first-order mistakes it also grants patents to bad applications with a positive probability. If a patent has been granted, the firm holds it for the remainder of the patent lifetime (possibly qualified by competitors' challenges). During the pending phase, a firm generates income from each pending patent, depending on the publicly held belief regarding the patent quality. These beliefs are based on the observable his- tory of the game. To focus on PTO inspection, it is postulated that publicly available information is limited mainly to the results of the PTO's examinations of patent applications. In particular, beliefs are not conditioned on potential post-grant lawsuits. For each granted patent in the firm's portfolio, the firm receives a (belief-dependent) income for each period of the patent lifetime.

An equilibrium that supports reputation or trust consists in the firms applying for patents only if an objectively patentable idea has been generated and to resist from doing so if the idea is of questionable value. This equilibrium is supported by a belief system with which competitors punish observed deviations from such a strategy, by becoming more sceptical about the quality of patent applications. Given such belief formation, reputation can be sustained in equilibrium if future profits play an important role. This basic result holds independent of a firm's existing patent portfolio. Note that since pending patent are valuable and

39 About a quarter of all patent filings in the US are provisional applications, see USPTO (2009), for a brief discussion on the development and on who files provisional applications, see http://www.patentlyo.com/patent/2008/06/a-first-look-at.html.

applications take time to evaluate, there would be short-term gains from deviating even if the PTO perfectly distinguished between patent applications which merit protection and those which do not.

An additional important insight is that a large patent portfolio makes it easier to support reputation in equilibrium. The reason is that not only expected profits from future ideas are endangered by deviating but that even existing ideas that are patent pending or protected by a patent lose value if a deviation is detected. The reason is that these patents (or pending patents) are more likely to be challenged and defending them is costly. Such behavior by competitors can be expected on the ground that the public does not exactly know when the innovating firm has started to deviate from the reputation strategy. Thus, after an observed detection, competitors question the validity of other granted or pending patents within the portfolio of that firm. Thus not only current and future behavior of the firm is thrown into doubt, but past behavior, as well. This results in enhanced negative effects on the profitability of a firm whose deviation is uncovered. This suggests that the change of market value of a deviating firm should not only include changes in discounted profits due to a particular rejected application but should include a multiplier accounting for earlier ideas that are still under protection as well as its reliance on generating profits from innovation in the future (e.g., the frequency of submitting patent applications). The theory predicts that more post-grant lawsuits should be observed for patents within the firm's patent portfolio (consisting of pending patents and those granted patents that have not yet expired) after an application has been rejected.

A policy lesson that emerges from this insight is that a firm with a strong patent portfolio (including pending patents) is less likely to put its reputation at risk and, optimally using scarce resources, should therefore be investigated with less scrutiny by the PTO than a firm with a weaker portfolio. The second policy lesson concerns the question whether the "US" policy of fast inspection with a relatively high rate of first-order mistakes or the "European" method of more careful scrutiny at the cost of relatively slow inspection is superior. Based on the reputation argument, it may be well worth the "price" to pay for the PTO to take more time to investigate if the associated benefit of fewer first-order mistakes is sufficiently large. This holds in particular in the case of firms with a strong patent portfolio since a deviation puts the value of the existing portfolio at risk and, thus, delaying the action by the PTO may not make a deviation much more attractive. However, the general trade-off between more rapid action and more precision also applies to a reputation model.

5 Conclusion

Various factors, such as the overload at the patent offices, the deterioration of patent quality,[40] and the substantial increase of patent litigation,[41] paint the picture of a crisis in patenting. The US has recently reacted by carrying out a substantial legislative reform. Despite this picture, or rather contributing to it, there is an unbroken trend of increased patenting activity at all major PTOs. As a result, applications will continue to spend a significant share of the patent life-span in the "purgatory" of pendency. This fundamentally affects the economics of patenting. To paint a particularly threatening future: As the incentive to uphold patents once they are granted deteriorates due to their dwindling remaining lifetime, for some industries pending patents may become the new standard, with the more expensive actual patents turning into an afterthought. Due to the limited possibilities to oppose pending patents, this would subvert the traditional system of patent inspection into a pure registration system. These worries highlight how important it is to further improve our understanding of pending patents. In this article, we addressed several issues within this subject and raise questions that we find important. Owing to both the breadth and the relevance of this topic, our endeavor is necessarily incomplete: Therefore we are hoping for and looking forward to relevant new research on the economics of pending patents.

40 For comprehensive discussions, see Jaffe and Lerner (2004) and Bessen and Meurer (2008).

41 For a recent empirical study on some of the determinants, see Cook (2007). For an empirical assessment of the relationship of firms' strategies and litigation, see Lanjouw and Schankerman (2001).

References

Anton, J. J., and D. A. Yao (2004), "Little Patents and Big Secrets: Managing Intellectual Property," *RAND Journal of Economics*, 35, 1–22.

Aoki, R., and Y. Spiegel (2009), "Pre-grant Patent Publication and Cumulative Innovation," *International Journal of Industrial Organization*, 27, 333–345.

Bar, T., and V. Atal (2011), "Patent Quality and a Two-Tiered Patent System," *mimeo*.

Bessen, J. E., and M. J. Meurer (2006), "Patent Litigation with Endogenous Disputes," *The American Economic Review – Papers and Proceedings*, 96, 77–81.

Bessen, J.e., and M. J. Meurer (2008), *Patent Failure*. Princeton University Press.

Caillaud, B., and A. Duchene (2009), "Patent Office in Innovation Policy: Nobody's Perfect," *Paris School of Economics Working Paper No 2009 - 39*.

Choi, J. P. (1998), "Brand Extension as Informational Leverage," *Review of Economic Studies*, 65, 655–669.

Cockburn, I. M., S. Kortum, and S. Stern (2003), "Are All Patent Examiners Equal? Examiners, Patent Characteristics, and Litigation Outcomes," in *Patents in the Knowledge-Based Economy*, ed. by W. M. Cohen, and S. A. Merrill, pp. 19–53. National Academy Press, Washington D.C.

Cockburn, I. M., and M. J. MacGarvie (2009), "Patents, Thickets and the Financing of Early-Stage Firms: Evidence from the Software Industry," *Journal of Economics & Management Strategy*, 18, 729–773.

Cook, J. P. (2007), "On Understanding the Increase in U.S. Patent Litigation," *American Law and Economics Review*, 9(1), 48–71.

Cornelli, F., and M. Schankerman (1999), "Patent Renewals and R&D Incentives," *RAND Journal of Economics*, 30, 197–213.

Denicolò, V., and L. A. Franzoni (2008), "Innovation, Duplication, and the Contract Theory of Patents," in *The Economics of Innovation*, ed. by R. Cellini, and L. Lambertini, pp. 15–32. Bingley, UK: Emerald Group.

EPO (2009), *European Patent Office – Annual Report 2009*. European Patent Office, Brussels.

Friebel, G., A. K. Koch, D. Prady, and P. Seabright (2006), "Objectives and Incentives at the European Patent Office," *IDEI Report*.

Gallini, N. T. (2002), "The Economics of Patents: Lessons from Recent U.S. Patent Reform," *Journal of Economic Perspectives*, 16, 131–154.

Gans, J., D. Hsu, and S. Stern (2008), "The Impact of Uncertain Intellectual Property Rights on the Market for Ideas: Evidence for Patent Grant Delays," *Management Science*, 54, 982–997.

Greenberg, G. (2009), "Small Firms, Big Patents? Estimating Patent Value Using Data on Start-Ups'

Financing Rounds," *mimeo*.

Hall, B. H., and D. Harhoff (2004), "Post-Grant Reviews in the U.S. Patent System - Design Choices and Expected Impact," *Berkeley Technology Law Journal*, 19(3), 989–1015.

Hall, B. H., and D. Harhoff (2004), "Recent Research on the Economics of Patents," *mimeo*.

Hall, B. H., A. Jaffe, and M. Trajtenberg (2005), "Market Value and Patent Citations," *RAND Journal of Economics*, 36, 16–38.

Harhoff, D., and S. Wagner (2009), "The Duration of Patent Examination at the European Patent Office," *Management Science*, 55, 1969–1984.

Häussler, C., D. Harhoff, and E. Müller (2009), "To Be Financed or Not... - The Role of Patents for Venture Capital Financing," *ZEW - Centre for European Economic Research Discussion Paper*, 09-003(7115).

Henderson, R., A. B. Jaffe, and M. Trajtenberg (1998), "Universities as a Source of Commercial Technology: A Detailed Analysis of University Patenting, 1965- 19888," *Review of Economics and Statistics*, 80(1), 119–127.

Henkel, J., and F. Jell (2010), "Patent Pending – Why Faster Isn't Always Better," *mimeo – Technical University Munich*.

Jaffe, A. B., and J. Lerner (2004), *Innovation and Its Discontents: How Our Broken Patent System is Endangering Innovation and Progress, and What to Do About It*. Princeton University Press, Princeton.

Johnson, D. K. N., and D. Popp (2003), "Forced out of the Closet: The Impact of the American Inventors Protection Act on the Timing of Patent Disclosure," *RAND Journal of Economics*, 34(1), 96–112.

King, J. L. (2003), "Patent Examination Procedures and Patent Quality," in *Patents in the Knowledge-Based Economy*, ed. by W. M. Cohen, and S. A. Merrill, pp. 54–73. National Academy Press, Washington D.C.

Klein, B., and K. B. Leffler (1981), "The Role of Market Forces in Assuring Contractual Performance," *Journal of Political Economy*, 89, 615–641.

Koenen, J., and M. Peitz (2011), "Firm Reputation and the Incentives to Milk Pending Patents," *mimeo*.

Lanjouw, J., and M. Schankerman (2001), "Characteristics of Patent Litigation: A Window on Competition," *RAND Journal of Economics*, 32(1), 129–151.

Lazaridis, G., and B. van Pottelsberghe de la Potterie (2007), "The Rigour of EPO's Patentability Criteria: An Insight into the "Induced Withdrawals"," *World Patent Information*, 29(4), 317–236.

Maskus, K. E. (2006), "Reforming U.S. Patent Policy - Getting the Incentives Right," *CSR, Council on Foreign Relations*, 19.

Mossinghoff, G., and V. Kuo (2002), "Post-Grant Review of Patents: Enhancing the Quality of the Fuel of Interest," *IDEA, The Journal of Law and Technology*, 43(1), 83–110.

Mossinghoff, G. J., and S. G. Kunin (2008), "The Need for Consensus on Patent Reform," *The Bureau of National Affairs Patent, Law and Trademark Daily*, 20.

Popp, D., T. Juhl, and D. K. Johnson (2004), "Time in Purgatory: Examining the Grant Lag for U.S. Patent Applications," *Topics in Economic Analysis & Policy*, 4.

Prady, D. (2009), "'Is that a Gun in Your Pocket...?' Advertising and Evaluation," *mimeo*.

Quillen, C. D. J., and O. H. Webster (2001), "Continuing Patent Applications and Performance of the U.S. Patent Office," *Federal Circuit Bar Journal*, 11(1), 1–21.

Quillen, C. D. J., O. H. Webster, and R. Eichmann (2002), "Continuing Patent Applications and Performance of the U.S. Patent and Trademark Office - Extended," *Federal Circuit Bar Journal*, 12(1), 35–55.

Regibeau, P., and K. Rockett (2010), "Innovation Cycles and Learning at the Patent Office: Does the Early Patent Get the Delay?," *Journal of Industrial Economics*, 58(2), 222–246.

Schankerman, M. (1998), "How Valuable is Patent Protection? Estimates by Technology Field," *RAND Journal of Economics*, 29, 77–107.

Schuett, F. (2011), "Patent Quality and the Incentives at the Patent Office," *mimeo - University Tilburg*.

Slusky, R. D. (2007), *Invention Analysis and Claiming: A Patent Lawyer's Guide*. American Bar Association, Chicago.

Straus, J., and N.-S. Klunker (2007), "Harmonisation of International Patent Law," *International Review of Intellectual Property and Competition Law*, 8, 907–36.

Thomas, J. R. (2010), "Deferred Examination of Patent Applications: Implications for Innovation Policy," *Congressional Research Service Report*, 7-5700.

USPTO (2009), *United States Patent and Trademark Office Performance and Accountability Report Fiscal Year 2009*. United States Patent and Trademark Office, Alexandria.

Van Pottelsberghe de la Potterie, B. (2010), "The Quality Factor in Patent Systems," *CEPR Discussion Paper No. 7921*.

van Zeebroeck, N. (2007), "Patents Live Only Twice: A Patent Survival Analysis of the Determinants of Examination Lags, Grant Decisions and Renewals," *CEB Working Paper 07/028*.

Webster, E., A. Palangkaraya, and P. H. Jensen (2007), "Characteristics of International Patent Application Outcomes," *Economics Letters*, 95, 362–368.