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Exploring the Opaqueness of the Patent System - Evidence from a Natural Experiment

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Exploring the Opaqueness of the Patent System - Evidence from a Natural Experiment

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Abstract One of the objectives of patent systems is to disclose information which other agents can build on in further inventions and in their decision-making. While some observers take it as given that real-world patent systems serve this objective, we argue in this article that patent systems are highly opaque and likely to be of limited value as a source of information. We use data from a natural experiment to explore this issue. Requests for accelerated examination used to be publicly observable at the European Patent Office (EPO). Starting in December 2001, the EPO started to treat these requests as confidential information. Using data on acceleration requests which were historically known only to the applicant and the EPO, and later provided to us, we test whether the change in the information regime impacted the actions of applicants and their rivals. We develop a theoretical model of acceleration requests and patent opposition to identify the extent to which the patent system is opaque. We confirm empirically that opposition and acceleration rates of high-value patents change significantly in most technological areas once acceleration requests become unobservable. We interpret these results as evidence that the system is highly opaque in many fields.

Keywords: patent value; opaqueness; accelerated examination; patent opposition; European Patent Office (EPO).

JEL Classification Numbers: K40, L00

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1 Introduction

Patent protection comes at a price to applicants - leaving aside costs for attorneys and patent office fees, the applicant has to disclose information regarding the invention he seeks to protect via an exclusion right. The information disclosed is supposed to reveal the technical teaching that underpins the patented invention. In a completely transparent system, the information would also support other parties in assessing the importance of a patented technology and hence its value. In this regard, patent protection is the natural counter-part of trade secrecy which is premised on exclusive use of information by one party.

In the assessment of the patent system's welfare balance, most work has focused on the incentive effect for inventors (respectively, applicants) - the "bait" of the promised exclusion rights is supposed to motivate inventors to spend more resources on research and development than they would in the absence of patent rights. The corresponding disclosure effects have received considerably less scrutiny, but many authors take as given that they exist and that they are sizeable.

Currently, the underlying assumption of policy makers and researchers alike is that the patent system is relatively transparent, that is, that searching for information on potentially conflicting prior art (which would limit the patentability of an invention) is rather costless. The patent system is apparently made to fulfill this ideal - disclosure by patent applicants is supposed to be complete, and insufficient disclosure can be held against the applicant by the examiner, leading to a refusal of the patent grant. At the same time, some users of the patent system have complained that the relevance of inventions is skillfully disguised by applicants who use arcane and complex language in order to avoid in-depth scrutiny by rivals. Bessen and Meurer (2008), for example, explicitly recommend a reform which would require patent applicants to use "plain language" in order to avoid intransparent descriptions of the patented invention and excessive opaqueness of the overall patent system.

The evidence presented in this article supports the notion that the patent system is highly opaque. We use a quasi-experimental setting in which publicly available information - the request for acceleration - became private information at the EPO. Ex ante, the observability of the acceleration may have guided rivals of a patent applicant in detecting particularly valuable inventions. The information may have contributed to an above-average rate of oppositions against these patents (once granted).

We develop a theoretical model of the ex ante and ex post applicant and opponent behavior. From this model, we derive hypotheses on changes in the behavior of patent applicants and their rivals - specifically, on changes in the propensity to request accelerated patent examination and in the propensity to initiate opposition proceedings - conditional on the presumption that the European patent system is intransparent with respect to patent value. Using non-public data on accelerations provided to us by the EPO, we show that in three of the five main technological areas after Schmoch (2008) the predictions of our model regarding changes in behavior in reaction to the EPO's 2001 decision to conceal acceleration information are met: Absent an observable signal of patent value, either the propensity of patent applicants to request accelerated patent examination increases or the likelihood of a patent being opposed drops. These changes - occurring once the signal is no longer available - suggest that in major parts of the European patent system potential opponents face problems in finding substitute signals for identifying the patent's contribution. Relying merely on conventional data generated by the patent office is apparently not sufficient to make opposition activity privately attractive. Given the quasi-experimental setting used here, we argue that our results provide fairly strong evidence in favor of the opaqueness presumption. Moreover, hiding an important signal leads to a weakening of oppositions which are considered helpful in identifying patents that were erroneously granted.

Our analysis adds to ongoing academic and policy debates in which information transmission by patents plays an important role: The extent to which patents disseminate information is of direct relevance for their role in diffusing technological information (see, amongst others, Cohen et al., 2002; Sorenson and Fleming, 2004; Gans et al., 2013). Further, as discussed in the context of markets for technology (Arora et al., 2004; Gans and Stern, 2010), formal intellectual property rights such as patents can play a crucial role in the emergence and strengthening of these markets. As a necessary precondition for the patent system to support the emergence of markets for technology, however, information on patented technologies should be transparent and not masked by opaque language. The degree of transparency in the patent system is also likely to impact patents in their financing function. Conti et al. (2013) and Hsu and Ziedonis (2013) show that patents are used to and can support the acquisition of venture capital. Haeussler et al. (2012) demonstrate that delays in the publication of search reports (which could presumably improve transparency) have a negative impact on the availability of venture capital for biotechnology startups in the UK and Germany. In light of these contributions, our result - that the European patent system is rather intransparent with respect to information revealing the value of a patented innovation - suggests that in its present state the European patent system does not fully exploit its potential of contributing to the diffusion of technological knowledge and the emergence of markets for technology. We further discuss these issues in the final section.

We find that the European patent system is rather intransparent with respect to information revealing the value of a patented innovation. Given the contributions emphasizing the need for transparency, this result suggests that the European patent system in its present state does not fully exploit its potential of contributing to the diffusion of technological knowledge and the emergence of markets for technology. These observations carry a number of important policy implications which we discuss further in the final section of the paper.

2 Institutional Background

The legal foundation for the activities of the European Patent Office (EPO) is given by the European Patent Convention (EPC) and a body of rules accompanying the Convention. The timing of patent filings and subsequent actions by the EPO is rather complex, but can be summarized as follows (see Harhoff and Wagner, 2009, for more details). Patent filings at the EPO are typically based on previous priority filings at national patent offices. These filings are then forwarded to the EPO and published there 18 months following the original priority date. With the publication of the patent document, the EPO also publishes a search report. The report is accessible to any third party and published prominently on the EPO's websites. Information contained in the search report may be crucial for the applicant in order to assess his or her chances of obtaining a strong patent grant. The information can also be crucial for rivals who wish to assess the legal strength of a particular patent.

Within six months of the publication, the patent applicant has to request the examination of the patent application, otherwise the patent filing will lapse. The examination process itself can be rather lengthy, and in many cases, applicants seek to delay the final decision by the EPO, since a patent grant with subsequent translation into national languages is rather expensive. However, some applicants are interested in fast resolution of patent examination. Reasons for being interested in a quick resolution may be that the patent holder wants to have the right to request an injunction against an infringer. Injunctions are only available after the patent application has been granted. Moreover, important investment decisions may have to be made by the applicant in order to enter product markets with patent protection. This may again explain why some applicants would like to see an acceleration of patent examination.

At the EPO, the applicant may request examination early (Article 96 (1) EPC). He may also unconditionally waive his right to receive an invitation from the EPO to confirm that he desires to proceed with the application. This waiver allows the application to reach the examining division more quickly. Typically, the request is made when filing the European patent application, but it can also be submitted later by separate communication to the EPO.

In Rule 93(d) - OJ2001, 458 - published on September 7, 2001 - the President of the European Patent Office announced that effective of December 3rd, 2001 (EPO 2001) requests for accelerated search and accelerated examination would no longer be made public (as they had been before).[1] This rule change meant that information that had been observable by any third party was now private information between the EPO and the applicant.

We exploit this setting by comparing statistics describing applicants' and their rivals' behaviors before and after the rule had been changed at the EPO. To have a foundation for interpreting the statistics, we first develop a theoretical model in the subsequent section.

3 Model of Patent Application and Opposition Process

In this section, we develop a theoretical framework to derive hypotheses on changes in the behavior of patent applicants and their rivals in reaction to a rule change in the European patent system. The changes we derive are *specific to the case* that the patent system is *intransparent* with respect to patent value or with respect to information that lets parties other than the owner to infer patent value. The rule change we exploit is the EPO's 2001 decision to keep information about applicants' acceleration requests secret. Our model focuses on two special features of the European

[1] Accelerated search is usually a precursor to accelerated examination. Therefore, we do not address any differences between the two institutions here. A differential treatment of the two proceedings is planned for an extended version of this article.

patent system: First, patent applicants have the option to request that the examination of their patent gets accelerated. Second, for a limited time period after grant third parties have the option to oppose a patent centrally at the EPO.[2]

3.1 Model Setup and Assumptions

We assume that there are two firms, firm A and firm B. Firm A shall have filed a patent application, and the EPO shall have published the search report regarding this application. The search report lists the prior art which the EPO regards as relevant with respect to the patentability of firm A's invention. That is, it informs both firm A and firm B about the legal strength of firm A's patent application. The strength of firm A's patent application determines whether (in case of a grant) it withstands opposition by firm B. In the following, we operationalize the strength of firm A's patent as the probability p that the patent is found valid in opposition cases. p shall be public information. We further assume that firm A does not withdraw its patent application, and that its patent gets granted with certainty, regardless of whether firm A opts for the accelerated or for the standard examination procedure.[3]

We construct our model to derive predictions on changes in the behavior of patent applicants and their rivals which are *specific to the case* that the patent system is *intransparent* with respect to value-related information. We model intransparency of the patent system by assuming that firm A knows the value of its patent, but that firm B does not. Conversely, in a transparent (non-opaque) patent system, firm B would be able to determine the value of A's patent. We understand the value of firm A's patent to be the cash stream of revenues firm A can generate if it uses its patent to introduce an innovation into the market - conditional on its patent being granted and not being revoked due to central opposition at the EPO (which is only possible during a short time period after grant).[4] Firm A's patent shall be of either high or low value. We further assume that firm B

[2]As soon as the window during which central opposition at the EPO is possible closes, the patent can no longer be revoked in a single procedure - separate opposition proceedings have to be initiated in each single state the patent got validated in, which increases costs of opposition considerably.

[3]This assumption approximates reality quite well: 95% of all patents which were applied for from 1995 to 2004 and which were not withdrawn by the applicant got granted.

[4]In practice, of course, also a patent applicant might not be perfectly informed about the value of his patent before it is granted and used to introduce an innovation into the market. However, our stylized assumption here captures that (at least on average) applicants should have a rather good estimate of the value of their patents, and that (without perfect information transmission by the patent system) applicants should have superior information about the value of their patents relative to third parties.

is active in the same market as firm A, and that firm A's innovation is rivalrous to firm B. That is, its introduction would lead to a decrease in firm B's (future) profits.

When requesting examination of its patent, firm A shall be able to choose between an accelerated (a) and a standard ($\neg a$) examination procedure. If firm A chooses accelerated patent examination and its patent gets granted and survives the opposition period, we assume that the profit (meaning the discounted present value of future profits) firm A gains from its patent will be higher than in case of standard examination. Formally, we denote the profit firm A reaps from its patent by $\pi_{(\cdot)}^{(\cdot)}$. This profit shall depend on the value of the patent, which is either high (h) or low (l), and on whether the patent examination has been accelerated (a) or not ($\neg a$). Firm A's cost of accelerated patent examination shall be $c_a > 0$. We assume that acceleration is worthwhile only for high-value patent: $\pi_h^a - \pi_h^{\neg a} > c_a$, and $\pi_l^a = \pi_l^{\neg a} (\equiv \pi_l)$. It shall hold that $\pi_h^a > \pi_h^{\neg a} > \pi_l$.

Firm B's profits shall decrease if firm A's patent is granted and survives the opposition period. For simplicity, we assume that firm A and firm B play a zero-sum game, which means that the gains of firm A in case its patent gets granted and survives the opposition period equal firm B's losses. That is, if firm A successfully patents its technology, profits $\pi_{(\cdot)}^{(\cdot)}$ firm A makes equal the losses firm B incurs. To avoid reduction in its profits, during a short time window after grant firm B has the possibility to oppose the patent of firm A centrally at the EPO.[5] If firm B decides to oppose firm A's patent, both firms have to pay c_o for the then enfolding opposition process. At the end of the opposition process, firm A's patent remains granted with probability p.

The timing of the game firm A and firm B play is as follows: First, nature draws the value v of firm A's patent and the probability p with which the patent withstands opposition. The value v can be high (h) or low (l). h shall be drawn with probability θ, l with probability $1 - \theta$. The probability p with which firm A's patent withstands opposition shall be public information. In contrast, whereas firm A always gets informed about the value v of its patent, firm B would get informed about the value of the patent of firm A only in case the patent system was transparent with respect to patent value (via information transmission through firm A's patent). In case of an

[5] After the short time window during which opposition at the EPO is possible closes, in practice firm B still has the possibility to take action against firm A's patent. However, firm B then has to file separate suits in each state firm A's patent got validated in, which both increases the costs of legal action and decreases the chance of an Europe-wide invalidation of firm A's patent by far. That is, filing separate suits at the national patent offices should usually be inferior to central opposition at the EPO, and in our model we thus focus on the latter.

intransparent patent system, firm B does not get informed about the value v of firm A's patent.[6] After getting informed, firm A can either request standard or accelerated examination of its patent ($\neg a$ respectively a). If firm A chooses accelerated patent examination, it incurs cost c_a. Next, firm B has the possibility to oppose firm A's patent. In case firm B decides to oppose firm A's patent, both firms have to pay costs c_o. At the end of the then enfolding opposition process, firm A's patent remains granted with probability p. Finally, payoffs are realized. These depend on the patent value (h respectively l), and on whether patent examination has been accelerated (a respectively $\neg a$).

Our goal is to use the theoretical framework we develop in this section to draw conclusions on whether the patent system is intransparent with respect to patent value from behavioral changes in reaction to the EPO's 2001 decision to conceal acceleration information. With respect to the information structure, in the following we will therefore differentiate between the case of a transparent and that of an intransparent patent system, and between the case of public and that of private acceleration information. We call the patent system "transparent" if both firm A and firm B are informed about the value v of firm A's patent, and "intransparent" if only firm A is informed. By "public" acceleration information we mean that firm B is informed about whether firm A chose to request accelerated patent examination, and by "private" acceleration information we mean that firm B is not informed about whether firm A requested acceleration patent examination.

Before we sum up our game, we have to make some parametric assumptions. We already assumed that, in general, if firm A's patent survives the opposition period, firm A's profits increase and firm B's profits decrease. In particular, we made the simplifying assumptions that we have a zero-sum game, which means that firm A's increase in profits equals firm B's decrease. Also, we already assumed that acceleration is worthwhile for high-value patents only. In order to establish a clear payoff-structure for our game, we make two small additional assumptions. First, we assume that the profits which can be gained from a low-value patent are larger than opposition and acceleration costs combined. Second, we assume that opposition costs are larger than acceleration

[6]Here we make the assumption that already at the beginning of the application process the value of a patent is known to (at least) the applicant. In practice, during the patent application process (and also shortly after grant during the time window in which central opposition at the EPO is possible) there might be some uncertainty about how a patented technology (respectively the innovation which springs from it) will be valued by the consumers in a given market. We acknowledge that there might be instances where supposed "hits" turn out to fail in the market (and vice versa), but we argue that on average applicants (which are usually larger companies with profound expertise in the technological fields and markets they are active in) should have a good idea of the value of a patent they are applying for, which is captured by our stylized assumption that patent value is known (at least to the applicant) at the beginning of the application process.

costs.[7] Put together, all our parametrical assumptions are:

A1 Acceleration is worthwhile only for high value patents: $\pi_h^a - \pi_h^{\neg a} > c_a$, and $\pi_l^{\neg a} = \pi_l^a (\equiv \pi_l)$.

A2 We have a zero-sum game, that is firm A's gains equal firm B' losses: $\pi_h^a(A) = \pi_h^a(B) = \pi_h^a$, $\pi_h^{\neg a}(A) = \pi_h^{\neg a}(B) = \pi_h^{\neg a}$, $\pi_l(A) = \pi_l(B) = \pi_l$.

A3 The profit from a low-value patent is larger than opposition and acceleration costs combined: $\pi_l > c_o + c_a$.

A4 Costs of acceleration are smaller than costs of opposition: $c_a \leq c_o$.

The extensive form of our game is given by the game-tree in figure 1. Depending on whether the patent system is assumed to be transparent or intransparent with respect to patent value, and on whether firm A's acceleration decision is assumed to be public or private information, the mapping of the decision nodes of firm B to information sets is different. For the sake of clarity, the different information sets for the different information structures we analyze are not explicitly drawn in the game tree but described in the caption.

We solve our model for the different information structures by applying the concept of the perfect Bayesian Nash equilibrium (PBNE). In addition, in order to rule out implausible equilibria, we apply the "intuitive criterion", which was introduced in the context of signaling games by Cho and Kreps (1987). Basically, in solving our model we follow standard textbook procedures (see, for example, Gibbons, 1992). The solution of our model is technically somewhat involved because we solve our model for every point in the parameter space, and thus have to account for changing relationships between payoffs. Appendix A.1 describes the solution of our model in detail.

3.2 Results

We determined how the behavior of firm A (the patent applicant) and that of firm B (its rival) changes when information about whether firm A requested accelerated patent examination gets concealed. For the case that the patent system is transparent with respect to patent value, for the

[7] These assumptions are made against the background of empirical findings. Gambardella et al. (2008) estimate the median patent value to be €0.3 m. According to Levin and Levin (2002), opposition costs at the EPA amount to around €0.1 m. If a firm chooses accelerated patent examination it does not have to pay an extra fee but only has to cope with increased administrative effort, which indicates that the costs of acceleration should be smaller than the costs of opposition.

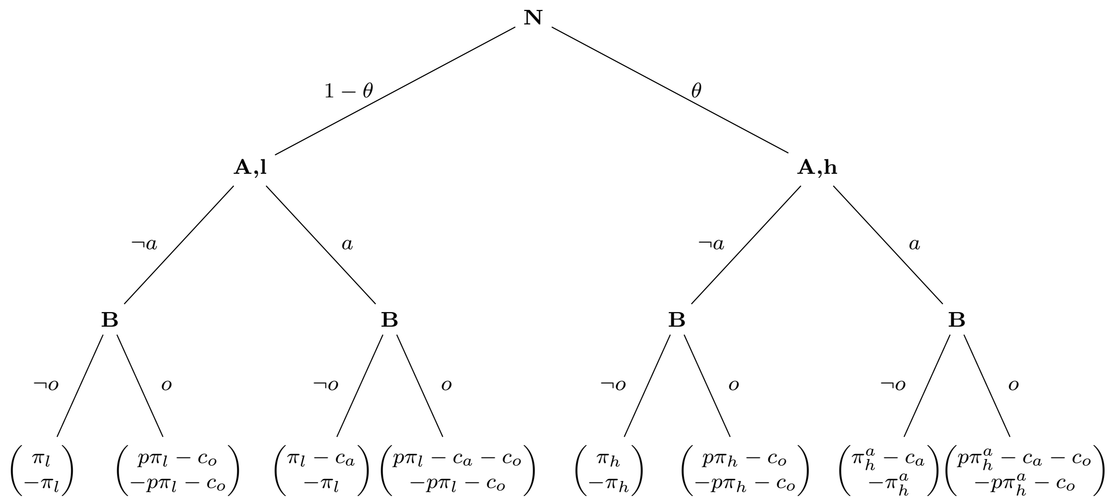


Figure 1: **Extensive form of the game.** The graph shows the extensive form of the game firm A (the patent applicant) and firm B (its rival) play. The mapping of the decision nodes of firm B to information sets depends on the assumptions about the transparency of the patent system (transparent vs. intransparent) and the visibility of firm A's acceleration decision (public vs. private): In the "transparent-public" case, each node forms one set. In the "transparent-private" case, the two nodes on the left branch of the tree form one set and the two nodes on the right another. In the "intransparent-public" case, the first and the third node form one set and the second and the fourth another. In the "intransparent-private" case, all four nodes form one set.

largest part of the parameter space (including the subset relevant for our application) behavior does not change in reaction to concealment of acceleration information.[8] For the case that the patent system is intransparent with respect to patent value, figure 2 summarizes our results on behavioral changes in reaction to concealment of acceleration information. In our model, we have three main exogenous parameters: The strength of a patent (p), the value of a patent (v), and the applicant's profits in case his patent was accelerated (π_h^a). Each graph in figure 2 shows the p-θ-space for a particular value of π_h^a. In each graph we marked the subsets of the p-θ-space in which the outcomes in case acceleration information is public are different from those in case acceleration information is private.[9] The sequence of graphs from top to bottom shows how the outcome-relevant subsets

[8]It is easy to show that, for a transparent patent system, there are changes in behavior in reaction to concealment of acceleration information only for a small subset of the parameter space. Specifically, this subset exists only for small gains from acceleration (that is, small values of π_h^a), and for the parameter p being larger than the cut-off value p_2^B. As we discuss in detail further down, for realistic parameter assumptions p_2^B is very large ($\geq 90\%$), but the p typically ranges between 50% to 70%. Thus, the small parameter subset where there might be changes in behavior also in case of a transparent patent system is irrelevant for our application.

[9]The division into subsets is done by cut-off values $p_{(\cdot)}^{(\cdot)}$. We only depict cut-off values which are relevant with respect to outcomes. (As the derivation of the outcomes in appendix A.1 shows, with respect to firms' strategies the p-θ space can be divided into smaller subsets.) The ordering of these cut-off values depends on the value of π_h^a at which a cross-section was produced. Note that the graphs in figure 2 give all possible relative orderings of the cut-off values - that is, with respect to the position of the cut-off values relative to each other, the π_h^a space is divided into one subset where the gains from acceleration are low, one where they are intermediate, and one where they are high.

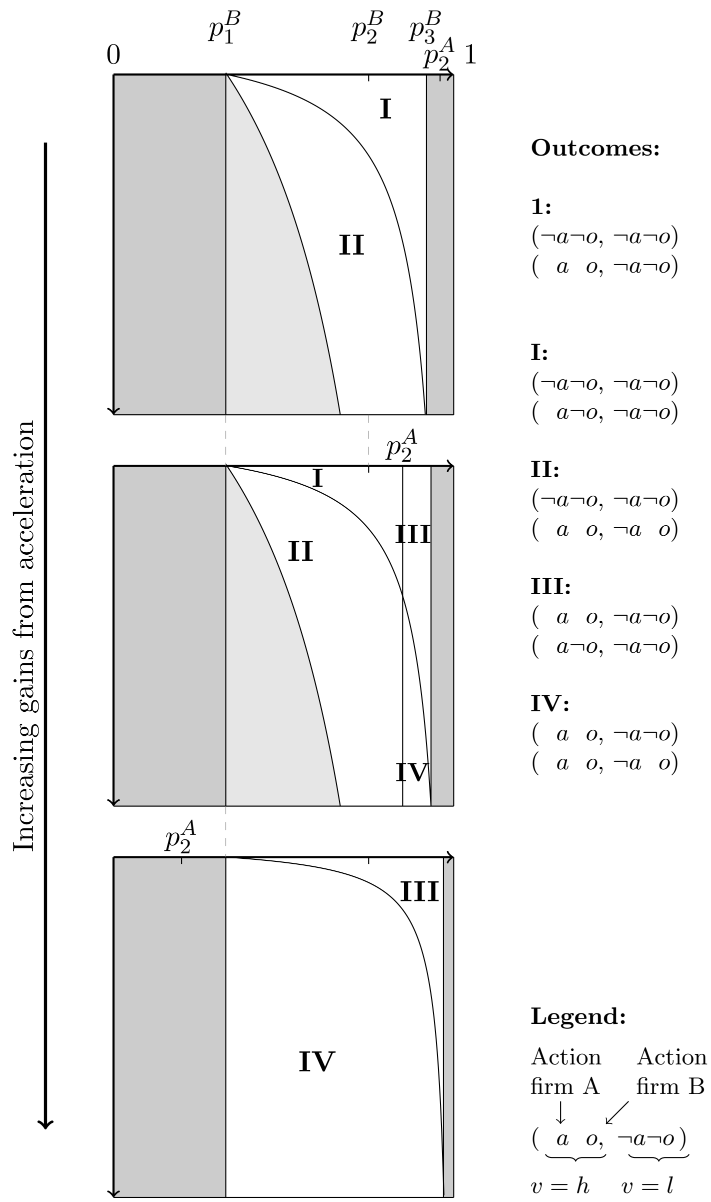


Figure 2: **Comparison of outcomes in case of public acceleration information to outcomes in case of private acceleration information.** Conditional on the assumption that the patent system is intransparent with respect to patent value, the graphs show the subsets of the p-θ-space for which outcomes in case acceleration information is public are different from outcomes in case it is concealed. The sequence of graphs shows how the outcome-relevant subsets evolve with increasing gains from acceleration. Outcomes are given conditional on nature's draw of patent value v (high or low) and are described by firm A's action, that is acceleration (a) or no acceleration ($\neg a$), and firm B's subsequent action, that is opposition (o) or no opposition ($\neg o$). For each subset, the upper parentheses give outcomes for the case that acceleration information is public, and the lower parentheses for the case that it is concealed.

evolve with increasing gains from acceleration (that is, with increasing π_h^a).

For weak patents and/or low gains from acceleration (subsets I and II), in case acceleration information gets concealed, the patent applicant changes from no acceleration of high-value patents to acceleration. The reason is that from the applicant's perspective the risk that his rival can use information about his acceleration request to identify and oppose his high-value patent outweighs the gains he has from requesting accelerated examination. Thus, the applicant refrains from acceleration in case information about his acceleration decision is public (he "hides" a high-value patent by not sending the acceleration signal), and accelerates high-value patents only in case acceleration information becomes concealed. Thus, neither in case acceleration information is private nor in case it is public the rival is able to infer information on patent value from the applicant's action. That is, the rival needs to base his opposition decision on the expected gains from opposition given the a-priori probability θ that a patent is of high value. In subset I, the probability that a patent is of high value is too low to make the rival better off (in expectation) when he chooses to oppose the applicant's patent. (Note that the rival only benefits from opposition if he "hits" a high-value patent.) Therefore, in subset I the rival refrains from opposition. In subset II, in case acceleration information is public (which means that the applicant does not accelerate high-value patents), the rival is better off in expectation when he refrains from opposition. However, in case acceleration information is concealed, the applicant accelerates high-value patents "in disguise", which increases their value by such an amount that the rival is now better off when he opposes the applicant's patent.

For strong patents and/or high gains from acceleration (subsets III and IV), we only observe changes in the opposition behavior of the rival. The reason is that the applicant does not care that by accelerating a high-value patent he might inform his rival about the value of his patent, as his patent is either strong and thus likely withstands opposition, or as the high gains from acceleration make up for the risk of being opposed. That is, the applicant always accelerates high-value patents, whereas he never accelerates low-value patents (the reason being that by assumption the gain from acceleration of low-value patents is zero.) In effect, when acceleration information is public, the applicant informs his rival about the value of his patent. Knowing that accelerated patents are high-value patents, the rival in consequence opposes accelerated patents only. When acceleration information becomes concealed, the applicant still accelerates high-value patents, but the rival no longer knows whether a given patent had been accelerated. Thus, for small probabilities that a patent is of high-value (subset III), he refrains from opposition, because chances for a "hit" (opposition of a high-value patent) are too low. (Note that in expectation the rival incurs losses when opposing a low-value patent.) In contrast, for large probabilities that a patent is of high-value (subset IV), the rival opposes the applicant's patent, because chances for a "'hit" are high enough such that in expectation the gains from opposing a high-value patent make up for the losses from opposing a low-value patent.

For very weak ($0 < p < p_1^B$) or very strong ($p_3^B < p < 1$) patents, we neither observe changes in the applicant's nor the rival's behavior. The reason is that if patents are very weak, the rival will always oppose the applicant's patent, whereas if patents are very strong, the rival will always refrain from opposition. That is, information about patent value does not play a role for the rival's behavior, and thus also the applicant does not have to care about whether by accelerating his patent he sends a signal about patent value.

3.3 Derivation of Hypotheses

We now derive hypotheses on how the EPO's 2001 decision to conceal information about applicants' requests for accelerated patent examination should have affected the behavior of both applicants and their rivals in case the European patent system was indeed intransparent with respect to patent value. To do so, we take a look into the literature on the European patent system to derive information on realistic value ranges of our model parameters. These parameters are the costs of acceleration and opposition (c_a and c_o), the distribution and the value of patents (θ and π_l respectively π_h), and the probability with which a patent withstands opposition (p). The possibility to request accelerated patent examination has not received much attention in the patent literature yet. Thus, instead of coming up with a concrete parametrization of π_h^a, we will derive predictions for the cases of low, medium and high gains from acceleration.

We first turn to the costs of acceleration and opposition. In line with others, Graham et al. (2002), who interviewed senior representatives of the European Patent Office, report that opposition costs c_o can be expected to be of a size of around €50 k to €100 k. Costs of acceleration c_a solely arise due to the need to cooperate closely with the EPO in case accelerated examination is requested (there is no fee for accelerated examination), and thus should be relatively small. There are no numbers on acceleration (effort) costs in the literature, but we expect acceleration costs to be at most in the range of opposition costs.

With respect to the value of patents the literature is ambiguous: The common finding here is that the distribution of patent value is heavily skewed - that is, the bulk of patents is of relatively low value, whereas a few patents are of quite high value. This is expressed by the fact that the median of the value distribution is commonly found to be far smaller than its mean. However, due to different methodologies and data sets, estimates of these two quantities range from magnitudes of below €0.1 m for both the median and the mean to an estimated median of €0.3 m and an estimated mean of €3 m in Gambardella et al. (2008). At the bottom line, the picture which emerges from studies on patent value is that the value of the bulk of patents seems to be close to the costs of opposition, whereas the value of a minority of high-value patents exceeds that of the majority of low-value patents by more than one order of magnitude. In terms of our model parameters, an established finding in the literature on patent value is that θ is rather small and that $\pi_l \ll \pi_h$.

Information on the strength of patents - that is, the probability that a granted patent withstands opposition - can be found in Harhoff and Reitzig (2004). In their sample, opposed patents were revoked in around one third and amended in 40% of all cases. In one fifth of the cases opposition was rejected. (In 10% of the cases the opposition procedure was closed due to unspecified reasons.) Note that the amendment of a patent can involve a narrowing of its scope, which might be counted as a (partial) success of the competing party. If we count half of the occasions where a patent was amended as successfully opposed, that means p lies somewhere in the range between 50% to 70%.

We operationalize the stylized facts collected above by the following parametric assumptions: c_o=€0.1 m, c_a=€0.05 m, π_l=€0.15 m and π_h= €1.0 m.[10] As information on the value of acceleration is basically non-existent in the literature, we do not use a single parametrization for the value of acceleration (respectively, π_h^a), but look at three cases: The case where gains from acceleration are low (25% increase in patent value, that is, π_h^a =€1.25 m), the case where they are intermediate (50% increase in patent value, that is, π_h^a =€1.5 m), and the case where they are high (100% increase in patent value, that is, π_h^a =€2 m). The graphs in figure 3 show the parameter space (to

[10]Note that with respect to the mechanics of our model and, consequently, the derivation of hypotheses, the exact numerical values of the single parameters are not critical. What matters is the relationship between the different parameter values. In particular, these relationships are that between c_o and π_l and that between c_o and π_h. These relationships determine the positions of the cutoff-values p_1^B, p_2^B and p_3^B, which separate the parameter space into the subsets where changes in outcomes can be observed in case acceleration information gets concealed (for details see appendix A.1).

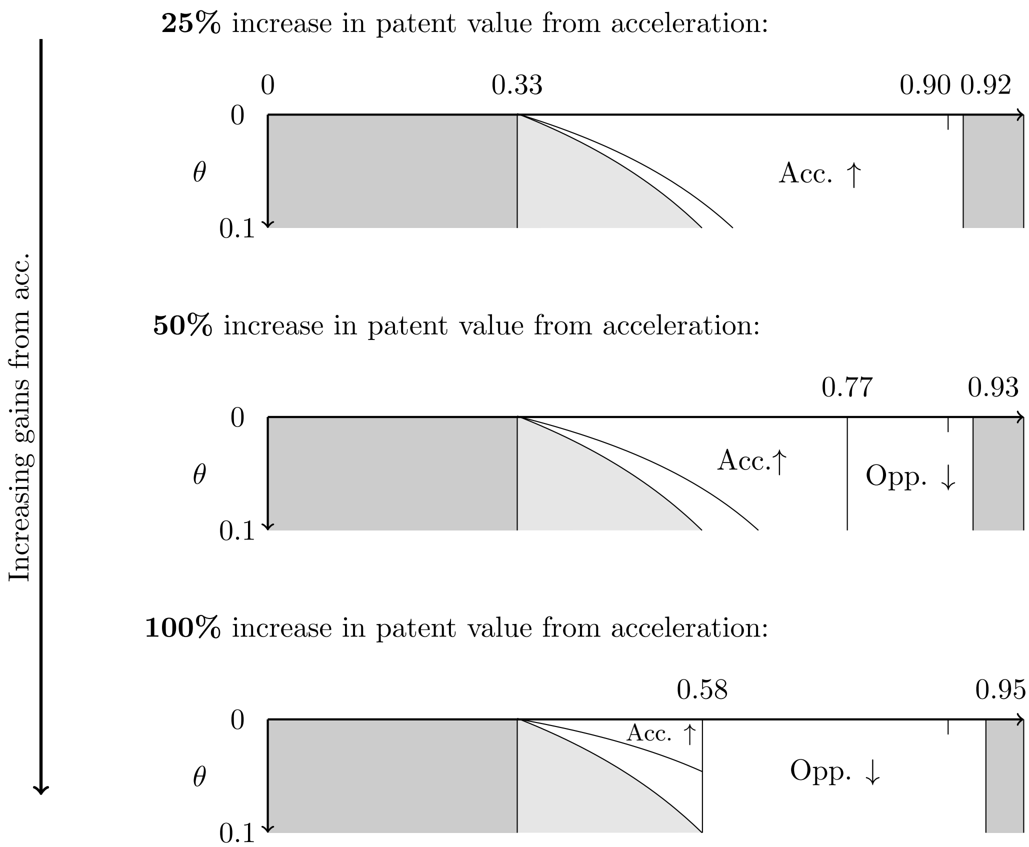


Figure 3: **Predictions on changes in acceleration and opposition frequencies.** The graphs display how we expect acceleration and opposition rates to change in case the patent system is intransparent with respect to patent value and information about applicants' acceleration requests gets concealed. The parameter assumptions made mirror stylized facts about the application and opposition process in the European patent system. These parameter assumptions are c_a=€ 0.05 m, c_o=€ 0.1 m, π_l=€ 0.15 m and π_h= € 1.0 m, and given these the graphs are drawn to scale. For the gray areas we do not expect do observe any changes in case acceleration information gets concealed. Note that changes in behavior in case the patent system is transparent are not depicted here, as we would expect to observe any only if $p > 0.90 = p_2^B$.

scale) for the above parameter assumptions and the cases of low, intermediate and high gains from acceleration. As we expect the share of high-value patents to be very small, we only depicted the parameter space up to $\theta = 10\%$.

For the derivation of hypotheses on how the behavior of patent applicants and their rivals changed in reaction to the EPO's 2001 decision to conceal information about requests for accelerated examination, we interpret the predictions of our model regarding individual changes in behavior as predictions on changes in the rates of acceleration requests and oppositions.[11] In the graphs in

[11]The reasoning behind this interpretation is the following: Our model assumes that there are two possible types of patents (high-value and low-value), that each type occurs with a certain probability, that there are certain gains and costs from patent acceleration, and that opposition is costly and successful with a certain probability. In reality, we expect these quantities not to be discrete and well-defined, but to follow distributions with non-zero support. If

figure 3, we marked how our model predicts these rates to change in case the patent system was intransparent with respect to patent value and acceleration information got concealed.[12]

From our results, which are summarized in figure 3, we now derive hypotheses on changes in behavior. Note first that we expect to observe changes in acceleration and opposition rates *only* in case the European patent system is intransparent with respect to patent value, but not in case it is transparent.[13] Accordingly, the following hypotheses on behavioral changes are conditional on the assumption that the European patent system is *intransparent* with respect to patent value:

H1 For technological areas where gains from acceleration are low and/or the probability that patents withstand opposition is low, in reaction to concealment of acceleration information we expect to observe a significant increase in the rate of acceleration requests for high-value patents.

H2 For technological areas where gains from acceleration are high and/or the probability that patents withstand opposition is high, in reaction to concealment of acceleration information we expect to observe a significant decrease in the rate of oppositions against high-value patents.

The intuition behind these hypotheses is straightforward: For the case where gains from acceleration are low and/or patents are weak, an applicant requests accelerated patent examination only in case his request is concealed from third parties, because otherwise the risk that rivals use the acceleration signal to identify, oppose and possibly revoke his patent outweighs the expected gains from acceleration. Thus, for low gains from acceleration and/or weak patents we expect the EPO's 2001 decision to conceal acceleration information to be accompanied by an increase in the rate of acceleration requests. For the case where gains from acceleration are high and/or patents are strong, an applicant does not care whether by requesting acceleration he transmits a signal to

we assume that most of the probability mass of the joint distribution of the data-equivalents of our model parameters is concentrated around the expected value (which, for example, is the case if the marginal distributions of the data-equivalents of our model parameters are single-peaked and sufficiently narrow), and if the expected values of the data-equivalents of our model parameters lie in a certain subset of the parameter space, then the change in behavior our model predicts for this subset corresponds to the change in behavior we expect to see in expectation in our data.

[12] For the sake of clarity, we focus on the changes in parameter subsets I and III. Subsets II and IV would only be of relevance if the fraction of high-value patents was quite large and if gains from acceleration were very high, both of which according to our review of the existing empirical literature on the European patent system we do not expect to be the case in practice.

[13] As mentioned above, for a transparent patent system changes in behavior in reaction to concealment of acceleration information only occur for a small subset of the parameter space which is characterized by $p \geq p_2^B$. In practice, however, we expect p to lie somewhere in between 50% and 70%, whereas we expect p_2^B to be equal to or larger than 90%. That is, in practice we do not expect to observe changes in behavior in case of a transparent patent system.

rivals which possibly leads to his patent being opposed - the reason being that the high expected gains from acceleration compensate him for the risk of being opposed. However, after 2001 rivals can no longer use the acceleration signal to identify high-value patent, and because a "miss" - that is, opposition against a low-value patent - is costly, they refrain from opposition. In effect, we thus expect to observe a drop in the rate of oppositions.

4 Empirical Evidence from the Natural Experiment

In December 2001, the EPO changed its information policy regarding the publication of requests for accelerated examination of patent applications: While before December 2001 information about whether an applicant requested accelerated examination was publicly available, after December 2001 this information was concealed from the public. In case the European patent system was indeed opaque with respect to patent value, we would expect this change in the EPO's information policy to have an impact on both the behavior of patent applicants and their rivals. In the following, we use data provided to us by the EPO to look into empirical evidence on opaqueness of the European patent system. In particular, the data we have available informs us about whether a given patent applicant requested accelerated examination of his patent application after December 2001. This kind of information was (and still is) not available to the public.

4.1 Data and Descriptives

For our empirical analysis we use detailed data on all patents which were applied for at the EPO during the time period 1997 to 2004. In particular, we use data from the extensive and publicly available PATSTAT database, which we combine with data on requests of accelerated examination by patent applicants. After 2001, these acceleration data was (and still is) concealed from the public, but it was made available exclusively to us by the EPO. Our dataset covers information on the characteristics of a given patent (destination of inventor, priority country, number of claims, and so on) and procedural information (time of application, status of application, time of grant, EPC member states validations, and so on). In particular, for each patent application we have available information on whether the applicant requested accelerated examination, and on whether (in case the application got granted) third parties initiated opposition proceedings. We focus our empirical analysis on all patent applications which were finally granted.[14] We follow Schmoch (2008) in grouping all patents into five main technological areas. These are "Electrical Engineering", "Instruments", "Chemistry", "Mechanical Engineering" and "Other Fields". We will do our empirical analysis both for the full sample of patents and separately for each of the five main technological areas. While we will report results for "Other Fields", we will focus the discussion in the text on the sample of all patents and the four largest technological areas.

In our sample, we have 438,120 patent applications which led to a grant. That is, on average there are 54,765 patent applications (which led to a grant) per year for the time period 1997 to 2004. (Table 9 gives the precise number of patent applications per year for this time period.) With regard to the five main technological areas, the largest area with respect to the number of patent applications is "Mechanical Engineering", followed by " Chemistry", "Electrical Engineering", "Instruments" and "Other Fields" (see also the upper part of table 1).

Our main variables of interest are the fraction of applications per year for which accelerated examination was requested, and the fraction of applications per year which were opposed after grant. In our full sample, per year on average 7.5% of all applications were accelerated, and on average 5.3% of all applications were opposed. When we take a closer look, for the five main technological areas different patterns with respect to the acceleration and the opposition rates emerge: Whereas in "Electrical Engineering" per year on average 9.4% of all applications were accelerated but only 2.3% were opposed, in "Chemistry" per year on average only 6.6% of all applications were accelerated but 8.0% were opposed. In between these two extremes are "Instruments", where per year on average 8.0% of all applications were accelerated and 4.3% were opposed, and "Mechanical Engineering", where per year on average 6.0% of all applications were accelerated and 5.7% opposed.

Our theory predicts that in reaction to the EPO's 2001 decision to conceal information about acceleration requests we should observe an increase in the rate of acceleration requests per year, and a decrease in the rate of oppositions per year. The graph in figure 4 shows the development of the yearly acceleration and opposition rates for the period 1997 to 2005. With the EPO's decision

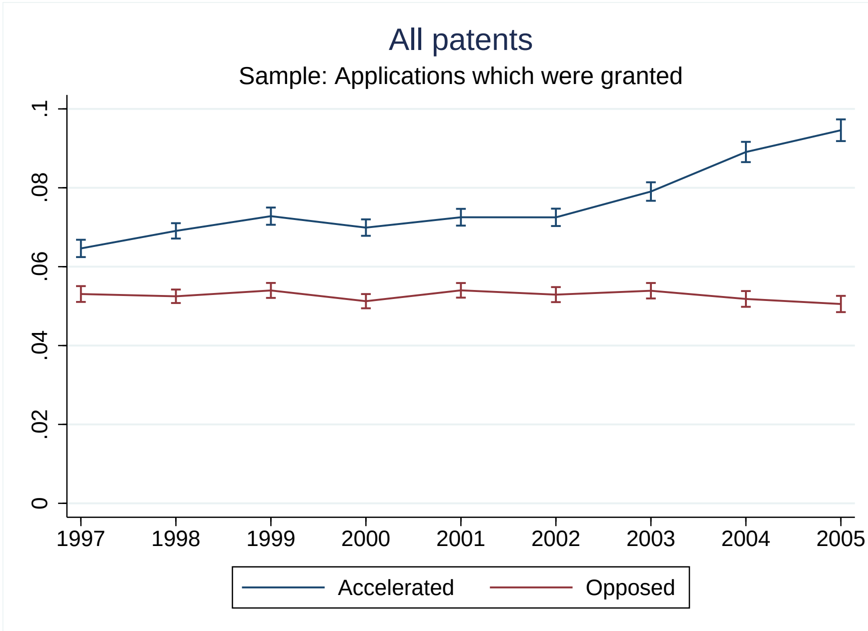
[14] Around 95% of all patents which are not withdrawn get granted. Also, we argue it is reasonable to assume that most of the patents which were withdrawn were of low value to the applicants, and we do not expect an effect of the EPO's 2001 decision to conceal acceleration information on low-value patents. Thus, by concentrating on granted patents only we should not introduce a systematic bias into our results. As a short technical remark: To be entirely accurate, we focus on all patents which were granted until December 31 2011 the latest. The reason is that for our analysis we need data on both whether a given patent got opposed after grant, and on the number of European Patent Convention (EPC) member states it got validated in. This data is only available sometime after grant.

	Main areas									
	Electr.Eng.		Instr.		Chem.		Mech.Eng.		Other	
	Acc. freq.	Opp. freq.	Acc. freq.	Opp. freq.	Acc. freq.	Opp. freq.	Acc. freq.	Opp. freq.	Acc. freq.	Opp. freq.
97-05	9.4	2.3	8.0	4.3	6.6	8.0	6.0	5.7	10.6	5.4
	(12,008)		(7,813)		(13,770)		(15,791)		(3,641)	
97-99	8.3	2.5	7.7	4.5	6.2	7.8	5.3	5.6	9.9	5.1
02-04	9.6	2.2	8.2	4.1	7.2	8.0	6.6	5.8	11.1	5.7
Change (%)	+16.3 (***)	-12.1 (***)	+6.8 (**)	-7.2 (*)	+16.0 (***)	+2.3	+25.0 (***)	+3.3	+12.1 (***)	+12.4 (**)

Table 1: **Acceleration and opposition rates.** The upper part of the table gives the average acceleration and opposition rates for patents which were applied for during the time period 1997 to 2005 and which were granted later on. The acceleration and opposition rates are given separately for the five main technological areas in which all patents can be grouped (according to Schmoch, 2008). The numbers in parentheses give the average number of applications per year. The lower part of the table separately displays the average acceleration and opposition rates during the pre-treatment period (1997 to 1999) and the post-treatment period (2002 to 2004). The last row gives the percentage change in these rates between the pre- and the post-treatment period. Whether the given changes are significant is tested via a two-sample ttest. Significance niveaus are indicated by stars: ***: 1%, **: 5%, *: 10%.

to conceal information about applicants' acceleration requests in 2001, the yearly acceleration rate seems to increase, whereas there seems to be no significant change in the yearly opposition rate. A similar picture emerges when we take a look at the development of the yearly acceleration and the opposition rates in the five main technological areas (see figure 8) - overall, yearly acceleration rates seem to increase, whereas there seems to be no change (or just a slight decrease) in yearly opposition rates.

In evaluating the effects of the EPO's 2001 decision to conceal acceleration information, it is important to account for the time structure of the proceedings at the EPO: In general, a request for accelerated examination has not to be filed together with the application for a patent, but can essentially be filed anytime between the filing date of the application and its grant. Most requests for accelerated examination are either filed at the date the application is filed, or around the date the request for examination is filed. The request for examination is typically filed one-and-a-half years after the application is filed. In effect, the median time span between the filing date of an application and the date at which the request for accelerated examination is filed turns out to be 1.9 years (see table 2). With respect to the evaluation of the EPO's policy change, this means that



	Years 97-05	Years 97-99	Years 02-04	Change
Avg. acc. rate	0.075	0.069	0.080	+15.8%***
Avg. opp. rate	0.053	0.053	0.053	-0.4%

Figure 4: **Acceleration and opposition rates over time.** For all patents of a given application year, the blue graph gives the fraction of these applications for which accelerated examination was requested, and the red graph gives the fraction which was opposed after being granted. From 1997 to 2004, on average 54,765 patent applications were filed at the EPO per year. Acceleration information was concealed from the public from December 2001 on. At each data point, a 95% confidence intervals is displayed.

a non-negligible part of the patent applications which were filed during the years 2000 and 2001 might be affected by the EPO's decision to conceal acceleration information from December 2001 on.

For our further investigation of the effect of the EPO's 2001 decision to conceal acceleration information on the behavior of patent applicants and their rivals, we will interpret the EPO's 2001 policy change as "treatment" and divide our data into patents whose applications were filed during a "pre-treatment period", and patents whose applications were filed during a "post-treatment period". In dividing our data into these two periods, timeliness is of crucial importance: On the one hand, we would like the two time periods to be as comparable as possible (ideally, the only difference between the pre- and the post-treatment period would be the availability of acceleration information). On the other hand, we have to make sure that patents from the pre-treatment period are not affected by the EPO's decision in December 2001 to conceal acceleration information. The first requirement calls to define the pre- and the post-treatment period to as close together in time

	Applications which were granted			Applications which were accelerated and granted	
	Time until grant	Time until grant (accelerated)	Time until grant (not accelerated)	Time until acceleration	Acceleration request before or with examination request
All areas	4.8a	4.1a	4.8a	2.4a	39.2%
	(4.5a)	(3.7a)	(4.5a)	(1.9a)	
Main areas:					
Electrical Eng.	5.2a	4.4a	5.3a	2.4a	44.3%
	(5.0a)	(3.9a)	(5.0a)	(1.8a)	
Instruments	5.1a	4.4a	5.2a	2.6a	36.7%
	(4.9a)	(3.9a)	(5.0a)	(2.0a)	
Chemistry	4.8a	4.2a	4.9a	2.4a	35.7%
	(4.5a)	(3.8a)	(4.6a)	(1.9a)	
Mechanical Eng.	4.2a	3.6a	4.3a	2.2a	39.0%
	(4.0a)	(3.2a)	(4.0a)	(1.8a)	
Other	4.4a	3.7a	4.5a	2.3a	36.7%
	(4.2a)	(3.4a)	(4.2a)	(1.9a)	

Table 2: **Time to patent grant and time to acceleration request.** The left part of the table displays the average time span between the filing of a patent application at the EPO and its grant. Average time spans are given for the sample of all patents which were applied for between 1997 and 2005 and which were granted later on, for the subset of these patents for which accelerated examination was requested, and for the subset of these patents for which there was no request for accelerated examination. In parentheses, the median time span is given. For all patent applications for which there was a request for accelerated examination, the right part of the table gives the average time span between the filing of a patent application at the EPO and the request for accelerated examination. (In parentheses the median time span is given.) The percentage numbers give the part of the accelerated applications for which the request for accelerated examination was made before or with the request for examination.

as possible. In light of the discussion in the last paragraph, however, the second requirement calls for some space between the pre- and the post-treatment period - as the request for accelerated examination is often filed together with the request for examination (which typically is filed one-and-a-half years after the filing of an application), a non-negligible part of the patent applications from the years 2000 and 2001 might be affected by the EPO's decision in December 2001 to conceal acceleration information. For the main part of our analysis, we therefore define the pre-treatment period to cover the years 1997 to 1999, and the post-treatment period to cover the years 2002 to 2004.[15]

Based on these definitions, we compare acceleration and opposition rates before and after the EPO's 2001 decision to conceal acceleration information. For the sample of all patents, the yearly

[15]Note at this point that the results we will derive in the following do not depend on the specific definition of the pre-treatment period and the post-treatment period - as demonstrated in appendix **??**, our results are in fact quite robust under variations in both the length and the location of these periods.

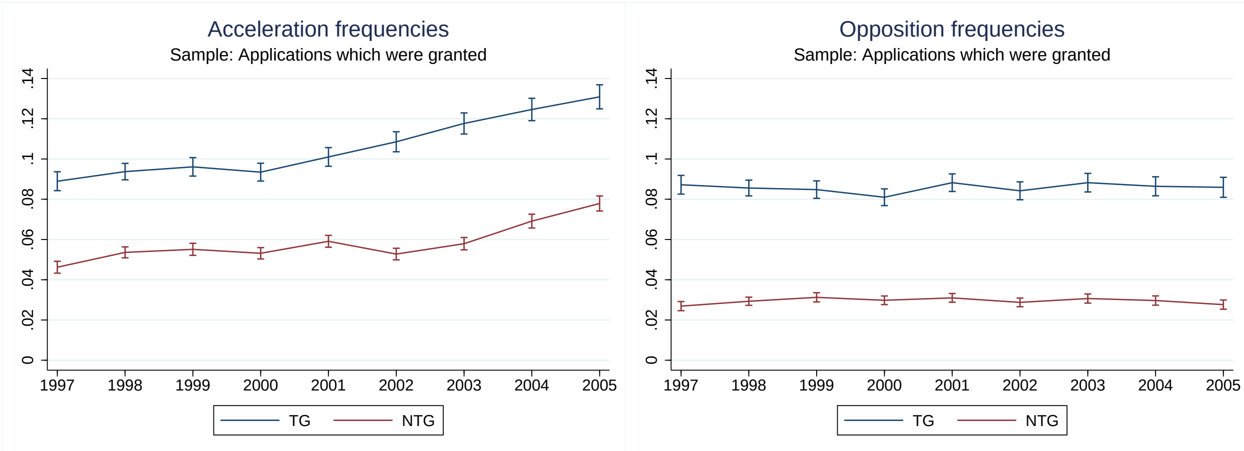


Figure 5: **Yearly acceleration and opposition the treatment and the control group.** The left graph compares the development of the acceleration frequency in the treatment group (TG) to that in the control group (NTG), the right graph compares the development of the opposition frequency in the treatment group to that in the control group. The treatment group consists of all applications whose value proxy is greater than or equal to the 75%-percentile of the distribution of the value proxy, the control group consists of all applications whose value proxy is smaller than or equal to the 25%-percentile of the distribution of the value proxy. The value proxy is the count of the EPC member states which a given patent application was validated in. At each data point a 95% confidence intervals is displayed.

acceleration rate increases from 6.9% during the years 1997-1999 to 8.0% during the years 2002-2004. This corresponds to a (statistically significant) relative increase of 15.8%. The yearly opposition rate, in contrast, does not change significantly - both during the years 1997-1999 and the years 2002-2004 it is 5.3%. For all five main technological areas, the lower part of table 1 compares the yearly acceleration and opposition rates before and after the EPO's 2001 policy change. Strong changes can be observed for "Electrical Engineering", where the yearly acceleration and opposition rates change significantly by +16.3% respectively −12.1%, for "Mechanical Engineering", where the yearly acceleration rate increases by +25%, and for "Chemistry", where the yearly acceleration rate increases by +16%. The changes for instruments - a +6.8% increase in yearly acceleration rate and a −7.2% decrease in yearly opposition rate - are less pronounced, both with regard to statistical and economic significance.

Our model predicts that in reaction to concealment of the acceleration signal in 2001, only for the group of *high-value* patents there should be an increase in yearly acceleration rates respectively a decrease in yearly opposition rates. For the group of low-value patents, there should be no effect at all. The aggregate numbers presented so far show that concealment of the acceleration signal indeed coincides with an increase in yearly acceleration rates and a decrease in yearly opposition rates. However, this might not be due to a change in the respective rates for the group of high-value patents only, but it could simply be due to underlying time trends unrelated to the EPO's 2001 policy change, which affect both the group of high-value patents and that of low-value patents the same way.

In order to explore this issue further, we identify high- and low-value patents by employing a version of the scope-year index suggested (amongst others) by Van Pottelsberghe de la Potterie and Van Zeebroeck (2008):[16] We assign every patent a score by counting in how many EPC member states the patent got validated in after grant.[17] The argument here is that validating a patent in an EPC member state is expensive, and therefore the number of EPC member states a patent was validated in should reflect the economic value of that patent. We assign patents to the group of high-value patents if their score is in the top quartile of the score distribution, and to the non-treatment group if it is in the bottom quartile.[18] Further down, we will call the group of high-value patents the "treatment group", and that of low-value patents the "non-treatment" group.

The left graph in figure 5 compares the development of yearly acceleration rates between the group of high-value patents and that of low-value patents. Over time, both the yearly acceleration rate of high-value patents and that of low-value patents increase. However, the increase in the yearly acceleration rate of high-value patents indeed seems to be more pronounced than that of low-value patents. The right graph in figure 5 compares the development of yearly opposition rates between the group of high-value patents and that of low-value patents. In contrast to the yearly acceleration rates, there seems to be no difference in the development of the yearly opposition rate - both for the group of high-value patents and that of low-value patents, yearly opposition rates do not change significantly over time. For each main technological area, the graphs in figures 9 and 10 compare the development of the yearly acceleration (respectively, opposition) rates in the group of high-value patents to that in the group of low-value patents. It shows that the differences in the development

[16]Note that our value proxy is based on data which is available only some time after the grant of a patent, whereas our theoretical predictions hinge on how applicants assess the value of a given patent before grant. However, we argue that, although there might be some error in the applicants' individual estimates of the (future) returns from their patents, in expectation the value which got apparent by the use of a given patent after grant coincides with the estimate of its value by the applicant before grant.

[17]For every patent we have information on whether fees in a given EPC member state were paid. We use this information to identify the EPC member states the patent was validated in.

[18]We do the assignment of patents into the group high-value patents and that of low-value patents separately for the whole sample of patents and for each main technological area. Table 10 offers information on the distribution of the score and on how patents are distributed among the group of high-value patents and that of low-value patents.

of the yearly acceleration (respectively, opposition) rates follow different patterns, depending on which main technological area is considered. For "Electrical Engineering", the decrease in yearly opposition rates seems to be more pronounced for the group of high-value patents than for the group of low-value patents. Both for "Chemistry" and "Mechanical Engineering", the increase in yearly acceleration rates seems to be significantly more pronounced for the group of high-value patents than for the group of low-value patent.

4.2 Difference-In-Difference Approach

■ **Econometric specification.** In this section, we turn to a formal analysis of whether there is a causal link between the observed changes in behavior and the EPO's 2001 decision to conceal acceleration information. In the following, we will interpret the EPO's 2001 decision to conceal acceleration information as "treatment". The method commonly applied to identify causal effects of a treatment is difference-in-difference (DID) estimation. Technically, a DID estimator compares changes over time in a group not affected by a given treatment (the non-treatment or control group) to changes over time in a group affected by that treatment (the treatment group). When composition controls are added, in doing so the DID estimator simultaneously controls both for changes in group composition and for changes over time unrelated to the treatment. Given the assumption that the change in the variable of interest would have been the same for the treatment and the control group in the hypothetical case of no treatment (the so-called "common-trend assumption"), observed differences in the changes of the variables of interest can be causally attributed to the treatment.

A computationally easy way to implement the DID estimator is to regress the variable of interest on a period dummy, a group dummy, and the interaction of the two:[19]

$$\mathrm{VOI} = \alpha + \beta\mathrm{POST} + \gamma\mathrm{TG} + \delta\mathrm{POST} * \mathrm{TG} + \mathrm{CTRLS} + \epsilon \tag{1}$$

VOI denotes the variable of interest. Depending on whether we analyze changes in yearly acceleration or opposition rates, it stands as a placeholder for either ACCEX or OPP. ACCEX is equal to one in case a patent application is accelerated, and zero otherwise. OPP is equal to one in case

[19] As discussed in Angrist and Pischke (2008), when control variables are included this regression is equivalent to a matching estimator with the controls as matching variables and a certain weighting.

a patent application is opposed after grant, and zero otherwise. POST equals one for observations from the post-treatment period and zero for observations from the pre-treatment period. TG equals one for observations from the treatment group, and zero for observations from the non-treatment group. As discussed in the previous subsection, we define the pre-treatment period to cover the years 1997-1999, and the post-treatment period to cover the years 2002-2004. Also, we define the treatment group to consist of all patents from the top quartile of the distribution of the value proxy (which is given by the count of all EPC member states a given patent was validated in), and the non-treatment group to consist of all patents from the bottom quartile - the reason being that, according to our theory, only high-value patents should have been affected by the concealment of the acceleration signal. CTRLS stands as a placeholder for the control variables which shall capture possible changes in the compositions of the treatment and the control group. As control variables we include whether an application is a PCT application, which country the applicant is from (France, Germany, Japan, UK, US or other), the number of claims of the patent, and the number of inventors.

In summary, we estimate two regression equations:

$$\text{ACCEX} = \alpha + \beta\text{POST} + \gamma\text{TG} + \delta\text{POST} * \text{TG} + CTRLS + \epsilon \tag{2}$$

$$\text{OPP} = \alpha + \beta\text{POST} + \gamma\text{TG} + \delta\text{POST} * \text{TG} + CTRLS + \epsilon \tag{3}$$

We estimate these two regression equations first for the sample of all patents and then for each main technological area. The main technological areas are “Electrical Engineering”, “Instruments”, “Chemistry”, “Mechanical Engineering” and “Other Fields”. For each area, the estimation sample consists of all patents which were applied for during either the pre- or the post-treatment period (1997 to 1999, respectively 2002 to 2004), which got granted, and which are either in the treatment or the non-treatment group (top respectively bottom quartile of the distribution of the count of all EPC member states a given patent was validated in).

■ **Results.** Table 3 display the results of DID regressions (2) and (3). The upper part displays the results of regression 2, which analyzes changes in acceleration rates, the lower part displays the results of regression 3, which analyzes changes in opposition rates. The first column in each part displays the regression results for the sample of all patents, columns two to six display the results for

	All Applications	Main Areas				
		Electrical Engineering	**Instruments**	**Chemistry**	**Mechanical Engineering**	**Other**
	Dependent variable: Indicator for request for **accelerated examination**					
POST	0.00592***	0.0102***	-0.000959	0.00560**	0.0102***	-0.00444
	(0.00126)	(0.00247)	(0.00333)	(0.00269)	(0.00200)	(0.00619)
TG	0.0389***	0.0486***	0.0445***	0.0501***	0.0387***	0.0496***
	(0.00159)	(0.00306)	(0.00467)	(0.00330)	(0.00286)	(0.00768)
POST $*$ TG	0.0136***	0.00211	0.00261	0.0161***	0.0157***	0.0285***
	(0.00237)	(0.00457)	(0.00668)	(0.00502)	(0.00426)	(0.0109)
CTRLS	X	X	X	X	X	X
N	226953	70872	32614	44793	64170	14025
adj. R^2	0.015	0.013	0.018	0.025	0.020	0.018

	Dependent variable: Indicator for request for **opposition**					
POST	-0.000430	-0.000710	-0.00454**	-0.000813	0.000915	0.000503
	(0.000927)	(0.00109)	(0.00223)	(0.00285)	(0.00192)	(0.00359)
TG	0.0520***	0.0268***	0.0454***	0.0535***	0.0426***	0.0535***
	(0.00144)	(0.00179)	(0.00380)	(0.00348)	(0.00290)	(0.00563)
POST $*$ TG	-0.000336	-0.00597**	-0.00487	0.00445	0.00385	0.00687
	(0.00206)	(0.00253)	(0.00525)	(0.00514)	(0.00412)	(0.00798)
CTRLS	X	X	X	X	X	X
N	226953	70872	32614	44793	64170	14025
adj. R^2	0.017	0.010	0.016	0.013	0.015	0.022

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3: **DID regressions, with controls.** The upper table shows the results of DID regressions with an indicator for the request for accelerated examination as dependent variable, the lower table shows the results of DID regressions with an indicator for opposition as dependent variable. In each table, the first column displays the results for the full sample, and columns two to six display the results for the five main technological areas in which the patents from the full sample can be grouped. (The full sample consists of all patents which where applied for during the pre- or the post-treatment period and which were granted later on.) The pre-treatment period covers the years 1997 to 1999, the post-treatment period the years 2002 to 2004. The treatment group consists of patents all patents whose value proxy is greater than or equal to the 75%-percentile of the respective distribution of the value proxy, the control group consists of all patents whose value proxy is smaller than or equal to the 25%-percentile. The value proxy is the count of the EPC member states a given patent was validated in. Controls are included in the regressions but not explicitly listed. Full regression tables can be found in appendix A.4.

the main technological areas "Electrical Engineering", "Instruments", "Chemistry", "Mechanical Engineering" and "Other Fields". In all regressions, the controls mentioned above are included (these are an indicator for PCT applications, covariates indicating the country the applicant is from, the number of claims of the patent, and the number of inventors). For the sake of clarity, the controls are not explicitly listed in table 3. Complete regression tables with all controls listed can be found in appendix A.4.

The covariate POST indicates whether a given patent application was filed during the pre- or the post-treatment period. Its coefficient β gives the change between the average yearly acceleration (respectively, opposition) rate in the pre-treatment period and that in the post-treatment period. More specifically, as composition controls are included in regressions (2) and (3), it gives the part of the change in the acceleration (respectively, opposition) rate which is not explained by variations in the composition of patent applications between the pre- and the post-treatment period. Overall, applicants' propensity to request accelerated examination seems to increase in time, whereas the likelihood that a patent is being opposed seems not to change. When comparing the changes given by β to the changes given in the lower part of table 1 (which were computed based on a simple direct comparison of the average yearly acceleration and opposition rates in the pre-treatment period to that in the post-treatment period), it shows that the former ones are somewhat weaker. This indicates that a part of the changes in yearly acceleration and opposition rates we observed initially is simply due to changes in the composition of patent applications, which stresses the necessity to include composition controls into regressions (2) and (3).

The coefficient γ at covariate TG, which indicates whether a given patent application is from the treatment group (that is, the group of high-value patents), is positive and strongly significant for both the acceleration and the opposition regression and throughout all main technological areas. That is, both the yearly acceleration rates and the yearly opposition rates appear to be significantly higher in the group of high-value patents than in the group of low-value patents. This finding is reassuring, because it confirms one of the main assumptions we made in our theoretical model - the (stylized) assumption being that, because acceleration and opposition proceedings are costly, only acceleration of (respectively, opposition against) high-value patents is worthwhile.

Our main interest lies in the treatment coefficient δ at covariate POST$*$TG. The treatment coefficient δ measures the difference (in absolute terms) between the change of the average yearly acceleration (respectively, opposition) rate of low-value patents and the change of the average yearly acceleration (respectively, opposition) rate of high-value patents. Via the time trend and composition controls included in (2) (respectively, (3)), this difference is computed in regard of possible changes in the sample composition and general time trends. For the sample of all applications, the impression we had from a first look at the graphs in figure 5, which compare the yearly acceleration (respectively, opposition) rates of high-value patents to that of low-value patents, is confirmed: There is a statistically significant difference in changes between the average yearly acceleration rate of low-value patents and that of high-value patents of +1.4% (in absolute terms), and there is no statistically significant difference in changes between the average yearly opposition rate of low-value patents and that of high-value patents. Given that over all years the average yearly acceleration rate for the sample of all patents is 7.5%, this difference in the changes of acceleration rates is not only statistically but also economically significant.

For main technological areas "Chemistry" and "Mechanical Engineering", we observe similar patterns: The results show a statistically significant difference in changes between the average yearly acceleration rate of low-value patents and that of high-value patents, but no statistically significant difference in changes of average yearly opposition rates. The difference in changes between the average yearly acceleration rate of low-value patents and that of high-value patents is +1.6% for "Chemistry", and +1.6% for "Mechanical Engineering". Again, given that over all years the average yearly acceleration rate is 6.6% for "Chemistry" and 6.0% for "Mechanical Engineering", these changes are not only of statistical, but also of economic significance. For main area "Electrical Engineering", we do not observe a statistically significant difference in changes of average yearly acceleration rates. However, we observe a statistically significant difference in changes between the average yearly opposition rate of high-value patents and that of low-value patents of −0.6%. Given that over all years, the average yearly opposition rate is 2.3% for "Electrical Engineering, this difference in changes in average yearly opposition rates is also of economic significance. Finally, for main technological area "Instruments" we observe no statistically significant differences in changes at all.

■ **Robustness.** A core assumption in our DID analysis is that prior to the treatment there is a common trend for the treatment group (the group of high-value patents) and the non-treatment group (the group of low-value patents). In order to test this assumption, we allow the treatment effect to vary over our observation periods, and we estimate accordingly modified versions of regression equations (2) and (3) for the sample of all patents and for all five main technological areas. Figures 11 and 12 in the appendix display the results. Overall the results show that before the EPO's 2001 policy change the estimated "treatment coefficients" are not statistically significant from zero. This supports the assumption that there is a common trend for the treatment and the non-treatment group prior to the treatment.

When deriving the results given in table 3, we had to make several technical choices regarding the setup of the DID estimator. In particular, these choices involved the definition of the pre- and the post-treatment period (1997-1999 respectively 2002-2004) and the definition of the treatment and the non-treatment group (the top respectively bottom quartile of the distribution of our value proxy). In order to exclude the possibility that our results are driven by our specific design choices, we performed several robustness checks with varying definitions of the pre- and the post-treatment period and the treatment and control group. The results are given in tables 16 and 17. Overall, our main results (which are given in table 3) turn out to be very robust against variations in the definitions of either the pre- and the post-treatment period or the treatment and control group. The only exception is “Electrical Engineering”, where under alternative definitions of the treatment and control group we observe an increase in the average yearly acceleration rate. The reason seems to be that the 25%-percentile/75%-percentile rule leads to a rather rough sorting of patents into the treatment and the control group (see table 10), whereas for example the 10%-percentile/90%-percentile sorting rule leads to a clearer separation (compare table 11), which supports the identification of differences between groups.

In order to define the treatment and the control group, we use ex-post information on the count of all EPC member states a given patent was validated in after grant to construct a value proxy: One concern here might be that patents which actually were of high value but which were revoked after successful opposition are spuriously assigned to the group of low-value patents, and that this incorrect assignment biases our results. However, the validation of a granted patent in a given EPC member state has to be done within three month after the patent grant, whereas the notice of opposition can be filed up to nine month after a patent got granted. In addition, the EPO needs on average three years to reach a decision in an opposition case. That is, our value proxy should be unaffected by whether a given patent got opposed (and possibly revoked) after grant.

Throughout the paper, we entertained the assumption that, when patent applicants file a request for accelerated examination, they do so with the strategic intent to reach a sooner patent grant, which in turn increases the value of their patent. However, for a few patent applications in our sample the request for accelerated examination is filed at a very late stage in the patent application process, which indicates that some patent applicants might use the tool of accelerated examination for different strategic reasons. In order to test whether different strategic rationals are of influence on our results, we redefine our dependent variable ACCEX to equal one if the request for accelerated was made up to half a year after the request for examination - the assumption being here that when the request for accelerated examination is made rather early in the patent application process, the intent of the patent applicant is to get his patent granted sooner. As table 16 shows, this redefinition of our dependent variable is of effect on our results only for "Electrical Engineering" - when using the redefined ACCEX variable, we observe an increase in the average yearly rate of acceleration. This indicates that in "Electrical Engineering" strategic motives different from the motive to reduce time-to-grant in order to increase patent value might play a non-negligible role. In all other areas, however, the motive to reduce time-to-grant seems to be the dominant one.

Finally, there might be the concern that our results do not capture the effect of the EPO's 2001 decision to conceal acceleration information, but the effect of some other event which happened simultaneously and which caused the observed changes in acceleration and opposition rates. For example, one might think that the advent of modern information technology in the early 2000s lowered applicants' (effort) costs of filing requests for accelerated examination, which in turn might have led to the observed increases in acceleration rates. However, the patterns we observe in our data - in particular, the ways acceleration and opposition rates change in the group of high-value patents relative to the group of low-value patents - are very specific, and fit very closely the theoretical predictions for the case that acceleration information gets concealed in a patent system which is intransparent with respect to patent value. We are not aware of any other event around the year 2001 which possibly could have reproduced the same patterns of changes. Thus, we are confident that our results actually do capture the effect of the EPO's 2001 decision to conceal acceleration information.

4.3 Discussion and Interpretation

We presented evidence that the EPO's 2001 decision to conceal acceleration information led to significant changes in both the acceleration and the opposition rates of high-value patents (with the respective developments in the group of low-value patents as baseline). In particular, for the sample of all patents we find that the 2001 change in the EPO's information policy led to a significant increase in the average yearly acceleration rate of high-value patents, and to no significant change

	All applications	Main areas: Electrical Engineering	Instruments	Chemistry	Mechanical Engineering	Other
Acc. rate	+	0	0	+	+	+
Opp. rate	0	–	0	0	0	0

Table 4: **Summary of our findings regarding changes in the accelereration and opposition frequency of high-value patents.** The table summarizes the results from the DID regressions displayed in table 3 regarding the changes in the acceleration and the opposition rates of high-value patents (that is, patents from the top-quartile of the distribution of the value proxy) relative to those of low-value patents (that is, patents from the bottom-quartile of the distribution of the value proxy). A "+" sign indicates that the treatment coefficient δ in (2) is significantly positive (on the 5% level), meaning that between the periods 1997-1999 and 2002-2004 the respective rate increased significantly stronger for the group of high-value patents than for that of low-value patents. A "-" sign indicates that the treatment coefficient δ in (2) is significantly negative, meaning that the respective rate decreased significantly stronger.

in the average yearly opposition rate. When looking at the main technological areas, we find two distinct patterns of changes: For "Chemistry" and "Mechanical Engineering", in the groups of high-value patents we observe a significant increase in the average yearly acceleration rates, and no significant change in average yearly opposition rates (relative to the respective developments in the groups of low-value patents). For "Electrical Engineering", in contrast, in the group of high-value patents we observe a significant decrease in the average yearly opposition rate of oppositions (relative to the respective development in the group of low-value patents). Table 4 summarizes these findings schematically. As demonstrated in the last section, overall these findings are very robust - that is, they hold under various specifications of the DID estimation (see tables 16 and 17).

In the theoretical part of our article, we derived hypotheses on changes in the behavior of patent applicants and their rivals in case information about acceleration requests gets concealed from the public. These hypotheses are conditional on the assumption that the European patent system is intransparent with respect to patent value. In general, in reaction to concealment of acceleration information, for the group of high-value patents we expect to observe either an increase in the rate of acceleration requests, or a decrease in the rate of opposition proceedings. (Note that we do not expect the group of low-value patents to be affected by concealment of acceleration information.) More specifically, in case gains from acceleration are low (meaning that there is only a minor increase in patent value due to an earlier grant), we expect to observe an increase in yearly acceleration rates only, whereas in case gains from acceleration are high we expect to observe a decrease in yearly opposition rates only.

The changes we see in our data correspond to these predictions: concealment of acceleration information from the public in December 2001 triggered either an increase in the average yearly acceleration rates of high-value patents, or a decrease in the average yearly opposition rates of high-value patents. In addition, in line with our predictions stated in hypotheses two and three, we observe increases in average yearly acceleration rates for technological areas in which we expect gains from acceleration to be relatively low ("Chemistry" and "Mechanical Engineering", which assemble rather matured technologies), and we observe a decrease in average yearly opposition rate for a technological area in which we expect gains from acceleration to be relatively high ("Electrical Engineering", which assembles rather young and dynamic technologies).

We argue that this close correspondence between the predictions of our model and the observations in our data gives strong support to our presumption that the European patent system is intransparent in a particular sense: the information content of publicly observable actions of informed parties goes considerably beyond what patent system users can extract from information disclosed in patent documents. In other words, economic agents appear to have serious difficulties in identifying a patent's contribution solely from the conventional data generated by the EPO in patent publications.

5 Conclusion

This article seeks to contribute towards a better understanding of the fundamental tradeoff between the disclosure of information and the granting of exclusion rights in patents systems. We ask whether the European patent system is transparent with respect to information revealing the value of a patented innovation, or instead rather opaque. We try to give an answer to this question by exploiting a rule change in the European patent system: While before December 2001 applicants' requests for accelerated examination were disclosed to the public, afterwards these requests were treated as confidential information. We develop a model of the patent application and opposition process which shows that concealment of the acceleration signal leads to specific changes in the behavior of applicants and rivals in case the European patent system is opaque with respect to patent value. In particular, in reaction to the EPO's 2001 policy change, we expect the frequency of acceleration requests to increase and that of oppositions to decrease. Using a difference-in-difference approach, we show that in three of the five main technological areas after Schmoch (2008) these predictions are met by the data. (These areas are "Electrical Engineering", "Instruments" and "Mechanical Engineering".) This gives support to our presumption that the European patent system is (at least in parts) opaque. Thus, the main conclusion we draw from our analysis is that it seems difficult to identify a patent's contribution solely on the basis of the conventional data generated by the EPO. Our analysis thus poses the question whether the patent office should accommodate the hiding of actions by informed parties which help other patent system users to navigate the system. In the cases studied by us, hiding information may make it possible for some patent-holders to accelerate patent examination without being attacked in opposition. But our results also demonstrate that treating information about agents' actions as private carries real social costs.[20] In further work, we intend to extend our analysis to a full-fledged welfare assessment.

As the Federal Trade Commission notes in its 2011 report on patent notice and patent remedies,[21] the failure of patent documents to clearly inform third parties about what they cover can be detrimental to competition among technologies and to emerging markets for technology. With intransparent or largely opaque information about the patent landscape, firms are not able to make well-informed decisions about which patents to oppose, in which new technologies to invest, what technologies to license or purchase, and with which other firms to collaborate. Also, if firms have to make technological investment decisions under incomplete information about the patent landscape, they risk entering into patent litigation after the market launch of an innovation. Our findings suggest that it may be necessary to put some effort into improving the notice function of European patents. First steps in this direction might be to tighten the disclosure requirements and, like demanded by Bessen and Meurer (2008), to place an obligation on patent applicants to use "plain language" in the construction of their patent claims.

[20] As noted by Lemley and Shapiro (2005) and Farrell and Shapiro (2008), enhanced scrutiny of patents can be socially valuable. Limiting information that can lead to post-grant review - in our case the EPO's 2001 decision to conceal acceleration information - therefore possibly has a (partially) negative welfare effect.

[21] Federal Trade Commission. "The Evolving IP Market Place: Aligning Patent Notice and Remedies with Competition, March 2011." (2012). Download: www.ftc.gov/reports/evolving-ip-marketplace-aligning-patent-notice-remedies-competition .

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A Appendix

A.1 Solution of our model

Table 6 displays the normal form of the signaling game for information structures "public" and "private". We look for all Perfect Bayesian equilibria which satisfy the "intuitive criterion" of Cho and Kreps (1987). The Perfect Bayesian equilibrium concept is a refinement of the Bayesian Nash equilibrium concept in the context of dynamic games with incomplete information, and Bayesian Nash equilibria can be deduced from the normal form of dynamic games. In practice, the determination of Bayesian Nash equilibria from the normal form of dynamic games is based on payoff comparisons.

In the following, we first establish relationships between the payoffs of firm and between that of firm B. These relationships turn out to be dependent on specific parameters. Thus, As a second step we divide the π_h^a-p-θ parameter space into subsets where the payoff relationships are non-ambiguous. Third, for each subset we then derive all Bayesian Nash equilibria. Fourth, we check for every Bayesian Nash equilibrium whether if fulfills the criteria of a Perfect Bayesian Nash equilbrium (Bayesian beliefs and sequential rationality). Fifth, We check for every Perfect Bayesian Nash equilibrium whether it satisfies the "intuitive criterion". For reasons of brevity, we will describe steps three to five exemplarily for one subset of the π_h^a-p-θ parameter space only. The approach for all other subsets is completely analogous.

■ **Relationships between payoffs.** The first step in solving our game for both information structures is to find all Bayesian Nash equilibria. Essentially, the search for Bayesian Nash equilibria can be reduced to simple payoff comparisons, and these payoff comparisons can be traced back to comparisons of the payoffs in case both the value of firm A's patent and firm A's acceleration decision are public knowledge. We denote this information structure by "full". Note that information structure "full" describes the situation where the patent system is transparent with respect to patent value (and firm A's acceleration decision). The normal forms for information structure "full" are given in table 5. We start with comparing the payoffs of the signaling game for information structure "full".

$\theta = h$	(o,o)		$(o,\neg o)$		$(\neg o,o)$		$(\neg o,\neg o)$	
a	$p\pi_h^a - c_a - c_o$	$-p\pi_h^a - c_o$	$p\pi_h^a - c_a - c_o$	$-p\pi_h^a - c_o$	$\pi_h^a - c_a$	$-\pi_h^a$	$\pi_h^a - c_a$	$-\pi_h^a$
$\neg a$	$p\pi_h - c_o$	$-p\pi_h - c_o$	π_h	$-\pi_h$	$p\pi_h - c_o$	$-p\pi_h - c_o$	π_h	$-\pi_h$

$\theta = l$	(o,o)		$(o,\neg o)$		$(\neg o,o)$		$(\neg o,\neg o)$	
a	$p\pi_l - c_a - c_o$	$-p\pi_l - c_o$	$p\pi_l - c_a - c_o$	$-p\pi_l - c_o$	$\pi_l - c_a$	$-\pi_l$	$\pi_l - c_a$	$-\pi_l$
$\neg a$	$p\pi_l - c_o$	$-p\pi_l - c_o$	π_l	$-\pi_l$	$p\pi_l - c_o$	$-p\pi_l - c_o$	π_l	$-\pi_l$

Table 5: **Payoffs for full information.** The upper table shows the payoffs for full information in case $\theta = h$. The lower table shows the payoffs for full information in case $\theta = l$.

For firm A if the patent is of high value ($\theta = h$) the payoff comparisons are

$$p\pi_h^a - c_a - c_o \quad \text{vs.} \quad p\pi_h - c_o, \tag{A1}$$
$$p\pi_h^a - c_a - c_o \quad \text{vs.} \quad \pi_h, \tag{A2}$$
$$\pi_h^a - c_a \quad \text{vs.} \quad p\pi_h - c_o, \tag{A3}$$
$$\pi_h^a - c_a \quad \text{vs.} \quad \pi_h, \tag{A4}$$

and if the patent is of low value ($\theta = l$) the comparisons are

$$p\pi_l - c_a - c_o \quad \text{vs.} \quad p\pi_l - c_o, \tag{A5}$$
$$p\pi_l - c_a - c_o \quad \text{vs.} \quad \pi_l, \tag{A6}$$
$$\pi_l - c_a \quad \text{vs.} \quad p\pi_l - c_o, \tag{A7}$$
$$\pi_l - c_a \quad \text{vs.} \quad \pi_l. \tag{A8}$$

For firm B the payoff comparisons if the patent is of high value ($\theta = h$) are

$$-p\pi_h^a - c_o \quad \text{vs.} \quad -\pi_h^a, \tag{A9}$$
$$-p\pi_h - c_o \quad \text{vs.} \quad -\pi_h, \tag{A10}$$

and if the patent is of low value ($\theta = l$) the comparions are

$$-p\pi_l - c_o \quad \text{vs.} \quad -\pi_l. \tag{A11}$$

Assumptions A1 to A4 determine the relationships between the payoffs in A3 to A8. For each other comparison there exists a certain cut-off value $p^{(\cdot)}$ at which payoffs are equal. For all p smaller (larger) then these $p^{(\cdot)}$ there exists a clear relationship between the underlying payoffs which follows directly from our assumptions A1 to A4. With "$\cdot|\cdot$" denoting the relationship left respectively right of the cut-off value $p^{(\cdot)}$, in case the patent is of high value ($\theta = h$) for firm A we have

$$\begin{aligned}
p\pi_h^a - c_a - c_o &\lesseqgtr p\pi_h - c_o, \quad \text{defines } p_1^A,\ < | >,\\
p\pi_h^a - c_a - c_o &\lesseqgtr \pi_h, \quad \text{defines } p_2^A,\ < | >,\\
\pi_h^a - c_a &> p\pi_h - c_o,\\
\pi_h^a - c_a &> \pi_h.
\end{aligned}$$

For firm A if the patent is of low value ($\theta = l$) we have

$$\begin{aligned}
p\pi_l - c_a - c_o &< p\pi_l - c_o, \qquad & p\pi_l - c_a - c_o &< \pi_l,\\
\pi_l - c_a &> p\pi_l - c_o, \qquad & \pi_l - c_a &< \pi_l.
\end{aligned}$$

For firm B if the patent is of high value ($\theta = h$) we have

$$\begin{aligned}
-p\pi_h^a - c_o &\lesseqgtr -\pi_h^a, \quad \text{defines } p_3^B,\ > | <,\\
-p\pi_h - c_o &\lesseqgtr -\pi_h \quad \text{defines } p_2^B,\ > | <,
\end{aligned}$$

and if the patent is of low value ($\theta = l$)

$$-p\pi_l - c_o \lesseqgtr -\pi_l, \quad \text{defines } p_1^B,\ > | < .$$

Public	(o,o)		$(o,\neg o)$		$(\neg o,o)$		$(\neg o,\neg o)$	
(a,a)	$(1-\theta)p\pi_l+\theta p\pi_h^a-c_a-c_o$	$-(1-\theta)p\pi_l-\theta p\pi_h^a-c_o$	$(1-\theta)p\pi_l+\theta p\pi_h^a-c_a-c_o$	$-(1-\theta)p\pi_l-\theta p\pi_h^a-c_o$	$(1-\theta)\pi_l+\theta\pi_h^a-c_a$	$-(1-\theta)\pi_l-\theta\pi_h^a$	$(1-\theta)\pi_l+\theta\pi_h^a-c_a$	$-(1-\theta)\pi_l-\theta\pi_h^a$
$(a,\neg a)$	$(1-\theta)p\pi_l+\theta p\pi_h^a-\theta c_a-c_o$	$-(1-\theta)p\pi_l-\theta p\pi_h^a-c_o$	$(1-\theta)\pi_l]+\theta p\pi_h^a-\theta c_a-\theta c_o$	$-(1-\theta)\pi_l-\theta p\pi_h^a-\theta c_o$	$(1-\theta)p\pi_l+\theta\pi_h^a-(1-\theta)c_o-\theta c_a$	$-(1-\theta)p\pi_l-\theta\pi_h^a-(1-\theta)c_o$	$(1-\theta)\pi_l]+\theta\pi_h^a-\theta c_a$	$-(1-\theta)\pi_l-\theta\pi_h^a$
$(\neg a,a)$	$(1-\theta)p\pi_l+\theta p\pi_h-(1-\theta)c_a-c_o$	$-(1-\theta)p\pi_l-\theta p\pi_h-c_o$	$(1-\theta)p\pi_l+\theta\pi_h-(1-\theta)c_a-(1-\theta)c_o$	$-(1-\theta)p\pi_l-\theta\pi_h-(1-\theta)c_o$	$(1-\theta)\pi_l+\theta p\pi_h-(1-\theta)c_a-\theta c_o$	$-(1-\theta)\pi_l-\theta p\pi_h-\theta c_o$	$(1-\theta)\pi_l+\theta\pi_h-(1-\theta)c_a$	$-(1-\theta)\pi_l-\theta\pi_h$
$(\neg a,\neg a)$	$(1-\theta)p\pi_l+\theta p\pi_h-c_o$	$-(1-\theta)p\pi_l-\theta p\pi_h-c_o$	$(1-\theta)\pi_l+\theta\pi_h$	$-(1-\theta)\pi_l-\theta\pi_h$	$(1-\theta)p\pi_l+\theta p\pi_h-c_o$	$-(1-\theta)p\pi_l-\theta p\pi_h-c_o$	$(1-\theta)\pi_l+\theta\pi_h$	$-(1-\theta)\pi_l]-\theta\pi_h$

Private	o		$\neg o$	
(a,a)	$(1-\theta)p\pi_l+\theta p\pi_h^a-c_a-c_o$	$-(1-\theta)p\pi_l-\theta p\pi_h^a-c_o$	$(1-\theta)\pi_l+\theta\pi_h^a-c_a$	$-(1-\theta)\pi_l-\theta\pi_h^a$
$(a,\neg a)$	$(1-\theta)p\pi_l+\theta p\pi_h^a-\theta c_a-c_o$	$-(1-\theta)p\pi_l-\theta p\pi_h^a-c_o$	$(1-\theta)\pi_l]+\theta\pi_h^a-\theta c_a$	$-(1-\theta)\pi_l-\theta\pi_h^a$
$(\neg a,a)$	$(1-\theta)p\pi_l+\theta p\pi_h-(1-\theta)c_a-c_o$	$-(1-\theta)p\pi_l-\theta p\pi_h-c_o$	$(1-\theta)\pi_l+\theta\pi_h-(1-\theta)c_a$	$-(1-\theta)\pi_l-\theta\pi_h$
$(\neg a,\neg a)$	$(1-\theta)p\pi_l+\theta p\pi_h-c_o$	$-(1-\theta)p\pi_l-\theta p\pi_h-c_o$	$(1-\theta)\pi_l+\theta\pi_h$	$-(1-\theta)\pi_l-\theta\pi_h$

Table 6: **Normal form of the game for information structures "public" and "private".** For both information structures each row represents a possible strategy of firm A, while each column represents a possible strategy of firm B. For each strategy of firm A its actions are conditional on nature's draw of the patent value. That is, (a,a) is short for $(a|v=h, a|v=l)$, and so on. For information structure "public", for each strategy of firm B its actions are conditional on whether firm B observes accelerated patent examination. That is, (o,o) is short for $(o|a, o|\neg a)$. For each information structure each box displays the payoffs of firm A (left) and firm B (right) if the respective strategies are played.

The cut-off values are defined as follows:

$$\begin{aligned}
p_1^A &= \frac{c_a}{\pi_h^a - \pi_h}, \\
p_2^A &= \frac{c_a + c_o + \pi_h}{\pi_h^a}, \\
p_1^B &= \frac{\pi_l - c_o}{\pi_l}, \\
p_2^B &= \frac{\pi_h - c_o}{\pi_h}, \\
p_3^B &= \frac{\pi_h^a - c_o}{\pi_h^a}.
\end{aligned}$$

The payoffs for information structures “public” and “private” are composed from the payoffs for information structure “full”. Thus, with information about the relationships between the payoffs for information structure “full” it is easy to derive the relationships between the payoffs for information structures “public” and “private”. Each row in table 6 corresponds to a strategy of firm A, and each column to a strategy of firm B. First, we determine the best reactions of firm A to each possible strategy of firm B. Based on our results for the payoffs of firm A for information structure “full” and our assumptions A1 to A4 we find for information structure “public”:

1st column: 4th row if $p < p_1^A$, 2nd row if $p > p_1^A$.

2nd column: 4th row if $p < p_2^A$, 2nd row if $p > p_2^A$.

3rd column: 1st row.

4th column: 2nd row.

The results for firm A and Information structure “private” are:

1st column: 4th row if $p < p_1^A$, 2nd row if $p > p_1^A$.

2nd column: 2nd row.

With that, the relationships between the payoffs of firm A are fully determined.

The results for firm B and information structure “public” are:

2nd row: 1st column if $0 < p < p_1^B$, 2nd column if $p_1^B < p < p_3^B$, 4th column if $p_3^B < p < 1$.

3rd row: 1st column if $0 < p < p_1^B$, 3rd column if $p_1^B < p < p_2^B$, 4th column if $p_2^B < p < 1$.

For the 1st row of information structure “public” and the 1st and 2nd row of information structure “private” the same payoffs have to be compared. The comparison to be made is

$$-(1-\theta)p\pi_l - \theta p \pi_h^a - c_o \text{ vs. } -(1-\theta)\pi_l - \theta\pi_h^a.$$

The relationship between these payoffs depends on the relationship between p and θ. With

$$p_{\theta,1} = 1 - \frac{c_o}{\theta\pi_h^a + (1-\theta)\pi_l}, \tag{A12}$$

we have equality for $p = p_{\theta,1}$. For values of p smaller than $p_{\theta,1}$ the former payoff is larger than the latter, and vice versa. For $\theta = 0$ $p_{\theta,1}$ equals p_1^B, and for $\theta = 1$ $p_{\theta,1}$ equals p_3^B. We denote the inverse

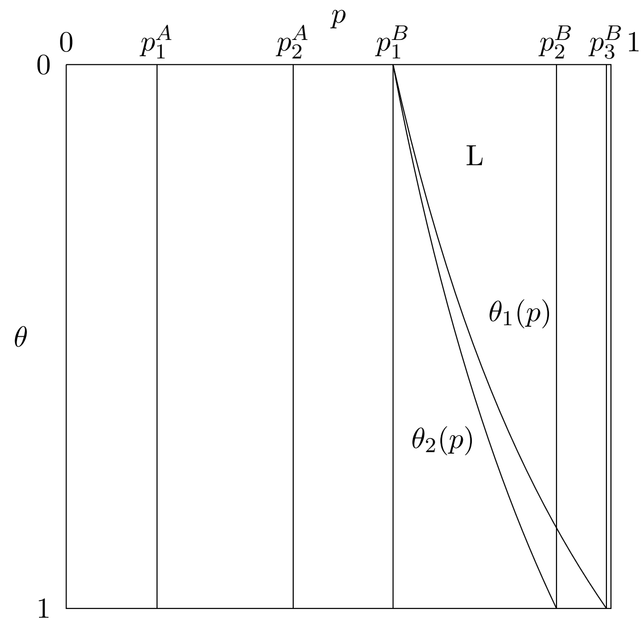


Figure 6: p-θ **subsets for the** π_h^a **subset** Π_6**.**

function of $p_{\theta,1}(\theta)$ by $\theta_1(p)$. The situation for the 4th row of information structure "public" and the 3rd and 4th row of information structure "private" is analogous: The comparison to be made is

$$-(1-\theta)p\pi_l - \theta p\pi_h - c_o \text{ vs. } -(1-\theta)\pi_l - \theta\pi_h.$$

The relationship between these payoffs depends on the relationship between p and θ. With

$$p_{\theta,2} = 1 - \frac{c_o}{\theta\pi_h + (1-\theta)\pi_l}, \tag{A13}$$

we have equality for $p = p_{\theta,2}$. For values of p smaller than $p_{\theta,2}$ the former payoff is larger than the latter, and vice versa. For $\theta = 0$ $p_{\theta,2}$ equals p_1^B, and for $\theta = 1$ $p_{\theta,2}$ equals p_2^B. We denote the inverse function of $p_{\theta,2}(\theta)$ by $\theta_2(p)$. With that we can complete the payoff comparisons for firm B. For information structure "public" we have:

1st row: 1st and 2nd column if $< p_{\theta,1}$, 3rd and 4th column if $p > p_{\theta,1}$.

4th row: 1st and 3rd column if $p < p_{\theta,2}$, 2nd and 4th column if $p > p_{\theta,2}$.

For information structure "private" the results are:

1st row: 1st column if $< p_{\theta,1}$, 2nd column if $p > p_{\theta,1}$.

2nd row: 1st column if $< p_{\theta,1}$, 2nd column if $p > p_{\theta,1}$.

3rd row: 1st column if $< p_{\theta,2}$, 2nd column if $p > p_{\theta,2}$.

4th row: 1st column if $p < p_{\theta,2}$, 2nd column if $p > p_{\theta,2}$.

With that, the relationships between the payoffs of firm B are fully determined.

■ **Subsets of the π_h^a-p-θ parameter space.** From assumptions A1 to A4 it follows that $p_1^A < p_2^A$ and $p_1^B < p_2^B < p_3^B$. The relationship between the boundaries of firm A (p_1^A, p_2^A) and that of firm B (p_1^B, p_2^B, p_3^B) depends on the value of π_h^a. We can define different subsets $\Pi_{(\cdot)}$ for π_h^a:

$$\begin{aligned}
\Pi_1: &\quad c_a + \pi_h < \pi_h^a < \frac{\pi_l}{\pi_l - c_o} c_a + \pi_h \\
\Pi_2: &\quad \frac{\pi_l}{\pi_l - c_o} c_a + \pi_h < \pi_h^a < c_a + c_o + \pi_h \\
\Pi_3: &\quad c_a + c_o + \pi_h < \pi_h^a < c_a + 2c_o + \pi_h \\
\Pi_4: &\quad c_a + 2c_o + \pi_h < \pi_h^a < \frac{\pi_h}{\pi_h - c_o}[c_a + c_o + \pi_h] \\
\Pi_5: &\quad \frac{\pi_h}{\pi_h - c_o}[c_a + c_o + \pi_h] < \pi_h^a < \frac{\pi_l}{\pi_l - c_o}[c_a + c_o + \pi_h] \\
\Pi_6: &\quad \frac{\pi_l}{\pi_l - c_o}[c_a + c_o + \pi_h] < \pi_h^a
\end{aligned}$$

For each subset $\Pi_{(\cdot)}$ there follows a clear relationship between the boundaries of firm A (p_1^A, p_2^A) and that of firm B (p_1^B, p_2^B, p_3^B) from our assumptions A1 to A4 :

$$\begin{aligned}
\Pi_1: &\quad 0 < p_1^B < p_1^A < p_2^B < p_3^B < 1 \\
\Pi_2: &\quad 0 < p_1^A < p_1^B < p_2^B < p_3^B < 1 \\
\Pi_3: &\quad 0 < p_1^A < p_1^B < p_2^B < p_3^B < p_2^A < 1 \\
\Pi_4: &\quad 0 < p_1^A < p_1^B < p_2^B < p_2^A < p_3^B < 1 \\
\Pi_5: &\quad 0 < p_1^A < p_1^B < p_2^A < p_2^B < p_3^B < 1 \\
\Pi_6: &\quad 0 < p_1^A < p_2^A < p_1^B < p_2^B < p_3^B < 1
\end{aligned}$$

For each subset $\Pi_{(\cdot)}$, the curve $p_{\theta,1}$ runs from $(p = p_1^B, \theta = 0)$ to $(p = p_3^B, \theta = 1)$, and the curve $p_{\theta,2}$ from $(p = p_1^B, \theta = 0)$ to $(p = p_2^B, \theta = 1)$.

To this point we have separated the 3-dimensional π_h^a-p-θ parameter space into several subsets. Figure 6 exemplarily displays the p-θ subsets for the π_h^a subset Π_6.

■ **Bayesian Nash equilibria.** A Bayesian Nash equilibrium is a pair of strategies for which firm A's strategy is a best response to firm B's strategy given his own type and his beliefs about firm B's type, and vice versa. A Bayesian Nash equilibrium can be interpreted as a Nash equilibrium of an expanded game, where the firms' pure strategies are type-contingent. Thus, a Bayesian Nash equilibrium is a pair of strategies of the expanded game for which firm A's strategy is a best response to firm B's strategy and vice versa.

The payoff matrices in table 6 are payoff matrices of expanded games. Each possible strategy of firm A is represented by a row, and each possible strategy of firm B by a column. In order to determine Bayesian Nash equilibria, we have to determine the best reaction of firm A to each strategy of firm B and vice versa. In practice, that means for each column of the matrices in table 6 we first have to find the row with the highest payoff for firm A (respectively for each row the column with the highest payoff for firm B). A Bayesian Nash equilibrium then corresponds to a cell in the output matrix for information structure "public" (respectively to a cell in the output matrix for information structure "private") which contains both the highest payoff of firm A in the respective column and the highest payoff of firm B in the respective row.

As the relationships between the payoffs depend on which subset of the π_h^a-p-θ parameter space we are in, we have to determine Bayesian Nash equilibria separately for every subset of the π_h^a-p-θ space. The procedure thereby is always the same. Thus, for reasons of brevity we will exemplarily demonstrate the determination of Bayesian Nash equilibria (and the subsequent determination of Perfect Bayesian Nash equilibria and the application of the intuitive criterion) for one subset of our parameter space. We marked this subset as subset “L” in figure 6.

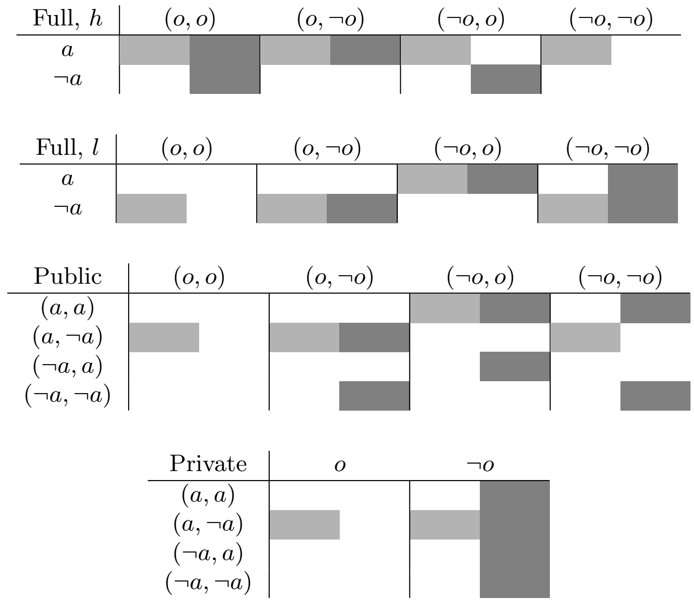


Table 7: **Bayesian Nash equilibria.** Displayed are schematic payoff matrices for information structures “full”, “public” and “private” and subset “L” of the parameter space (see figure 6). In each matrix the highest payoffs of firm A in each column and of firm B in each row are marked. Bayesian Nash equilibria are cells which contain both the highest payoff of firm A and firm B.

In the schematic payoff matrices in table 7 the highest payoffs of firm A in each column and of firm B in each row are marked for each payoff structure. Bayesian Nash equilibria are cells which contain both the highest payoff of firm A and firm B. In case the patent system is transparent and the patent is of high value there are two Bayesian Nash equilibria: $[a; (o, o)]$ and $[a; (o, \neg o)]$. In case the patent system is transparent and the patent is of low value there are three equilibria: $[\neg a; (o, \neg o)]$, $[a; (\neg o, o)]$ and $[\neg a; (\neg o, \neg o)]$. For information structure “public” there are two equilibria: $[(a, \neg a); (o, \neg o)]$ and $[(a, a); (\neg o, o)]$. For information structure “private” there is one equilibrium: $[(a, \neg a); \neg o]$.

■ **Perfect Bayesian Nash equilibria.** For information structures “public” and “private” we check for every Bayesian Nash equilibrium whether it fulfills the criteria of a Perfect Bayesian Nash equilibrium - that is, whether there is a belief structure which is consistent with this equilibrium. We exemplarily demonstrate the procedure for the two equilibria of information structure “public” in subset “L”.

For the separating equilibrium $[(a, \neg a); (o, \neg o)]$ a belief structure of firm B which is consistent with this equilibrium is as follows: Firm B puts probability one on the event “firm A’s patent is of high value” if it observes acceleration. If it does not observe acceleration it puts probability one on the event “firm A’s patent is of low value”. It is easy to show that this belief is consistent with the equilibrium: If firm B believes that firm A’s patent is of high value, it is optimal for firm B to oppose firm A’s patent. The reason is that for $p < p_3^B = \frac{\pi_h^a - c_o}{\pi_h^a}$ (which is the case for subset “L”) firm B’s payoff in case it opposes an accelerated high-value patent of firm A ($-p\pi_h^a - c_o$) is larger than its payoff in case it does not oppose ($-\pi_h^a$). If firm B believes that firm A’s patent is of low value it is optimal for firm B not to oppose firm A’s patent. The reason is that for $p > p_1^B = \frac{\pi_l - c_o}{\pi_l}$ (which is the case for subset "L") firm B's payoff in case it does not oppose a non-accelerated low-value patent of firm A ($-\pi_l$) is larger than its payoff in case it does not oppose ($-p\pi_l - c_o$). Given that firm B opposes an accelerated patent, firm A only benefits from accelerating a high-value patent. The reason is that in subset "L" in case firm A has a low-value patent its payoff in case it does not accelerate the patent (π_l) is obviously larger than its payoff in case it accelerates the patent ($p\pi_l - c_o$). (Note that $p < 1$.) In contrast, in case firm A has a high-value patent its payoff in case it accelerates the patent ($p\pi_h^a - c_o - c_a$) is larger than its payoff in case it does not accelerate the patent (π_h). (In subset "L" it holds that $p > p_2^A = \frac{\pi_h + c_a + c_o}{\pi_h^a}$. Thus, in subset "L" it holds that $p\pi_h^a - c_o - c_a \geq \pi_h$.)

For the pooling equilibrium $[(a, a); (\neg o, o)]$ a belief structure of firm B which is consistent with this equilibrium is as follows: Off the equilibrium path firm B puts probability one on the event "firm A has a high-value patent". On the equilibrium path firm B puts probability θ on the event "firm A has a high-value patent" and probability $1-\theta$ on the event "firm A has a low-value patent". Given this belief structure, on the equilibrium path firm B's payoff in case it does not oppose ($(1-\theta)(-\pi_l)+\theta(-\pi_h^a)$) is larger than its payoff in case it does oppose ($(1-\theta)(-p\pi_l - c_o)+\theta(-p\pi_h^a - c_o)$). The reason is that in subset "L" it holds that $p > p_{\theta,1} = 1 - \frac{c_o}{\theta\pi_h^a + (1-\theta)\pi_l}$:

$$
\begin{aligned}
p &> 1 - \frac{c_o}{\theta\pi_h^a + (1-\theta)\pi_l} \quad \Leftrightarrow \\
c_o &> (1-p)\theta\pi_h^a + (1-p)(1-\theta)\pi_l \quad \Leftrightarrow \\
(1-\theta)(-\pi_l) + \theta(-\pi_h^a) &> (1-\theta)(-p\pi_l - c_o) + \theta(-p\pi_h^a - c_o)
\end{aligned}
$$

As in subset "L" it holds that $p < p_2^B = \frac{\pi_h - c_o}{\pi_h}$, off the equilibrium path firm B's payoff in case it opposes ($-p\pi_h$) is larger than its payoff in case it does not oppose ($-\pi_h$). Given that in case firm B would observe acceleration it would oppose, firm A is better off accelerating both high-value and low-value patents. The reason is that both for high-value patents and for low-value patents the payoff of firm A in case it does accelerate and firm B does not oppose is larger than its payoff in case it does not accelerate and firm B does oppose ($\pi_l - c_a > p\pi_l - c_o$ and $\pi_h^a - c_a > p\pi_h - c_o$).

■ **Intuitive criterion.** For some subsets of the π_h^a-θ-p parameter space we find several Perfect Bayesian Nash equilibria for information structures "public" and "private". We use the "intuitive criterion" introduced by Cho and Kreps (1987) to reduce the number of equilibria. The "intuitive criterion" uses a forward induction argument: It eliminates equilibria when firm A would be better off if it deviated from the equilibrium. We demonstrate the use of the "intuitive criterion" exemplarily for information structure "public" and subset "L" of our parameter space. There we have two equilibria which fulfill the criteria of a Perfect Bayesian Nash equilibrium. These are the separating equilibrium $[(a, \neg a); (o, \neg o)]$ and the pooling equilibrium $[(a, a); (\neg o, o)]$. For the separating equilibrium there is no deviation which would make firm A better off. However, the pooling equilibrium fails the intuitive criterion:

For the pooling equilibrium $[(a, a); (\neg o, o)]$ to be sequentially rational firm B has to believe that firm A has a high-value patent if it does not accelerate. However, this belief is not plausible: If firm A has a high-value patent, in equilibrium it gets $\pi_h^a - c_a$. When firm A deviates, it only gets π_h. Yet, if firm A has a low-value patent, it has an incentive to deviate: In equilibrium, firm A gets $\pi_l - c_a$ if it has a low-value patent. However, if firm A deviates and convinces firm B that it has a low-value patent, it gets π_l (because if convinced firm B would not oppose). Thus, firm B should put zero probability on firm A having a high-value patent when firm A does not accelerate. However, in this case firm B would play $\neg o$ in reaction to $\neg a$, which upsets the equilibrium. That is, the pooling equilibrium $[(a, a); (\neg o, o)]$ fails the intuitive criterion.

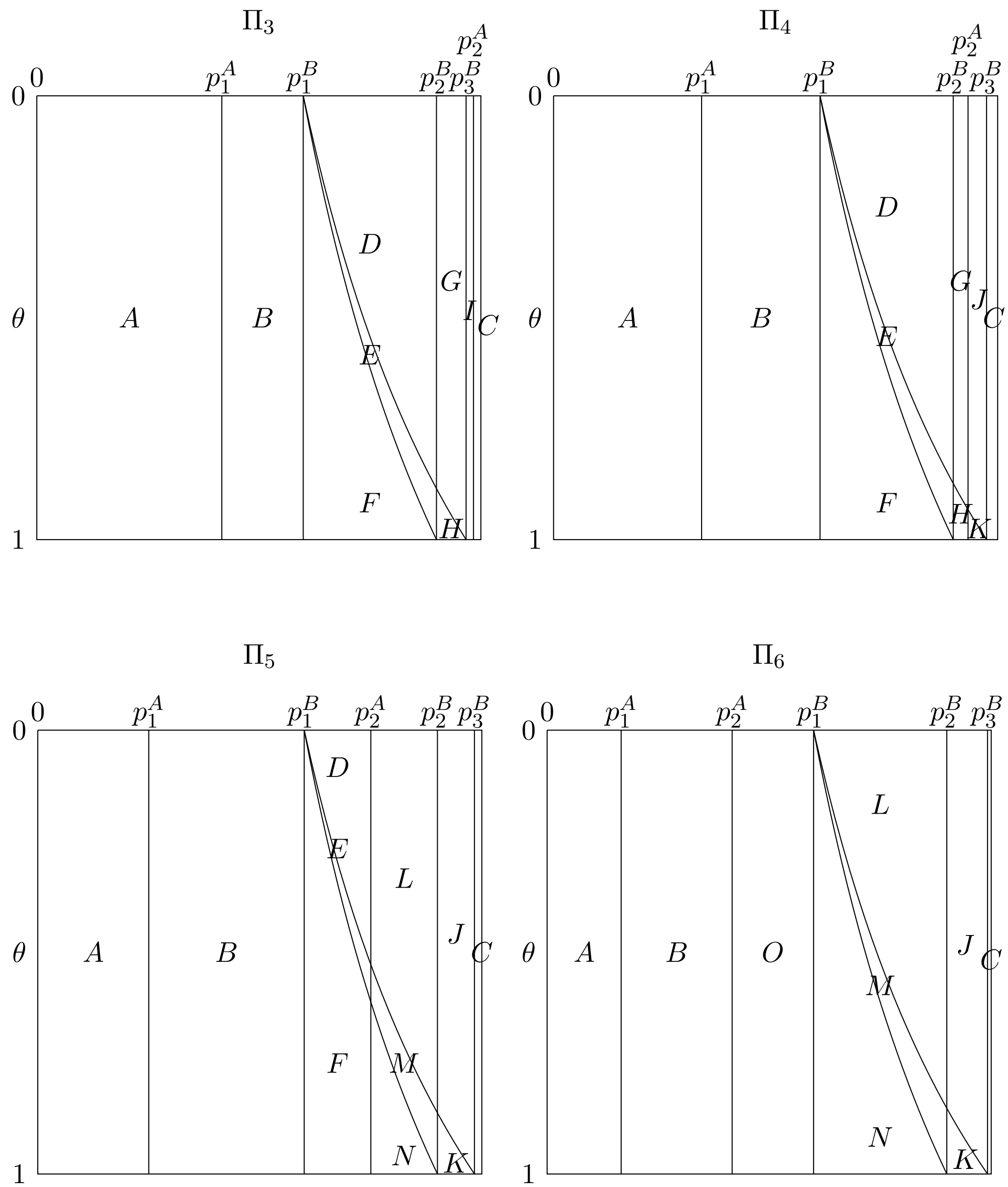


Figure 7: **Subsets of the π_h^a-θ-p parameter space.** Each graph displays the complete θ-p parameter space for a subset $\Pi_{(\cdot)}$ of the π_h^a parameter space. We marked subsets of the π_h^a-θ-p parameter space with specific payoff relationships by romanic upper-case letters. For each of these subsets and each information structure all Perfect Bayesian Nash equilibria which fulfill the intuitive criterion are given in table 8.

■ **Results.** We summarize our results in figure 7 and table 8. Figure 7 displays all subsets of the π_h^a-θ-p parameter space with specific relationships between the payoffs of firm A and firm B. We marked these subsets by romanic upper-case letters. For each of these subsets and each information structure table 8 displays all Perfect Bayesian Nash equilibria which fulfill the intuitive criterion introduced by Cho and Kreps (1987). Note that we did not display the subsets for very low gains from acceleration (Π_1 and Π_2). The reason is that cases where there are no economically significant gains from acceleration are uninteresting for our analysis. From the equilibrium strategies of the

	A	**B**	**C**	**D**
Full, h	$\neg a; (o, o)$	$a; (o, o)$	$a; (\neg o, \neg o)$	$a; (o, o)$
Full, l	$\neg a; (o, o)$	$\neg a; (o, o)$	$\neg a; (\neg o, \neg o)$	$\neg a; (\neg o, \neg o)$
Public	$(\neg a, \neg a); (o, o)$	$(a, \neg a); (o, o)$	$(a, \neg a); (\neg o, \neg o)$	$(\neg a, \neg a); (o, \neg o)$
Private	$(\neg a, \neg a); o$	$(a, \neg a); o$	$(a, \neg a); \neg o$	$(a, \neg a); \neg o$

	E	**F**	**G**	**H**
Full, h	$a; (o, o)$	$a; (o, o)$	$\neg a; (o, \neg o)$	$\neg a; (o, \neg o)$
Full, l	$\neg a; (\neg o, \neg o)$	$\neg a; (\neg o, \neg o)$	$\neg a; (\neg o, \neg o)$	$\neg a; (\neg o, \neg o)$
Public	$(\neg a, \neg a); (o, \neg o)$	No eq.	$(\neg a, \neg a); (o, \neg o)$	$(\neg a, \neg a); (o, \neg o)$
Private	$(a, \neg a); o$	$(a, \neg a); o$	$(a, \neg a); \neg o$	$(a, \neg a); o$

	I	**J**	**K**	**L**
Full, h	$a; (\neg o, \neg o)$	$a; (o, \neg o)$	$a; (o, \neg o)$	$a; (o, o)$
Full, l	$\neg a; (\neg o, \neg o)$	$\neg a; (\neg o, \neg o)$	$\neg a; (\neg o, \neg o)$	$\neg a; (\neg o, \neg o)$
Public	$(a, \neg a); (\neg o, \neg o)$	$(a, \neg a); (o, \neg o)$	$(a, \neg a); (o, \neg o)$	$(a, \neg a); (o, \neg o)$
Private	$(a, \neg a); \neg o$	$(a, \neg a); \neg o$	$(a, \neg a); o$	$(a, \neg a); \neg o$

	M	**N**	**O**
Full, h	$a; (o, o)$	$a; (o, o)$	$a; (o, o)$
Full, l	$\neg a; (\neg o, \neg o)$	$\neg a; (\neg o, \neg o)$	$\neg a; (o, o)$
Public	$(a, \neg a); (o, \neg o)$	$(a, \neg a); (o, \neg o)$	$(a, \neg a); (o, o)$
Private	$(a, \neg a); o$	$(a, \neg a); o$	$(a, \neg a); o$

Table 8: **Perfect Bayesian Nash equilibria which fulfill the intuitive criterion for all subsets of the π_h^a-θ-p parameter space and all information structures.** For each subset of the parameter space and each information structure firm A's strategy is given before the semicolon, and firm B's strategy is given after the semicolon. In case firm A's actions ("accelerate" or "not accelerate") are contingent on the draw of the patent value, the first entry in the parentheses gives firm A's action in case the patent is of high value, and the second entry gives firm A's action in case the patent is of low value. In case firm B's actions ("oppose" or "not oppose") are contingent on firm A's acceleration decision, the first entry in parentheses gives firm B's action in case firm A accelerates, and the second entry gives firm B's action in case firm A does not accelerate.

firms it is easy to derive expected outcomes for each subset of the parameter space and each information structure. It shows that for some of the subsets marked in figure 7 outcomes are the same for all information structure. Thus, with respect to outcomes we can combine some of the subsets. In result, we get the graphs in figure 2, which display the outcomes for every subset of the parameter space.

A.2 Acceleration and opposition frequencies

Year	Filings (#)	Accelerated examination (%)	Opposition (%)
1997	49,868	6.7	5.3
1998	53,350	7.4	5.1
1999	55,605	7.4	5.4
2000	59,193	7.0	5.1
2001	59,070	7.2	5.3
2002	55,822	7.3	4.9
2003	53,889	8.0	5.0
2004	51,323	8.8	4.7

Table 9: **Yearly data on the number of filings and acceleration and opposition frequencies.** For each of the years 1997 to 2004, the table displays the number of filed patent applications (which were granted in the end), the fraction of these for which accelerated search was requested, the fraction for which accelerated examination was requested, and the fraction which was opposed after getting granted.

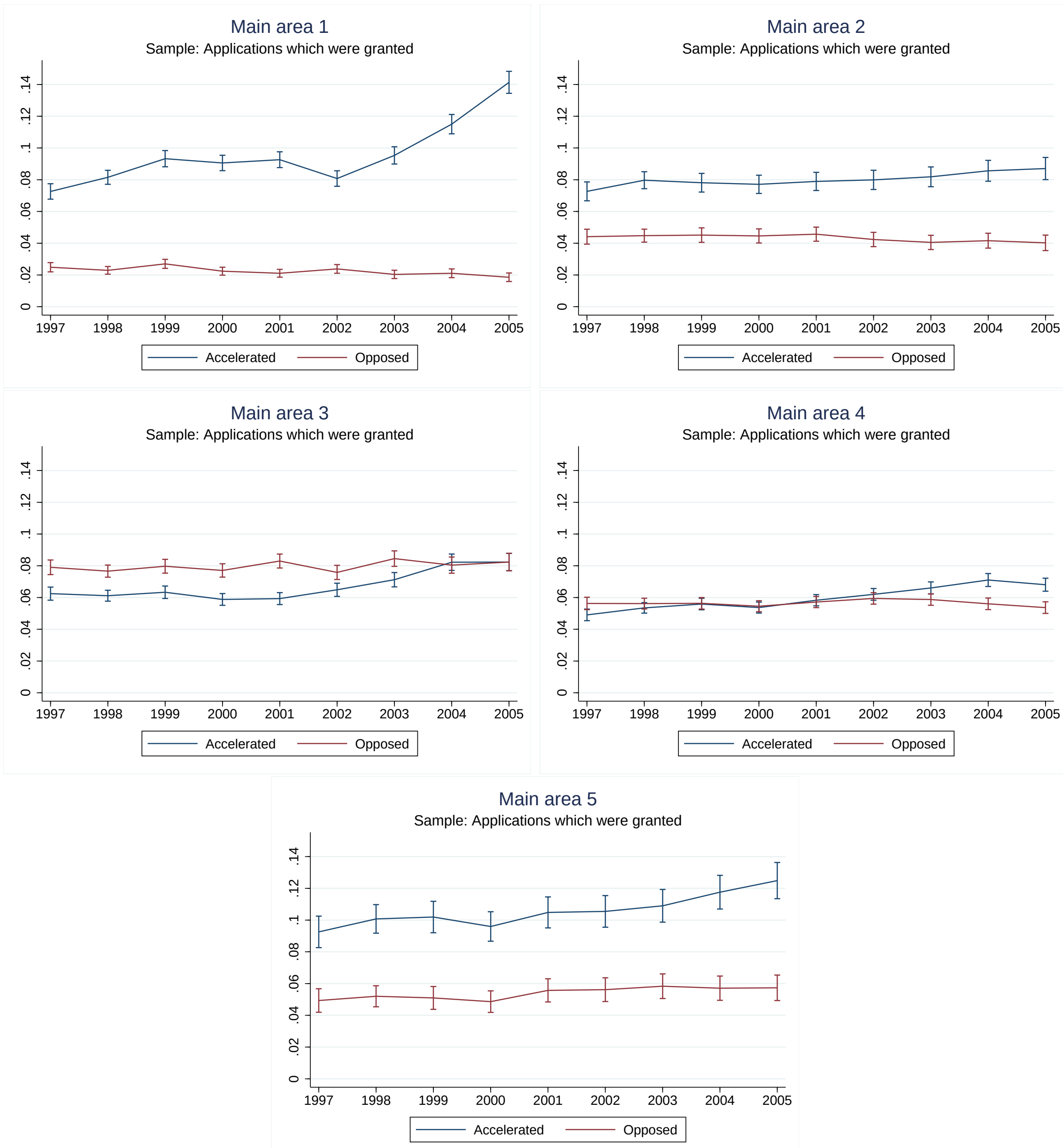


Figure 8: **Acceleration and opposition frequencies over time for all five main technological areas.** Each of the graphs above corresponds to one of the five main technological areas into which all patents in our sample can be grouped. Main area 1 is "Electrical Engineering", main area 2 is "Instruments", main area 3 is "Chemistry", main area 4 is "Mechanical Engineering", and main area 5 is "Other". In each graph, for all patents of a given application year, the blue line gives the fraction of these applications for which accelerated examination was requested, and the red line gives the fraction which was opposed after being granted. Acceleration information was concealed from the public from December 2001 on. At each data point, a 95% confidence intervals is displayed.

A.3 Value Proxy

	p25	p50	p75	Mean	Fraction of appl. in treatment group:	Fraction of appl. in control group:
All areas	3	4	6	5.1	29.3%	42.5%
Main areas:						
Electrical Eng.	3	3	4	3.8	40.5%	59.5%
Instruments	3	4	6	4.7	25.4%	44.4%
Chemistry	3	5	9	7.0	26.0%	28.1%
Mechanical Eng.	3	4	6	4.6	25.7%	42.6%
Other	3	4	7	5.4	27.8%	36.6%

Table 10: **Distribution of the value proxy and composition of the treatment and the control group (75%-percentile respectively 25%-percentile).** The left part of the table provides information on the distribution of our value proxy by displaying its percentiles (25%, 50%, 75%) and mean. Our value proxy for a given patent is the count of EPC member states in which the patent got validated in. The minimum count is 0, the maximum count 29. The right part of the table gives information on what part of applications is in the treatment group, and what part of applications is in the control group. An application is defined to be in the treatment group if its value proxy is larger or equal the 75%-percentile of the respective distribution of the value proxy, and it is defined to be in the control group if its value proxy is smaller or equal the 25%-percentile of the respective distribution of the value proxy.

	p10	p50	p90	Mean	Fraction of appl. in treatment group:	Fraction of appl. in control group:
All areas	1	4	10	5.1	11.2%	10.1%
Main areas:						
Electrical Eng.	1	3	7	3.8	10.1%	10.6%
Instruments	2	4	9	4.7	10.2%	19.9%
Chemistry	2	5	16	7.0	11.3%	13.8%
Mechanical Eng.	1	4	8	4.6	13.0%	10.4%
Other	1	4	11	5.4	10.8%	13.0%

Table 11: **Distribution of the value proxy and composition of the treatment and the control group (90%-percentile respectively 10%-percentile).** The left part of the table provides information on the distribution of our value proxy by displaying its percentiles (25%, 50%, 75%) and mean. Our value proxy for a given patent is the count of EPC member states in which the patent got validated in. The minimum count is 0, the maximum count 29. The right part of the table gives information on what part of applications is in the treatment group, and what part of applications is in the control group. An application is defined to be in the treatment group if its value proxy is larger or equal the 75%-percentile of the respective distribution of the value proxy, and it is defined to be in the control group if its value proxy is smaller or equal the 25%-percentile of the respective distribution of the value proxy.

A.4 Full regression tables

	All Applications	Electrical Engineering	Instruments	Chemistry	Mechanical Engineering	Other
	Dependent variable: Indicator for request for **accelerated examination**					
POST	0.00768***	0.0126***	0.00127	0.00618**	0.0108***	-0.00156
	(0.00125)	(0.00247)	(0.00332)	(0.00268)	(0.00200)	(0.00612)
TG	0.0411***	0.0489***	0.0503***	0.0526***	0.0446***	0.0507***
	(0.00156)	(0.00301)	(0.00460)	(0.00316)	(0.00283)	(0.00757)
POST ∗ TG	0.0159***	0.00434	0.00497	0.0199***	0.0177***	0.0304***
	(0.00238)	(0.00457)	(0.00670)	(0.00504)	(0.00428)	(0.0110)
_cons	0.0520***	0.0622***	0.0599***	0.0404***	0.0366***	0.0818***
	(0.000851)	(0.00164)	(0.00227)	(0.00178)	(0.00136)	(0.00426)
N	226953	70872	32614	44793	64170	14025
adj. R^2	0.009	0.008	0.009	0.015	0.013	0.012

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 12: **DID regressions with indicator for request for accelerated examination as dependent variable, no controls.** The table shows the results of DID regressions with an indicator for the request for accelerated examination as dependent variable. The first column displays the results for the full sample, columns two to six display the results for the five main technological areas in which the patents from the full sample can be grouped. (The full sample consists of all patents which where applied for during the pre- or the post-treatment period and which were granted later on.) The pre-treatment period covers the years 1997 to 1999, the post-treatment period the years 2002 to 2004. The treatment group consists of patents all patents whose value proxy is greater than or equal to the 75%-percentile of the respective distribution of the value proxy, the control group consists of all patents whose value proxy is smaller than or equal to the 25%-percentile. The value proxy is the count of the EPC member states a given patent was validated in. Controls are not included into the regressions.

	All Applications	Electrical Engineering	Instruments	Chemistry	Mechanical Engineering	Other
	Dependent variable: Indicator for request for **opposition**					
POST	0.000429	-0.000224	-0.00318	-0.00103	0.00218	0.00305
	(0.000923)	(0.00108)	(0.00222)	(0.00283)	(0.00192)	(0.00355)
TG	0.0565***	0.0293***	0.0488***	0.0559***	0.0475***	0.0568***
	(0.00141)	(0.00178)	(0.00375)	(0.00339)	(0.00287)	(0.00557)
POST $*$ TG	0.0000442	-0.00611**	-0.00543	0.00574	0.00504	0.00524
	(0.00206)	(0.00252)	(0.00525)	(0.00513)	(0.00413)	(0.00800)
_cons	0.0293***	0.0126***	0.0280***	0.0495***	0.0372***	0.0241***
	(0.000646)	(0.000755)	(0.00158)	(0.00196)	(0.00137)	(0.00239)
N	226953	70872	32614	44793	64170	14025
adj. R^2	0.016	0.008	0.012	0.012	0.011	0.018

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 13: **DID regressions with indicator for request for accelerated examination as dependent variable, no controls.** The table shows the results of DID regressions with an indicator for opposition against the given patent as dependent variable. The first column displays the results for the full sample, columns two to six display the results for the five main technological areas in which the patents from the full sample can be grouped. (The full sample consists of all patents which where applied for during the pre- or the post-treatment period and which were granted later on.) The pre-treatment period covers the years 1997 to 1999, the post-treatment period the years 2002 to 2004. The treatment group consists of patents all patents whose value proxy is greater than or equal to the 75%-percentile of the respective distribution of the value proxy, the control group consists of all patents whose value proxy is smaller than or equal to the 25%-percentile. The value proxy is the count of the EPC member states a given patent was validated in. Controls are not included into the regressions.

	All Applications	Electrical Engineering	Instruments	Chemistry	Mechanical Engineering	Other
	Dependent variable: Indicator for request for **accelerated examination**					
POST	0.00592***	0.0102***	-0.000959	0.00560**	0.0102***	-0.00444
	(0.00126)	(0.00247)	(0.00333)	(0.00269)	(0.00200)	(0.00619)
TG	0.0389***	0.0486***	0.0445***	0.0501***	0.0387***	0.0496***
	(0.00159)	(0.00306)	(0.00467)	(0.00330)	(0.00286)	(0.00768)
POST ∗ TG	0.0136***	0.00211	0.00261	0.0161***	0.0157***	0.0285***
	(0.00237)	(0.00457)	(0.00668)	(0.00502)	(0.00426)	(0.0109)
PCT	-0.0252***	-0.0215***	-0.0222***	-0.0296***	-0.0212***	-0.0330***
	(0.00122)	(0.00234)	(0.00347)	(0.00297)	(0.00202)	(0.00548)
ADest_DE	-0.00110	-0.0182***	0.0243***	0.0203***	-0.00908***	-0.00910
	(0.00180)	(0.00367)	(0.00557)	(0.00416)	(0.00302)	(0.00708)
ADest_FR	-0.0296***	-0.0386***	-0.0232***	-0.0215***	-0.0376***	-0.0236**
	(0.00233)	(0.00435)	(0.00709)	(0.00511)	(0.00390)	(0.00926)
ADest_GB	-0.0251***	-0.0380***	-0.0365***	-0.000681	-0.0228***	-0.0411***
	(0.00289)	(0.00597)	(0.00723)	(0.00651)	(0.00556)	(0.0107)
ADest_JP	-0.0317***	-0.0364***	-0.0351***	-0.0271***	-0.0325***	-0.0105
	(0.00178)	(0.00336)	(0.00509)	(0.00370)	(0.00312)	(0.0112)
ADest_US	-0.0301***	-0.0252***	-0.0396***	-0.0211***	-0.0393***	-0.0296***
	(0.00161)	(0.00322)	(0.00417)	(0.00345)	(0.00293)	(0.00795)
CLMSNR	0.00101***	0.000861***	0.000809***	0.00123***	0.000760***	0.00133***
	(0.0000536)	(0.0000948)	(0.000134)	(0.000113)	(0.000108)	(0.000282)
RINV	-0.00356***	0.00301***	-0.00289***	-0.00442***	-0.00487***	-0.00907***
	(0.000308)	(0.000706)	(0.000882)	(0.000561)	(0.000562)	(0.00173)
_cons	0.0775***	0.0754***	0.0870***	0.0642***	0.0688***	0.110***
	(0.00181)	(0.00351)	(0.00513)	(0.00424)	(0.00321)	(0.00749)
N	226953	70872	32614	44793	64170	14025
adj. R^2	0.015	0.013	0.018	0.025	0.020	0.018

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 14: **DID regressions with indicator for request for accelerated examination as dependent variable, with controls.** The table shows the results of DID regressions with an indicator for for the request for accelerated examination as dependent variable. The first column displays the results for the full sample, columns two to six display the results for the five main technological areas in which the patents from the full sample can be grouped. (The full sample consists of all patents which where applied for during the pre- or the post-treatment period and which were granted later on.) The pre-treatment period covers the years 1997 to 1999, the post-treatment period the years 2002 to 2004. The treatment group consists of patents all patents whose value proxy is greater than or equal to the 75%-percentile of the respective distribution of the value proxy, the control group consists of all patents whose value proxy is smaller than or equal to the 25%-percentile. The value proxy is the count of the EPC member states a given patent was validated in. Controls are included in the regressions.

	All Applications	Electrical Engineering	Instruments	Chemistry	Mechanical Engineering	Other
	Dependent variable: Indicator for request for **opposition**					
POST	-0.000430	-0.000710	-0.00454**	-0.000813	0.000915	0.000503
	(0.000927)	(0.00109)	(0.00223)	(0.00285)	(0.00192)	(0.00359)
TG	0.0520***	0.0268***	0.0454***	0.0535***	0.0426***	0.0535***
	(0.00144)	(0.00179)	(0.00380)	(0.00348)	(0.00290)	(0.00563)
POST * TG	-0.000336	-0.00597**	-0.00487	0.00445	0.00385	0.00687
	(0.00206)	(0.00253)	(0.00525)	(0.00514)	(0.00412)	(0.00798)
PCT	-0.00111	-0.000269	0.000943	-0.0138***	-0.00310	0.00229
	(0.000982)	(0.00121)	(0.00240)	(0.00292)	(0.00192)	(0.00391)
ADest_DE	0.0101***	0.0118***	0.00485	-0.00148	0.0101***	0.0141***
	(0.00150)	(0.00214)	(0.00392)	(0.00393)	(0.00277)	(0.00520)
ADest_FR	-0.00518**	-0.00478**	-0.0178***	0.00593	-0.0136***	-0.0121**
	(0.00203)	(0.00232)	(0.00483)	(0.00576)	(0.00373)	(0.00596)
ADest_GB	-0.000763	0.00743*	-0.0223***	0.00811	-0.0122**	-0.00336
	(0.00263)	(0.00392)	(0.00512)	(0.00681)	(0.00519)	(0.00839)
ADest_JP	-0.0145***	-0.00768***	-0.0160***	-0.0151***	-0.0218***	-0.0160***
	(0.00130)	(0.00147)	(0.00323)	(0.00373)	(0.00270)	(0.00617)
ADest_US	-0.00315**	0.000301	-0.00186	-0.00274	-0.0126***	-0.0140**
	(0.00137)	(0.00161)	(0.00326)	(0.00363)	(0.00289)	(0.00553)
CLMSNR	0.000380***	0.000151***	0.000354***	0.000555***	0.000948***	0.000547***
	(0.0000440)	(0.0000551)	(0.0000988)	(0.000104)	(0.000117)	(0.000207)
RINV	0.00271***	0.00150***	0.00512***	-0.00139**	0.00410***	0.00819***
	(0.000274)	(0.000373)	(0.000773)	(0.000558)	(0.000617)	(0.00167)
_cons	0.0209***	0.00775***	0.0150***	0.0581***	0.0241***	0.00332
	(0.00141)	(0.00186)	(0.00357)	(0.00415)	(0.00289)	(0.00510)
N	226953	70872	32614	44793	64170	14025
adj. R^2	0.017	0.010	0.016	0.013	0.015	0.022

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 15: **DID regressions with indicator for opposition as dependent variable, with controls.** The table shows the results of DID regressions with an indicator for opposition against the given patent as dependent variable. The first column displays the results for the full sample, columns two to six display the results for the five main technological areas in which the patents from the full sample can be grouped. (The full sample consists of all patents which where applied for during the pre- or the post-treatment period and which were granted later on.) The pre-treatment period covers the years 1997 to 1999, the post-treatment period the years 2002 to 2004. The treatment group consists of patents all patents whose value proxy is greater than or equal to the 75%-percentile of the respective distribution of the value proxy, the control group consists of all patents whose value proxy is smaller than or equal to the 25%-percentile. The value proxy is the count of the EPC member states a given patent was validated in. Controls are included in the regressions.

A.5 Changes in frequencies for treatment and control group

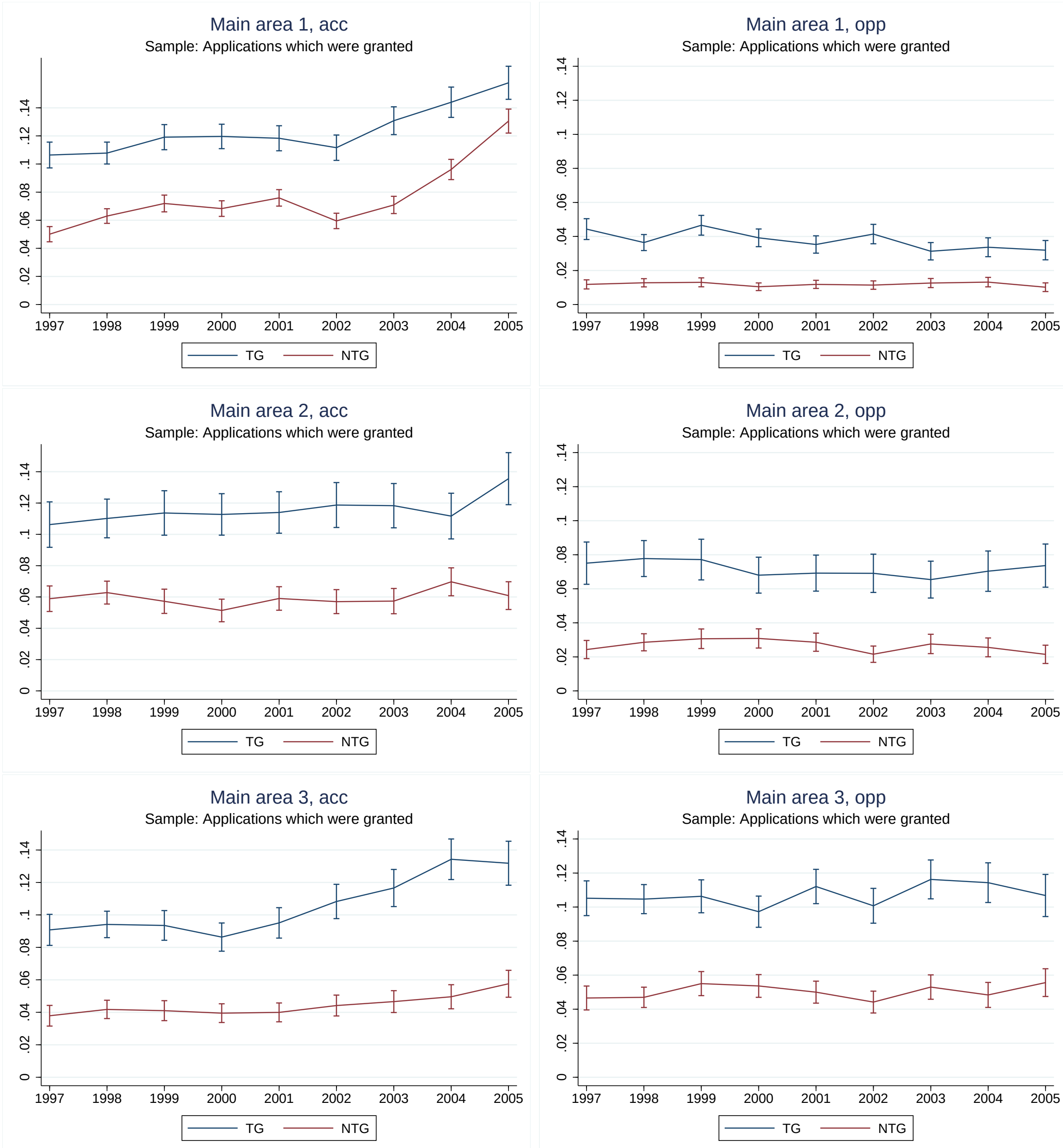


Figure 9: **Comparison of the treatment and the control group.** Each of the pairs of graphs above corresponds to one of the five main technological areas into which all patents in our sample can be grouped. Main area 1 is "Electrical Engineering", main area 2 is "Instruments", and main area 3 is "Chemistry". The left graph of each pair compares the development of the acceleration frequency in the treatment group (TG) to that in the control group (NTG), the right graph of each pair compares the development of the opposition frequency in the treatment group to that in the control group. The treatment group consists of all applications whose value proxy is greater than or equal to the 75%-percentile of the distribution of the value proxy in the respective main technological area, the control group consists of all applications whose value proxy is smaller than or equal to the 25%-percentile of the distribution. The value proxy is the count of the EPC member states is which a given patent application was validated in. At each data point a 95% confidence intervals is displayed.

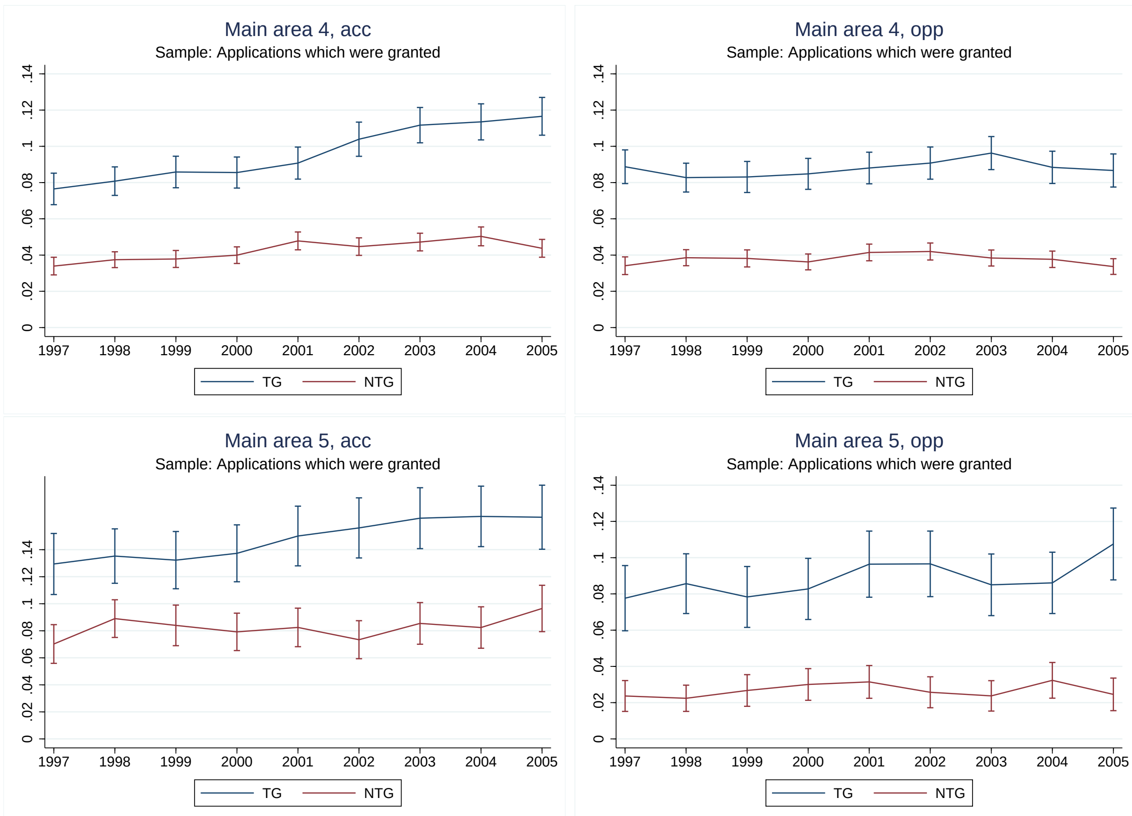


Figure 10: **Comparison of the treatment and the control group, continued.** Each of the pairs of graphs above corresponds to one of the five main technological areas into which all patents in our sample can be grouped. Main area 4 is "Mechanical Engineering", and main area 5 is "Other". The left graph of each pair compares the development of the acceleration frequency in the treatment group (TG) to that in the control group (NTG), the right graph of each pair compares the development of the opposition frequency in the treatment group to that in the control group. The treatment group consists of all applications whose value proxy is greater than or equal to the 75%-percentile of the distribution of the value proxy in the respective main technological area, the control group consists of all applications whose value proxy is smaller than or equal to the 25%-percentile of the distribution. The value proxy is the count of the EPC member states is which a given patent application was validated in. At each data point a 95% confidence intervals is displayed.

A.6 Robustness Checks

Dependent variable: ACCEX	**Treatment Coefficients**					
	All applications	**Main areas:** Electrical Engineering	Instruments	Chemistry	Mechanical Engineering	Other
Base specification, years 1997-1999 and 2002-2004:	+	0	0	+	+	+
Alternative specifications, years 1997-1999 and 2002-2004:						
Early acceleration only (request up to half a year after examination request the latest):	+	+	0	+	+	0
Treatment and control group defined via 90%-/10% percentile:	+	+	0	+	0	0
Yearly computation of distribution of value proxy:	+	+	+	+	(+)	(+)
Inclusion of year-fixed-effects (instead of POST):	+	0	0	+	+	+
Base specification, **alternative time-periods**:						
years 1997-1998 and 2002-2003:	+	0	0	(+)	+	(+)
years 1997-1998 and 2003-2004:	+	0	0	+	+	(+)
years 1998-1999 and 2002-2003:	+	0	0	(+)	+	+
years 1998-1999 and 2003-2004:	+	0	0	+	+	+
years 1997-1999 and 2003-2005:	+	0	0	+	+	+

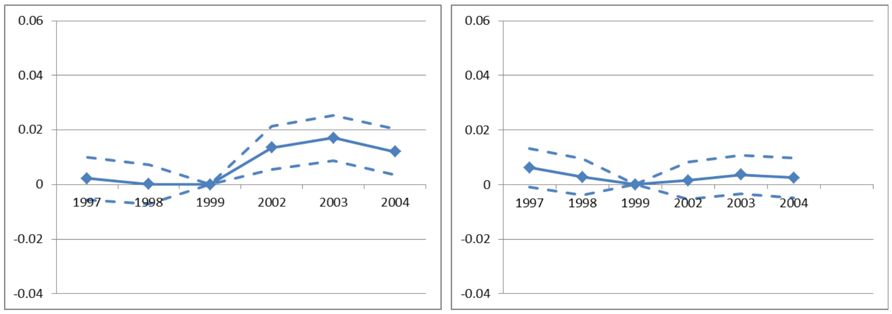
Table 16: **Robustness checks - results for changes in the acceleration frequency.** This table summarizes the results from different robustness checks for our findings in the main part of the paper regarding changes in the acceleration frequency. We performed robustness checks for different definitions of the value proxy, the treatment and the control group, and the pre- and post-treatment period. As our main interest lies in the changes in the acceleration and the opposition frequencies of high-value patents relative to those of low-value patents, for the sake of simplicity here we only present the estimation results for the treatment coefficient (that is, the coefficient δ in equation (2)) in a schematic way. A “+” sign in the table above indicates that the treatment coefficient in the respective specification was positive and significant on the 5% level, a “(+)” sign that it was positive and significant on the 10% level. “0” means that the treatment coefficient was not significantly different from 0. A negatively significant treatment coefficient did not occur in the above specifications.

Dependent variable: OPP	**Treatment Coefficients**					
	All applications	**Main areas:** Electrical Engineering	Instruments	Chemistry	Mechanical Engineering	Other
Base specification, years 1997-1999 and 2002-2004:	0	–	0	0	0	0
Alternative specifications, years 1997-1999 and 2002-2004:						
Early acceleration only (request up to half a year after examination request the latest):	0	–	0	0	0	0
Treatment and control group defined via 90%-/10% percentile:	0	–	0	0	0	0
Yearly computation of distribution of value proxy:	0	–	0	0	0	0
Inclusion of year-fixed-effects (instead of POST):	0	–	0	0	0	0
Base specification, **alternative time-periods**:						
years 1997-1998 and 2002-2003:	0	0	0	0	0	0
years 1997-1998 and 2003-2004:	0	–	0	0	(+)	0
years 1998-1999 and 2002-2003:	0	0	0	0	0	0
years 1998-1999 and 2003-2004:	0	–	0	0	0	0
years 1997-1999 and 2003-2005:	0	–	0	0	0	0

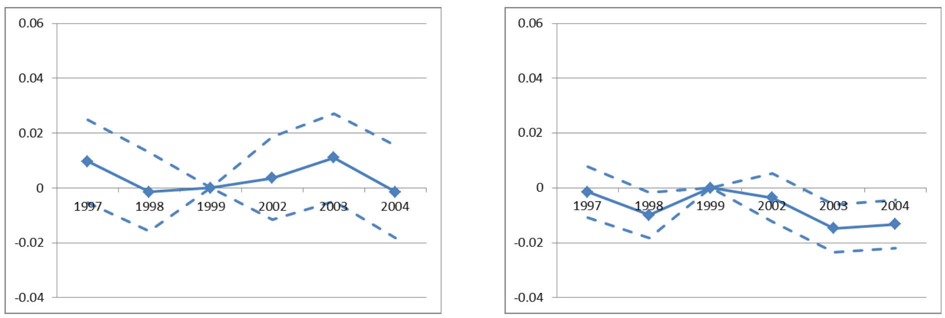
Table 17: **Robustness checks - results for changes in the opposition frequency.** This table summarizes the results from different robustness checks for our findings in the main part of the paper regarding changes in the opposition frequency. We performed robustness checks for different definitions of the value proxy, the treatment and the control group, and the pre- and post-treatment period. As our main interest lies in the changes in the acceleration and the opposition frequencies of high-value patents relative to those of low-value patents, for the sake of simplicity here we only present the estimation results for the treatment coefficient (that is, the coefficient δ in equation (2)) in a schematic way. A "-" sign in the table above indicates that the treatment coefficient in the respective specification was negative and significant (on the 5% level). "0" means that the treatment coefficient was not significantly different from 0. A positively significant treatment coefficient did not in the above specifications.

A.6 Parallel trend analysis

All patents:



Electrical Engineering:



Instruments:

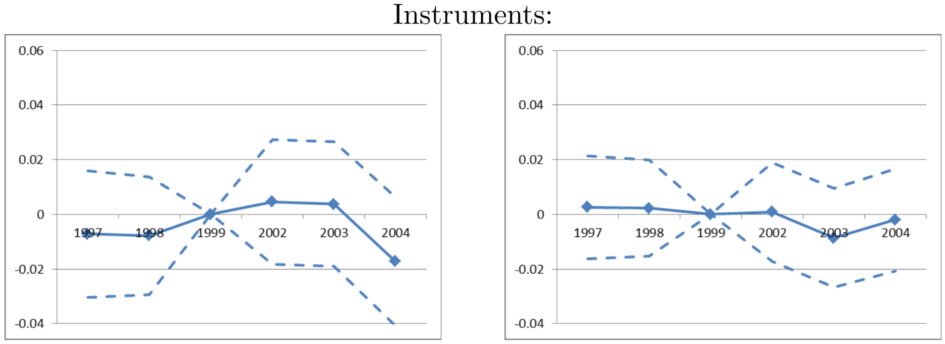
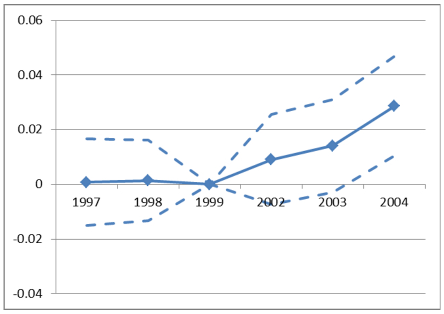
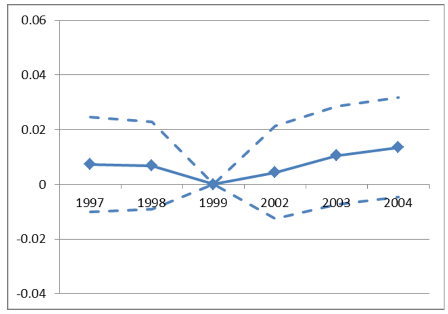


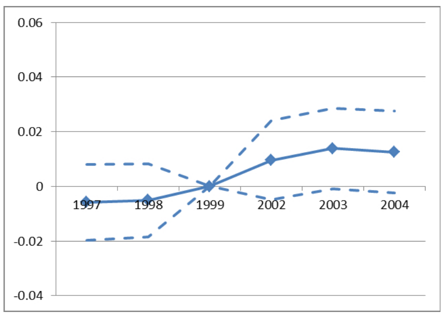
Figure 11: **Parallel trend analysis.** The graphs show the treatment effects for a modification of model 2, respectively, 3 which allows the "treatment effect" to vary over our observation periods. (The coefficient of the observation period before the treatment is normalized to zero). In each row, the left graph shows the "treatment effects" on the acceleration frequencies, and the right graph that on the opposition frequencies. In each graph, estimated 95% confidence bands are depicted.

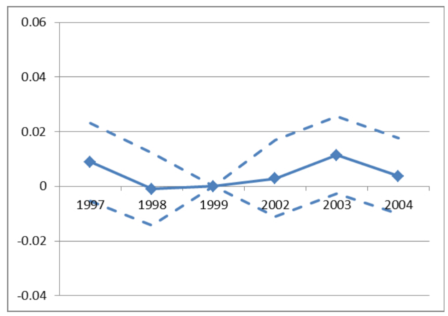
Chemistry:



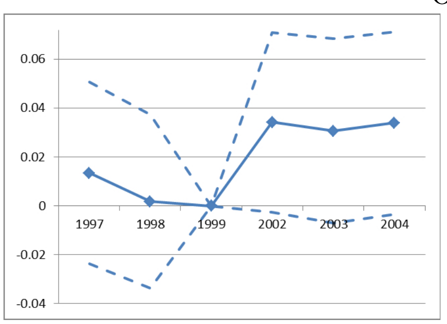


Mechanical Engineering:





Other:



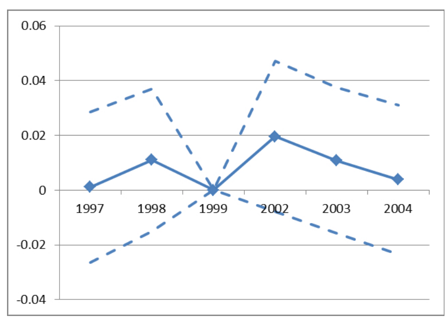


Figure 12: **Parallel trend analysis, continued.** The graphs show the treatment effects for a modification of model 2, respectively, 3 which allows the "treatment effect" to vary over our observation periods. (The coefficient of the observation period before the treatment is normalized to zero). In each row, the left graph shows the "treatment effects" on the acceleration frequencies, and the right graph that on the opposition frequencies. In each graph, estimated 95% confidence bands are depicted.