# EXPLORING THE EFFECTS OF PATENT OPPOSITIONS: A COMPARATIVE STUDY OF US AND EUROPEAN PATENTS

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# EXPLORING THE EFFECTS OF PATENT OPPOSITIONS: A COMPARATIVE STUDY OF US AND EUROPEAN PATENTS

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## 1. INTRODUCTION

The research questions addressed in this paper are twofold: 1) What are the determinants of the post-issue challenges of patent validity in the United States and Europe?[1] 2) How do patents pertaining to the same invention fare in the two different systems? In answering these questions, we use data from both the European and the United States Patent Offices, including a newly created dataset of "twin" patents, that is, patents taken out in both jurisdictions on the same invention.

The institutions which allow for post-grant challenges of patent validity are remarkably different in the U.S. and Europe. An important feature of the proceedings at the European Patent Office (EPO), one whose significance has been widely remarked among practitioners but minimally analyzed, is the "opposition process".[2] For nine months following the issue of a patent by the European Patent Office (EPO), interested parties can contest its validity by filing an opposition. Typically, oppositions argue that an issued patent is invalid because it fails to meet the standard requirements of novelty and nonobviousness. In response to an opposition, the EPO may uphold the issued patent in its entirety, amend the patent by limiting or removing claims, or invalidate it entirely.

Patents issued by the EPO designate European states in which protection of the intellectual property is desired. Since EPO patent applications cost roughly three times as much as national applications in most European states, the EPO patents have significant cost advantages for inventions being commercialized internationally (and thus requiring protection in a number of European markets). Using opposition, citizens of any of the European nations for which an EPO patent has been designated can challenge the patent for all of the designated states, rather than having to pursue legal proceedings in each of the European nations designated in the patent.

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[1] We use the terms European patents or opposition in Europe as short-hand descriptions for patent applications, grants, and challenges administered by/at the European Patent Office. Strictly speaking, a European patent does not exist.

[2] The opposition process at the EPO resembles the opposition process at the German Patent Office. The frequency of opposition is also quite similar (see below).

The EPO opposition process has been cited by Merges (1999) as a more effective means to improve the "quality" of patents, especially in novel technological areas, than those available in the United States. U.S. patents are issued on the basis of criteria that are broadly similar to those employed by the EPO, but the reliance by the US Patent and Trademark Office (USPTO) on searches of "prior art" that frequently are confined to prior patents means that in areas such as computer software or biotechnology, a lack of such prior art can result in the issue of patents of dubious merit or quality. Interested parties wishing to challenge a U.S. patent after its issue have two options: (1) Challenge the patent in federal court; or (2) Request a "re-examination" of the patent by the USPTO.

In absolute terms, patent litigation has grown significantly in the United States during the period from 1985 to 2000. But litigation is a very costly and time-consuming means for establishing the validity and/or claims of a patent. In addition, the growth of patent litigation may be partially responsible for the increase in "defensive" patenting during this period, another resource-intensive process with limited social returns (Hall and Ziedonis, 2001).

The patent re-examination procedure was created by federal legislation during the 1980s. The number of annual re-examination requests grew from the mid-1980s through the early 1990s, but the annual number of requests has scarcely grown since 1994. Unlike litigation or oppositions, the re-examination process is not an adversarial proceeding in which advocates for each side introduce evidence and arguments in support of their position, and there are limits on the types of issues that can be raised within a re-examination. Moreover, Merges (1999) points out that the requirement that any opposition be filed within nine months of the issue of an EPO patent means that the validity of these patents is determined at a much earlier point in their term than is true of the re-examination or litigation processes. Merges estimates that almost 7% of EPO patents trigger opposition proceedings, while only 0.3% of U.S. patents result in re-examination requests. In addition, oppositions result in much higher rates of patent revocation than do re-examinations. According to Merges more than 34% of oppositions filed in 1995 resulted in the revocation of the relevant EPO patent, considerably higher than the 12% of re-examination requests producing a similar result in U.S. patents during this period.[3]

In this paper, we report the results of the first comparative study of the effects of patent oppositions in Europe on the validity and claims of EPO patents and the effects of re-examination or litigation on corresponding patents issued in the United States. We have assembled a dataset consisting of matched EPO and US patents that includes all EPO patents in four technology categories (biotechnology, pharmaceuticals, semiconductors, and computer software) for which oppositions were filed and considered by the EPO.[4] We used the EPO numbers assigned to these patents to match them with the corresponding US patents (their "equivalents") and we also selected a "control sample" of US and EPO patents in the same technology categories for comparison with the experimental population.

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[3] See Merges (1999), pp. 612-614. Our data focus on selected technical fields and show similar numbers: we find a slightly lower opposition rate over the whole period 1980-1999 and a higher revocation rate, once the results of appeals are taken into account.

[4] The IPC classes included were A61K, C07G, C12M, C12N, C12P, and C12Q (biotechnology/pharmaceutical) and G01R, G06F, G06K, G11C, H01L, H03F, H03K, H03M, and H04L (semiconductors/computers/software).

Using our matched sample of patents, we address the second main topic of this paper by investigating the following questions:

1. How do the US patents that match opposed EPO patents compare to the US control sample in terms of the number or breadth of post-issue citations? Do we observe that EPO oppositions and US re-examinations are filed against relatively "important" patents, measured in terms of citations?

2. Do we observe significant differences in the probability that a US patent corresponding to an EPO patent for which an opposition is filed will be challenged through a re-examination request or through litigation, relative to the probability that patents in the US "control samples" will be so challenged?

3. Based on the number and vintage of the citations to prior art in the US and EPO patents for which EPO oppositions are filed, do we observe consistent tendencies for oppositions to affect patents in relatively new areas of these broad technology classes?

4. For EPO patents that are filed in Europe before they are filed in the US, how do oppositions affect the number of claims in the issued US patent?

5. What if any conclusions about the cost and efficiency of oppositions, as opposed to re-examination requests and litigation, are supported by a comparative analysis of this matched set of US and EPO patents?

6. Does a more detailed analysis of the content of the EPO oppositions and USPTO re-examinations support conclusions about the ability of the opposition process to capture more relevant prior art, especially nonpatent prior art, than the US patent examination process or re-examination processes capture?

Our analysis of the broader patent oppositions dataset assembled and analyzed by Harhoff and Reitzig (2000), together with the re-examination dataset collected for the present paper, explores issues related to the first main topic of the paper:

1. How does the rate of opposition (number of oppositions/all issued patents) vary by patent class within the EPO data, and similarly for USPTO re-examinations? Which EPO and USPTO patent classes exhibit the highest opposition and re-examination rates?

2. How does the outcome of the opposition process vary by patent class?

3. On average, how long does an opposition process last? How much does this average duration vary by IPC class? How much does this average duration vary by outcome, i.e., do oppositions resulting in the invalidation of the patent on average last longer?

4. What fraction of oppositions involve cross-national challenges, i.e., the nationality of the individual opposing the patent differs from the nationality of the patentholder? How if at

all do the outcomes of cross-national oppositions differ from those of "intra-national" oppositions?

## 2. BACKGROUND

At the present time and in spite of their differing historical origins, the United States and European patent systems are substantially similar in their aims and requirements for patentability, but with important differences in the allowable subject matter and in their administration. This section of the paper gives a brief overview of the two systems and how they operate.

In the U.S., an invention ("process, machine, manufacture or composition of matter") must satisfy three requirements to be patentable: 1) novelty; 2) usefulness; and 3) non-obviousness. Since 1977, firms and individuals have been able to submit a single application to the European Patent Office that specifies up to 19 national jurisdictions within Europe where they desire patent protection for an innovation. The patentability requirements are similar to that in the United States: 1) novelty; 2) industrial application; and 3) having the characteristic of an "inventive step." Clearly the last two are similar to, but not the same as, the U.S. "usefulness" and "non-obviousness."

Figure 1 shows a rough timeline between patent application and grant for the two systems. During the period covered by our dataset, the U.S. patent application was kept secret until the patent issued, which meant the median time between application and publication was 18 months to two years, with a long tail. As part of the patent system harmonization called for in the TRIPS agreements, the U.S. instituted a policy of publication 18 months after application in November 2000, at least for those patents that will be applied for in other jurisdictions besides the United States. In contrast, EPO applications have always been published with an 18 month lag, regardless of whether they have issued.

Both systems have a "re-examination" challenge available after grant, but the two systems function rather differently, as we describe in more detail below. Both systems also are backed up by the right to litigate for infringement and validity (with some restrictions as to when a suit can be filed), but in Europe, the suits are brought in the individual national courts.[5] That is, when an EPO patent issues, it becomes a bundle of patent rights in individual European countries (those named on the application) and enforcement moves to the national rather than the community-wide arena.

### *2.1 U. S. PTO Re-examination*

- Administrative *ex parte* proceeding—requester role limited to application, and
  Right to receive notice of decision

[5] A truly European patent right (the so-called EU patent) may be established over the next years. In order to deal with litigation regarding these European patents, the European Union is likely to establish a central patent court. The examination and granting of EU patents will be administered by the EPO.

Right to receive copy of patentee's response
Right to file rejoinder to that response

- Relatively large filing fee ($2,500)
- Admissible evidence limited—prior patents and publications
- Regulatory hurdle: "Substantial question of patentability"
- Examiners are final arbiters
- Acts as barrier to pursuing litigation *ex post.*

There are therefore significant barriers, both cost and other, that inhibit the use of re-examination by third parties.

### *2.2 U. S. Litigation System*

- Adversarial appeal to court-arbiter.
- Costly: estimates of patent suits run between $1 and $3 million, some as high as $10 million. In part due to extensive and possibly excessive use of discovery.
- Challenge contingent upon a charge by the patentee of infringement (patentees avoid doing things that will legitimize a suit from a nonpatentholder, such as overt threats). That is, in general, patentees control the timing of litigation.
- A patent is afforded a presumption of validity.
- The burden of proof requires much more than a mere preponderance of evidence: "clear and convincing" standard is used.
- Judge, jury may have limited expertise.

### *2.3 EPO Opposition System*

Patent protection for European member states can be obtained by filing several national applications or one EPO patent application designating the states for which patent protection is requested. Considering the fees charged by the various patent offices in Europe, a European patent application costs approximately €29.800 and thus about three times as much as a typical national application.[6] Thus, if patent protection is sought for more than three designated states, the application for a European patent becomes cheaper than independent applications in several jurisdictions. This cost advantage has made the European filing path particularly attractive for applicants that are selling goods and services in international markets. Due to the increasing application and grant numbers, the European Patent Office has now gained a level of economic importance similar to that of the United States Patent and Trademark Office (USPTO). Moreover, the opposition procedure before the European Patent Office has become an important instrument for first-instance challenges to the validity of patents granted by the EPO.

European patents are granted for inventions which are novel, mark an inventive step, are commercially applicable, and are not excluded from patentability for other reasons. After the filing of the application, a search report is provided by the EPO and made available to the

[6] As in other patent systems, the official patent office fees are a relatively small part of the costs (in this case €4,300). Professional representation before the EPO amounts to €5,500 on average, while translation into the languages of eight contracting states requires €11,500. Renewal fees for a patent maintained for ten years amount to roughly €8,500.

applicant. The search report is generated by EPO staff in the The Hague office and then transferred to the examining staff in the Munich office. It describes state of the art regarded as relevant according to EPO guidelines for the patentability of the invention, i.e., it contains a list of references to prior patents and/or non-patent sources.[7] Within six months after the announcement of the publication of the search report in the EP Bulletin, the applicant can request the examination of his application which is a compulsory prerequisite for the patent grant. If examination is not requested, the patent application is deemed to be withdrawn. Eighteen months after the priority date the patent application will be published. At this point, the application will normally still be under examination; thus, the patent owner will already reveal some information prior to the grant of the patent. Moreover, the content of the application is revealed even if no patent is ever issued.

If engaged with the examination, the EPO will present an examination report; either the EPO will inform the applicant that the patent will be granted in the way it was applied for, or the EPO will propose changes after which the patent could be granted if the invention was patentable at all. In the latter case it is up to the applicant to decide whether to accept the alterations proposed by the EPO, or to come up with a different proposal for alteration. Once the applicant and EPO have reached a consensus on the version of the application to be granted, the patent is centrally granted for all the designated states and then translated into the respective languages. If no such agreement is reached and if the EPO declines to grant a patent, the applicant may turn to the appeals proceeding in which the reasons for the refusal to grant a patent right are reconsidered.[8] After the grant, the European patent becomes a "bundle" of national patent rights. On average, the granting process for a European patent takes about 4.2 years from the date of filing the application.

Once the European patent is granted, its national successors are treated like "normal" national patents that can be attacked by third parties through legal means allowed for by the respective national legislation. Outcomes of such national litigation cases are always restricted to the national level, e.g., the patent may be invalidated in Spain, but this does not affect its validity in Italy. Up to nine months after the granting date, however, third parties can attack the European patent centrally at the European Patent Office by filing their opposition against the granting decision. Comparable to the granting decision, the outcome of the opposition procedure is again binding for all designated states. The opposition procedure is thus the only central "challenge suit" for European patents. After the expiration of nine months subsequent to the grant, a competitor will have to attack the national patents emerging from the EPO grant in each jurisdiction separately.

Opposition to a European patent is again filed with the EPO. The opponent has to substantiate his opposition by presenting evidence that the prerequisites for patentability were not fulfilled, e.g., he has to show that the invention lacked novelty, and/or an inventive step, or that the disclosure was poor or insufficient. The opposition is formally admitted by the EPO where an

[7] It is important to note that a best-mode requirement for patent applications – as it applies in the US system – does not exist in Europe. Practitioners consider this as one of the main reasons why the number of references to prior art are considerably lower in patents issued by EPO (or national European patent offices) than in the U.S.

[8] This form of appeal has to be distinguished from appeals seeking to reverse the decisions rendered by the opposition division of the EPO.

opposition division decides on the case. At the end of the opposition procedure the chamber may uphold the patent without amendments, or it may amend[9] or even revoke[10] the patent. Patents are revoked in about one third of all cases.[11] The decision affects all of the "designated states," i.e., the states for which the patent applicant sought to obtain a patent

A further interesting aspect of the opposition procedure that distinguishes it from a "real" litigation before civil courts concerns the possibility of settlement between the litigating parties. Once an opposition is filed, the EPO may continue to decide on the case even if the opponent does no longer actively pursue opposition. Thus, opponent and patent holder may not be free to settle their case outside of the EPO opposition process once the opposition is filed.[12]

Both the patent holder(s) and the opponent(s) may file an appeal against the outcome of opposition procedures. The appeal has to be filed within two months after the receipt of the decision of the opposition division, and it has to be substantiated within an additional two months. The Board of Appeal is the final instance at the EPO to decide on the validity of the contested European patent. The official fee for filing an opposition is €613; for filing an appeal against the outcome of opposition, the fee is €1022. But the total costs to an opponent or the patent holder are much higher. Estimates by patent attorneys range between €15,000 and €25,000 for an opposition case (for each party). Approximately the same amount would be due for an appeal against the outcome of the opposition proceedings.

In cases of unsuccessful opposition and appeal against commercially valuable patents, third parties may try to attack the national successors of the European patent in the designated states. As of today, this option is not touched by the harmonisation of the European patent laws. However, national authorities can refer to former trials, thus, the probability of winning a national trial after having lost at the European level may be reduced. The differences across national jurisdictions are still enormous. Economies of scale are therefore difficult to achieve, thus making it quite expensive to attack the national successor patents in all of the designated states. The costs for litigation in any one of the national courts has been estimated to be between €50,000 and €500,000, depending on the complexity of the case. This cost structure makes an attack at the European level via the opposition procedure particularly attractive for a potential competitor of the patent holder.

## 3. AGGREGATE STATISTICS

In this section we present some statistics on the aggregate behavior of patent opposition and re-examination in the two different patent systems over the past two decades. First we look at the

[9] An amendment normally results in a reduction of the "breadth" of the patent by altering the claims which define the area for which exclusive rights are sought.

[10] On average, the opposition procedure takes around 2.2 years if the patent is revoked and about 4 years if the patent is amended. See Table 2 for similar information on our samples.

[11] See EPO (1999), p. 17 and Merges (1999), pp. 612-614. There are no publicly available data as to the frequency and extent of amendments, or the frequency of rejected oppositions. For the data we use, we compute these figures below.

[12] EPO may, but will not necessarily pursue the opposition procedure after the opponent's withdrawal from his attack.

rate at which these post-grant challenges are pursued, for all granted patents, and for our two main technology classes. Then we examine the length of time until challenge occurs and until it is resolved. We go on to summarize the determinants of post-grant challenges in a probit regression that controls for the correlation among our covariates (such as varying citation behavior across technology classes).

It is important to keep in mind the one overriding fact about any comparison between opposition and re-examination, which is that there are far more opposition cases (33,599 between 1980 and 1998) than there are re-examination cases (2,949 during the same period). This reflects the fact that there are many barriers, both cost and legal, to re-examination and is the central reason why we are exploring the comparison. However, because of the small sample size for re-exams, we cannot really study them using the sample of "twinned" opposition patents described in Section 4 of the paper.[13] Therefore we conclude the present section by looking briefly at the outcomes of all the re-examinations in the United States, rather than confining out attention to the twin sample only.

Figure 2 displays the time series of the opposition and re-examination rates in all technology sectors, while Figure 3 shows the rates for our two technology classes. The rate is defined as the share of patents granted in a given year that are ultimately challenged. In the case of the United States, this variable will be truncated because challenges can happen any time during the lifetime of a patent.[14] We have used a simple model of the re-examination lag to compute a minor correction for this truncation. Two facts are immediately apparent from these figures:

1. Overall the opposition rate at the EPO is much higher than the re-examination rate at the USPTO, as has been noted previously by Merges (1999) and Harhoff and Reitzig (2000) (note the differing scales). The average rate during the 1981-1990 period was 0.25% for re-examination and 8.3% for opposition.
2. The opposition rate for patents in the semiconductors, computing, and software sector is substantially lower than that for patents in the biotechnology/pharmaceutical sector and for patents in all sectors, whereas the re-examination rate is roughly the same for our two technology classes, as well as for patents in the other sectors.

Figure 4 displays the average lag distribution between applying for a patent and the filing of a re-examination or opposition request.[15] Because opposition can only be filed within 9 months of a patent grant, the lag distribution is much tighter for opposition. However, the grant lag in Europe is longer, so the mean lags are similar in the two countries: 5.9 in Europe vs 7.4 in the United States.

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[13] 16 patents in the EPO opposed sample and 3 in the control sample described in Section 4 had twins that encountered re-examination requests, implying re-exam probabilities of 1.6% and 0.15% respectively. This means the re-exam probability is ten times as high for opposed patents, but still very small overall.

[14] See Figure 4 to get an idea of the distribution of the lag between patent *application* and challenge. About three-fourths of the re-exam requests happen within 8 years of application, which is within approximately 6 years of grant.

[15] Except for Figure 2, in this version of the paper the numbers for the EPO are based on all oppositions in our technology classes, a sample of approximately 2400 oppositions filed between 1980 and 1999. In the future we hope to add data on all 34,000 oppositions between 1980 and 1999.

Figure 5 shows distribution of the lag between a patent application and final resolution of the post-grant challenge. From the perspective of administrative policy, this quantity is likely to be the most closely related to the private and social costs of opposition-type systems, because of the costs to both patentholder and opposer of uncertainty and because during the entire period, it is likely that legal counsel will have to be retained. The distributions are quite different between the two systems, with greater delay evident in the European system. The mean length of time overall between application and final outcome is 10 years at the EPO and 7.2 years at the USPTO. However, if we look only at patents applied for before 1986, in order to minimize the effects of lag truncation, the means are 10.5 and 9.2 years respectively, because of the more diffuse distribution at the USPTO.

Table 2 summarizes the characteristics of the lag distributions for the two systems. The median lag between application and final opposition outcome at the EPO is almost two years greater than for re-examination at the USPTO, but the interquartile range is almost two years less.

The conclusion from all the figures presented in this section is that both processes experience the same average delay, but that the distribution of length of delay is far more disperse for the re-examination process than for the opposition process. This fact is almost entirely due to the EPO requirement that opposition be filed within 9 months of patent grant.

### *3.1 Determinants of a Post-Grant Challenge*

What are the characteristics of patents that undergo post-grant challenges? And are these characteristics the same for opposition and re-examination? We look at this question using U.S. re-examinations for patents issued between 1975 and 1999 that were requested between 1975 and 1999 (3,220 patents out of a one percent sample of 23,590) and EPO oppositions to biotechnology/pharmaceutical patents issued between 1979 and 1996 and for which oppositions were filed (1,158 patents out of 13,889).[16]

Harhoff and Reitzig (2000) reported the following variables to be highly significant predictors of opposition for biotech/pharma patents:

- The logarithm of the number of designated states for patent validity or corresponding dummy variables for 1-5, 6-9, 10-14 and more than 14 designated states.
- Dummy variables for 4-digit IPC groupings, especially those for C12N (micro-organisms or enzymes), C12P (fermentation or enzyme-using processes), and A61K (medical and dental preparations).[17]
- A set of dummy variables for the number of subsequent citations to the patent.

The following predictors were somewhat less important but still significant:

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[16] The results for opposition probability reported in this version of the paper are from Harhoff and Reitzig (2000), Table 6. The one percent sample of all U.S. patents was drawn from all patents granted 1975-1999, stratified by year of grant (thus the base dataset consists of roughly 2.36 million patents).

[17] Harhoff and Reitzig (2000) exclude patents in this class that were for toilet preparations; we have not yet done so. Interestingly, the field of cosmetics displays an opposition rate that is about twice as high as the overall average of 8.2 percent.

- The crowdedness of the field, measured by the cumulative number of patents in the 4-digit IPC.
- The size of the holder's patent portfolio (negative for opposition).
- A set of dummies for the nationality of the holder - only Japanese patentholders are significantly less likely to face opposition that the reference group of German holders.
- The share of backward citations that have been classified by the EPO during the pre-examination search to render the claimed invention not novel or not involving an inventive step even when taken alone.

However, their results also indicate that patents owned by individual inventors are not more likely to be opposed, nor are those with more backward citations in total.

The results for probit regressions of re-examination on a set of variables similar to those used by Harhoff and Reitzig (2000) are shown in Table 1. The first panel shows results for the whole 1975-1999 sample, while the second panel restricts the sample to patents granted before 1991, because our measure of forward citations (those during the first 9 years of patent life) is somewhat inadequate for the later years. The variables have fairly high predictive value, with a pseudo R-squared of about 0.15 and an error rate of about 13-17% compared to 23% for random assignment.

We find that forward citations are also highly related to re-examination requests and that patents owned by individual inventors are no more likely to be re-examined. Our data include re-examinations in all technology classes, and we find that biotechnology/pharmaceutial patents in general are no more likely to be re-examined, while patents in the semiconductor, computer hardware and software classes are less likely to be re-examined.[18] The nationality of the patentholder makes little difference, although patents held by a U.S. assignee are slightly more likely to be re-examined.

### *3.2 Re-examination outcomes*

Table 3 summarizes the results of re-examinations conducted by the USPTO between 1980 and 1999. The top panel shows all 3563 re-examinations for which we have outcome information and the bottom panel shows the results for our two main technology classes. The proportions are similar, although for the newer technologies, it appears that claim amendment is relatively more likely than the addition or cancelling of claims. In both cases, about 32 per cent of the patents are confirmed in full on re-examination.

We are unable (yet) to determine how many patents are cancelled in their entirety as a result of re-examination. An upper bound is provided by the number of patents which have cancelled claims and no other action, approximately 20 per cent, which is somewhat higher than the 12 per

[18] Looking at the detailed classes, the following are less likely to be re-examined: C12P (fermentation or enzyme-using processes), G06F (electronic digital processing), and H01L (semiconductor devices). More likely to be re-examined are H03K (electronic switching (pulse) devices), G11C (static information storage), and H03F (amplifiers).

cent reported by Merges (1999) for 1995. Unfortunately, we have no way of knowing whether any claims were left standing at the present time. In the next section, we will compare these results to those achieved by the EPO opposition system for our technologies.

## 4. U.S.-EPO EQUIVALENT PATENTS

### *4.1 Sampling Stategy*

Our sampling strategy is based on the IPC classifications done at the European Patent Office, because these assignments are believed by a number of patent professionals to be of higher quality than the IPC assignments done after the fact at the USPTO.[19] The sampling strategy is illustrated in Figure 6. We began by drawing a sample of approximately 2,000 EPO patents that met the following criteria:

- They were granted between 1980 and 1997 (applied for between 1978 and 1995).
- They were classified in one of our two broad technology classes (62% in biotechnlogy/pharmaceuticals and 38% in semiconductors/computers/software).
- An opposition was filed against them after grant.

These patents are shown in the upper left hand corner of Figure 6.

Using these 2,027 patents as our sampling frame, we then drew an 8% sample of unopposed EPO patents in these technology classes to use as controls, stratifying on month and year of filing and IPC class, yielding a total of 2,861 patents. These are shown in the upper right hand corner. Note that because biotech/pharma patents are opposed at a higher rate, there are fewer of them in the control sample.

U.S. equivalents for these two samples of patents were then collected off the esp@cenet website, yielding the patents in the two bottom panels. In about 2-3 percent of the cases, an EPO patent has more than one U.S. equivalent; three patents have more than 3. The likelihood of having an equivalent is higher for semiconductor/software than for biotechnology and pharmaceuticals.

More interesting is the fact that the probability of having a U.S. equivalent is higher for the controls than for the opposed patents, even when we control for broad technology class. We are not sure why this should be the case, and will investigate the reasons further in the following.

### *4.2 Probability of Opposition*

Table 4 displays the results of a series of probit regressions that relate the probability that a patent is opposed to the characteristics of the patent, its owner, and the U.S. twin, if there is one. All of the right hand side variables are dummies and the estimates shown are the change in the

[19] This conclusion is based on private communications from more than one U.S. Patent Examiner. The search system at the USPTO is based on the U.S. patent classification system and IPCs are assigned only after the fact, based on a rough concordance.

probability if the the dummy changes from 0 to 1. The first data column of the table gives the number of observations for which the dummy was equal to one.

When we included only grant year dummies, the biotech/pharma dummy, and the U.S. twin dummy in the probit, we obtained the following estimate:

*Prob(opposition) = year effects + 0.293 D(biopharm) – 0.118 D(U.S. twin exists)*

This result essentially summarizes the results of our sampling strategy: biotechnology/pharma patents are 30 per cent more likely to be opposed, and patents with U.S. twins are approximately 12 per cent less likely to be opposed. Including only these variables yielded an R-squared of 0.09.

Columns (1) and (2) relate opposition to a large number of characteristics of the patent and its holder. In column (2) we replace the biotech/pharma dummy by a full set of dummies for the 15 4-digit IPC classes we are considering. These dummies are clearly significant ($\chi^2(12) = 101.2$), but their estimates do not affect the other coefficients much.[20] The other variables in the regression are the following:

- A set of dummies for the number of EPO citations received by the patent between its issue date and 1999. One additional forward cite raises opposition probability about 3-5 per cent, with some diminishing returns.
- A set of dummies for the number of EPO states in which the patent was taken out (1-5, 6-10, and more than 10). Designating more states raises the probability of opposition.
- A set of dummies for the number of claims (1-5, 6-9, 10, 11-15, more than 15). Having more claims raises the probability of opposition, but only if the number of claims is greater than about 10.[21] Interpretation of this result is difficult, because the presence of a large number of claims is ambiguous. Long patents with a large number of claims could be complex because they are trying to narrow the invention claimed, which may be why we see a small relationship here. The implication is that there are other similar inventions out there, which may lead to opposition. On the other hand, some have argued that patents with large numbers of claims are broader, rather than narrower
- Whether the patentholder is an independent inventor. This variable may not always be correctly coded, as it is derived from an exact check that the name of the assignee is the same as that of the inventor.[22] The coefficient is insignificant.

[20] The degrees of freedom are lowered by the fact that some cells are sparse and therefore not identified in the regression. Those that had much lower opposition probability than average were G06F, G11C, H01L, H03K, H03M, and H04L, which are most of the semiconductor/computing classes. Those that were higher were C07G and C12M. This result essentially confirms the fact that the biopharm dummy captures most of the difference in opposition rates for these technologies.

[21] The focal point at 10 claims is apparently caused by the fact that EPO charges a separate claims fee of €40 for the eleventh and each subsequent claim (Rule 31, 51 and 101 EPC).

[22] We intend to improve on this variable in future work. It disagrees with the U.S. assignment code for the twin in about half the cases, which seems unlikely to us.

- Whether an accelerated search was requested by the patent applicant at the EPO. This lowers the probability of opposition by about 14 per cent.[23] Accelerated search is often requested when the applicant is unsure of the state of the art, or of whether their invention is patentable.
- Whether an accelerated examination was requested by the patent applicant. This raises the probability of opposition by 25 per cent. It is very likely that this request indicates that the applicant attaches high value to the patent and that there something in the nature of a race going on, which makes it more likely that there will be a competitor that wishes to oppose the patent.
- Whether a Patent Cooperation Treaty (PCT) application was filed, enabling the applicant to file for protection later in up to 80 countries at WIPO. This raises the probability about 12 per cent. This variable is presumably correlated with the value of the invention.
- A set of dummies for the country of the patent holder. Although they are jointly significant, none are significant invidually. Looking closely at them, it appears that those for Germany and the rest of Western Europe are marginally significant so we retain those.
- A dummy for the presence of one or more U.S. twins. Once we control for other patent characteristics, the relative probability that a patent with a twin is opposed increases slightly, from minus 12 per cent to minus 9 per cent.

In general the results from the regressions in columns (1) and (2) confirm the findings in Harhoff and Reitzig that variables positively correlated with the value of a patent predict the probability that the patent will be subject to opposition. It is suggestive that patents held by independent inventors are no more likely to be opposed than other patents, other things equal. However, if we do not control for patent characteristics, patents held by independent inventors are 11 per cent *more* likely to be opposed; the main reason seems to be that they are more likely to be biotechnology/pharmaceutical patents.[24]

In column (3), we drop the insignificant variables to obtain our preferred specification, without affecting the coefficient estimates very much at all. The main difference is that patents held by German and West European assignees are now about 7-8 per cent more likely to be opposed than patents held by residents of other countries. We explored the identity of the opposers, finding that they are relatively more likely to come from countries that share a language with Germany or are in close proximity to a country that does. This suggests that the opposition system is more heavily used by those who are familiar with the language and culture of the country in which it is operated. It is natural therefore that the opposed patents also come from nearby countries, either because the (potential) opposers are more informed about them, or simply because they are more likely to be in the same narrow line of business. On the other hand, this finding may be caused by the choice of designated states for patent coverage, with Germany being the most favored choice. Inventors and corporations in European countries for which patent protection is not

[23] We are grateful to Markus Reitzig for suggesting inclusion of this and the next two variables. A detailed assessment of their usefulness for assessing the value of patent rights is given in Reitzig (2001).

[24] This may be an artifact of the way the sample was constructed and needs to be checked – the coding of the independent inventor variable is probably of somewhat higher quality for the biotech/pharma category, since it was coded manually. Harhoff and Reitzig used this variable and report that patents of independent inventors are c.p. not more likely to be opposed.

sought will have lower incentives to challenge patents that are not valid in their home country. We will explore this in further work.

Finally, in column (4), we add some information about the U.S. twins for these patents, where they exist. The variables added are the following:

- Whether the patent has more than one U.S. twin. This variable is insignificant.
- A set of dummies for the number of USPTO citations received by the patent in the first ten years of its life. One additional forward cite of this type raises opposition probability 1 per cent, again with some diminishing returns at high citation levels. The slightly lower coefficient may reflect the fact that USPTO patents have many more cites per patent than EPO patents. It is noteworthy that although the EPO citation variables fall slightly in the presence of USPTO citation variables, both enter the equation significantly.
- Whether the U.S. application date was prior to the EPO application date. This reduces the probability of opposition by about 4 per cent, possibly reflecting the fact that for these patents, more of the value will derive from the U.S., so opposition in Europe is less important.
- Whether the USPTO coded the inventor as an independent inventor. This increases the probability by 7 per cent, but insignificantly. Measuring this more accurately is of some concern given the reluctance of the independent inventor community to embrace an opposition system.[25] Controlling for grant year and nothing else, the raw difference in probability is 9.4 per cent with a standard error of 4.8 per cent.

The set of variables that describe the U.S. twin are jointly significant, with a $\chi^2(7) = 37.3$, and adding them has little effect on the other coefficients, except that the U.S. twin dummy falls to minus 14 per cent.

### *4.3 Opposition outcomes*

The outcomes of the oppositions for our sample are shown in Table 4. The category "opposition closed" is likely to reflect cases in which the patent holders – after the opposition has been filed – do not renew patent protection so that the patent lapses into the public domain. Thus, these cases will mostly reflect a successful challenge of the patent's validity. Two facts are particularly striking: first, opposition against patents with U.S. equivalents is more likely to be rejected. This may simply be due to the fact that patents from non-European applicants are selected carefully for patenting in Europe and are therefore more robust against the opposition challenge. This may also be a plausible explanation for the negative impact of the twin status variable on the likelihood of opposition.

Second, the probability of outright revocation of the patent is much higher than it is for re-examination: a total of 35.2 percent of the patents are revoked, not counting the opposition cases

[25] This variable needs to be checked rather carefully, since there are many cases when it is simply not coded. These are currently included in the independent inventor class, but may not belong there. In EPO applications, both the listing of the applicant and of the inventors is compulsory.

that are closed because the patent lapses. Presumably, these results reflect the wider grounds allowed for opposition and the presence of the third party in the process.

## 5. CONCLUSIONS AND FURTHER QUESTIONS

*To be supplied (or filled in by the discussant!)*

## 6. REFERENCES


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http://www.european-patent-office.org

http://www.uspto.gov

## Table 1
## Probability of a Re-examination Request
**Binary probit estimation (23,590 observations; 3,220 re-exams)**

| | All Observations (23,590) | | | | Patents granted prior to 1991 (12,283) | | | |
|---|---|---|---|---|---|---|---|---|
| | **Dprob/dx+** | **Std. Error** | **Dprob/dx+** | **Std. Error** | **Dprob/dx+** | **Std. Error** | **Dprob/dx+** | **Std. Error** |
| Bio/pharma | -0,0092 | 0,0193 | -0,0162 | 0,0178 | -0,0193 | 0,0379 | -0,0264 | 0,0363 |
| Semiconductor/hardware | **-0,0264** | **0,0071** | **-0,0227** | **0,0071** | -0,0049 | 0,0146 | -0,0012 | 0,0148 |
| Software | **-0,0483** | **0,0101** | **-0,0512** | **0,0093** | **-0,0750** | **0,0192** | **-0,0788** | **0,0182** |
| #cites (10yr) = 1 or 2 | **0,0476** | **0,0083** | **0,0448** | **0,0082** | **0,0965** | **0,0164** | **0,0933** | **0,0163** |
| #cites (10yr) = 3 to 10 | **0,1372** | **0,0089** | **0,1301** | **0,0088** | **0,2023** | **0,0145** | **0,1964** | **0,0145** |
| #cites (10yr) = 10 to 20 | **0,3479** | **0,0167** | **0,3285** | **0,0167** | **0,4665** | **0,0222** | **0,4530** | **0,0226** |
| #cites (10yr) > 20 | **0,5716** | **0,0196** | **0,5430** | **0,0205** | **0,6615** | **0,0209** | **0,6449** | **0,0220** |
| Individually owned | 0,0075 | 0,0055 | -0,0053 | 0,0051 | 0,0085 | 0,0088 | -0,0060 | 0,0085 |
| Government-owned | **-0,0659** | **0,0094** | **-0,0687** | **0,0082** | **-0,0903** | **0,0163** | **-0,0968** | **0,0145** |
| U.S. patent | | | 0,0642 | 0,0354 | | | 0,0741 | 0,0563 |
| Japanese patent | | | 0,0003 | 0,0403 | | | -0,0044 | 0,0631 |
| Non-European developed country patent* | | | 0,0969 | 0,0648 | | | 0,0703 | 0,0840 |
| Other regional dummies** | -- | | yes | | | | yes | |
| Grant year dummies | yes | | yes | | yes | | yes | |
| Pseudo R-squared | 0,142 | | 0,154 | | 0,118 | | 0,128 | |
| Log likelihood | -8071,62 | | -7957,87 | | -5066,31 | | -5006,01 | |
| Chi-squared (df)++ | 1685,9 | 9 | 1913,4 | 16 | 1282,04 | 9 | 1402,64 | 16 |

The left-out category is a corporate-owned patent granted in 1975/76 with no citations within 10 years after grant.

+This is the increase in probability for a unit change to the dummy (all variables are dummy variables).

++The null hypothesis is year dummies only.

*Australia, Canada, New Zealand, Israel

**Asia, W. Europe, E. Europe, Other

## Table 2
## Lags between Application, Grant, Challenge, and Final Outcome

| | EPO* | | | USPTO** | | |
|---|---|---|---|---|---|---|
| | # Obs. | Median | IQ Range | # Obs. | Median | IQ Range |
| Lag btwn application & grant | 2692 | 4,88 | 2,30 | 3144 | 1,71 | 0,90 |
| Lag btwn grant & first challenge | 2692 | 0,75 | 0,02 | 3074 | 2,61 | 4,21 |
| Lag btwn first challenge & final outcome | 2015 | 3,07 | 2,80 | 3074 | 1,28 | 0,89 |
| Total lag | 2007 | 9,53 | 3,67 | 3074 | 6,17 | 4,88 |
| **Pre-1991 Applications Only** | | | | | | |
| Lag btwn application & grant | 2332 | 5,17 | 2,21 | 2522 | 1,78 | 0,92 |
| Lag btwn grant & first challenge | 2326 | 0,75 | 0,02 | 2464 | 3,51 | 5,07 |
| Lag btwn first challenge & final outcome | 1854 | 3,19 | 2,97 | 2464 | 1,28 | 0,92 |
| Total lag | 1854 | 9,00 | 3,72 | 2464 | 7,25 | 5,59 |

*These numbers are for our sample of opposed patents only.

**These numbers are for all re-examined patents; they have not been adjusted for truncation.

## Table 3
## Reexamination outcomes, 1980-1999

Of 3614 records, 3563 (98%) have outcome notations

| Claims | NOA* | Added | with Cancelled | Add&Cancel | Totals | Share | Share with any |
|---|---|---|---|---|---|---|---|
| Added | 149 | -- | -- | -- | **149** | **4,2%** | **14,1%** |
| Cancelled | 568 | 152 | -- | -- | **720** | **20,2%** | **40,5%** |
| Amended | 678 | 124 | 645 | 78 | **1525** | **42,8%** | **42,8%** |
| No change | 1169 | -- | -- | -- | **1169** | **32,8%** | **32,8%** |
| **Total** | **2564** | **276** | **645** | **78** | **3563** | **100,0%** | |

**Re-examination outcomes, 1980-1999**
**Biotech/pharma and Semiconductors/computer hardware & software**

| Claims | NOA* | Added | with Cancelled | Add&Cancel | Totals | Share | Share with any |
|---|---|---|---|---|---|---|---|
| Added | 9 | -- | -- | -- | **9** | **3,2%** | **10,6%** |
| Cancelled | 48 | 3 | -- | -- | **51** | **18,0%** | **37,5%** |
| Amended | 66 | 12 | 49 | 6 | **133** | **47,0%** | **47,0%** |
| No change | 90 | -- | -- | -- | **90** | **31,8%** | **31,8%** |
| **Total** | **213** | **15** | **49** | **6** | **283** | **100,0%** | |

*NOA=no other action noted

Each re-exam appears only once.

Numbers in the last column do not add to 100% because some re-exams yield multiple outcomes.

## Table 4
## Probability of an Opposition
**Binary probit estimation (4759 observations; 1974 opposed)**

| | No. of obs equal to 1 | (1) Dprob/dx+ | Std. Error | | (2) Dprob/dx+ | Std. Error | | (3) Dprob/dx+ | Std. Error | | (4) Dprob/dx+ | Std. Error | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **EPO characteristics** | | | | | | | | | | | | | |
| Biotech/pharma technology | 2.113 | 0,1621 | 0,0203 | *** | Full 14 tech dummies++ | | | 0,1679 | 0,0201 | *** | 0,1827 | 0,0204 | *** |
| No. of forward EPO cites = 1 | 953 | 0,0549 | 0,0227 | ** | 0,0598 | 0,0230 | | 0,0575 | 0,0227 | ** | 0,0474 | 0,0228 | ** |
| No. of forward EPO cites = 2/5 | 1.275 | 0,1609 | 0,0211 | *** | 0,1723 | 0,0214 | *** | 0,1657 | 0,0210 | *** | 0,1413 | 0,0216 | *** |
| No. of forward EPO cites = 6/10 | 247 | 0,2230 | 0,0360 | *** | 0,2172 | 0,0368 | *** | 0,2305 | 0,0357 | *** | 0,1889 | 0,0375 | *** |
| No. of forward EPO cites >10 | 79 | 0,3964 | 0,0518 | *** | 0,4152 | 0,0508 | *** | 0,3937 | 0,0519 | *** | 0,3610 | 0,0565 | *** |
| No. of designated states 6-10 | 1.053 | 0,1360 | 0,0229 | *** | 0,1260 | 0,0233 | *** | 0,1269 | 0,0224 | *** | 0,1273 | 0,0226 | *** |
| No. of designated states >10 | 1.705 | 0,1762 | 0,0248 | *** | 0,1712 | 0,0251 | *** | 0,1661 | 0,0240 | *** | 0,1659 | 0,0242 | *** |
| No. of EPO claims 6-9 | 1.166 | 0,0127 | 0,0248 | | 0,0082 | 0,0250 | | | | | | | |
| No. of EPO claims = 10 | 573 | 0,0367 | 0,0300 | | 0,0158 | 0,0302 | | | | | | | |
| No. of EPO claims 11-15 | 1.041 | 0,0513 | 0,0261 | ** | 0,0334 | 0,0264 | | | | | | | |
| No. of EPO claims >15 | 1.218 | 0,1167 | 0,0264 | *** | 0,1023 | 0,0269 | *** | 0,0848 | 0,0185 | *** | 0,0805 | 0,0185 | *** |
| Independent inventor (EPO ass.) | 172 | 0,0072 | 0,0399 | | -0,0065 | 0,0398 | | | | | | | |
| Accelerated search requested | 86 | -0,1358 | 0,0541 | ** | -0,1410 | 0,0539 | ** | -0,1317 | 0,0547 | ** | -0,1326 | 0,0549 | ** |
| Accelerated exam requested | 137 | 0,2524 | 0,0458 | *** | 0,2475 | 0,0465 | *** | 0,2510 | 0,0457 | *** | 0,2492 | 0,0460 | *** |
| PCT application | 925 | 0,1184 | 0,0236 | *** | 0,1284 | 0,0238 | *** | 0,1147 | 0,0233 | *** | 0,0960 | 0,0236 | *** |
| **Nationality of patentholder** | | | | | | | | | | | | | |
| U. S. | 1.630 | 0,1047 | 0,1746 | | 0,1115 | 0,1740 | | | | | | | |
| Germany | 701 | 0,2182 | 0,1736 | | 0,2078 | 0,1745 | | 0,0880 | 0,0231 | *** | 0,0907 | 0,0243 | *** |
| Other West European | 1.203 | 0,1956 | 0,1743 | | 0,1867 | 0,1745 | | 0,0694 | 0,0186 | *** | 0,0708 | 0,0198 | *** |
| East European | 12 | 0,1120 | 0,2325 | | 0,0999 | 0,2322 | | | | | | | |
| Japan | 1.108 | 0,1617 | 0,1760 | | 0,1600 | 0,1759 | | | | | | | |
| Other Asia | 10 | -0,0048 | 0,2490 | | -0,0094 | 0,2495 | | | | | | | |
| Other developed country | 87 | 0,1602 | 0,1846 | | 0,1545 | 0,1850 | | | | | | | |
| Chi-squared (7) for region dummies | | 30,73 | | *** | 21,45 | | *** | | | | | | |
| Chi-squared (5) for US,JP,E Eur,Asia,Other | | 7,55 | | | 5,57 | | | | | | | | |
| **US Twin characteristics** | | | | | | | | | | | | | |
| US Twin exists | 2.855 | -0,0916 | 0,0163 | *** | -0,0954 | 0,0165 | *** | -0,0910 | 0,0162 | *** | -0,1421 | 0,0352 | *** |
| More than one US twin | 40 | | | | | | | | | | -0,0162 | 0,0832 | |
| No. of US forward cites = 1 or 2 | 553 | | | | | | | | | | -0,0155 | 0,0395 | |
| No. of US forward cites = 3/10 | 1.269 | | | | | | | | | | 0,0761 | 0,0368 | ** |
| No. of US forward cites = 10/20 | 497 | | | | | | | | | | 0,1591 | 0,0425 | *** |
| No. of US forward cites >20 | 260 | | | | | | | | | | 0,1676 | 0,0489 | *** |
| US app. date prior to EPO | 1.460 | | | | | | | | | | -0,0418 | 0,0217 | ** |
| Independent inventor (USPTO ass.) | 113 | | | | | | | | | | 0,0676 | 0,0508 | |
| Log likelihood | | -2794,31 | | | -2740,58 | | | -2800,04 | | | -2781,39 | | |
| Pseudo R-squared | | 0,134 | | | 0,150 | | | 0,133 | | | 0,139 | | |
| Chi-squared (df) | | 868.1 (40) | | | 966.8 (52) | | | 856.7 (31) | | | 894.0 (38) | | |

+This is the increase in probability for a unit change to the dummy.

++One of the dummies predicts opposition perfectly, so the increase in degrees of freedom is only 12 = 13-1.

All equations include a complete set of 18 grant year dummies.

The left-out category is a corporate patent in semiconductor/software with number of states <6, number of claims <6, zero forward cites, and with holder from Argentina, Turkey, or South Africa.

## Table 5
## Final Outcome of Oppositions

| | Total | With US Twin | Percent with US Twin | Share of outcomes |
|---|---|---|---|---|
| Opposition rejected | 260 | 167 | 64,2% | |
| Opposition rejected on appeal | 81 | 43 | 53,1% | |
| **Opposition rejected - total** | **341** | **210** | **61,6%** | **22,4%** |
| Patent amended | 348 | 201 | 57,8% | |
| Patent amended on appeal | 153 | 71 | 46,4% | |
| **Patent amended - total** | **501** | **272** | **54,3%** | **32,9%** |
| Patent revoked | 357 | 172 | 48,2% | |
| Patent revoked on appeal | 180 | 88 | 48,9% | |
| **Patent revoked - total** | **537** | **260** | **48,4%** | **35,2%** |
| **Opposition closed** | **145** | **76** | **52,4%** | **9,5%** |
| Patent pending | 189 | 71 | 37,6% | |
| Patent pending on appeal | 261 | 93 | 35,6% | |
| **Patent pending - total** | **450** | **164** | **36,4%** | **--** |
| **Total** | **1974** | **906** | **45,9%** | |

**Figure 1**

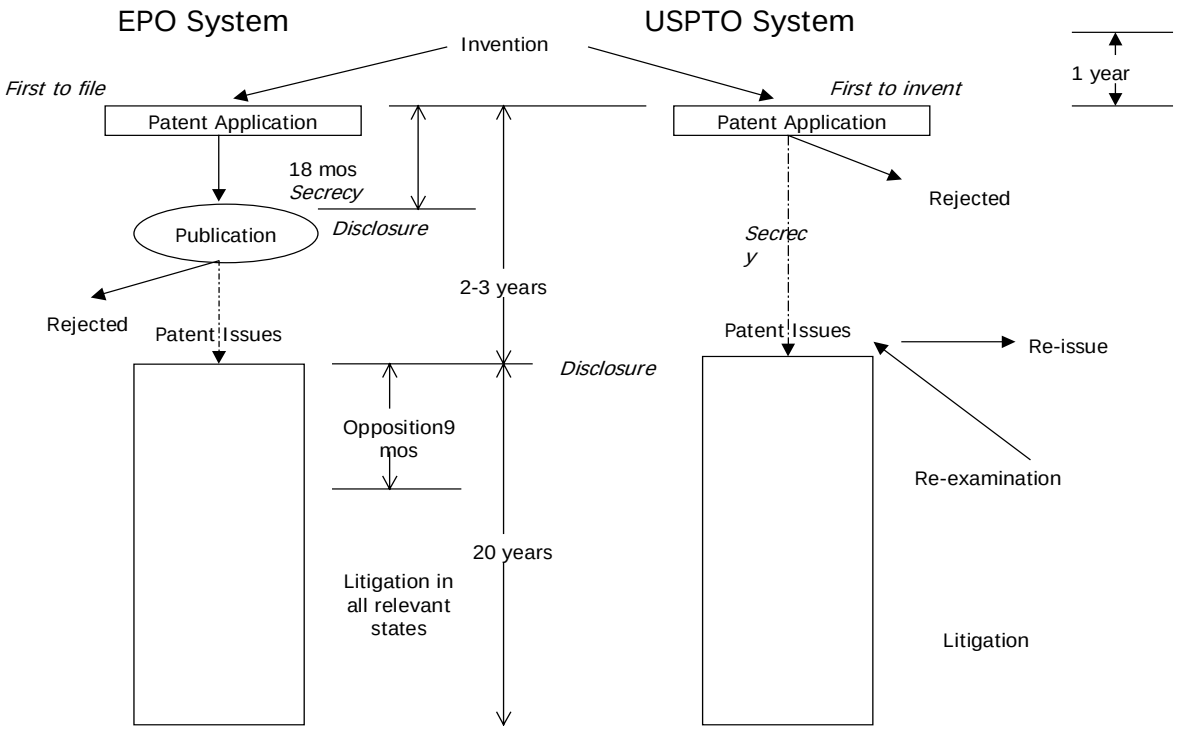
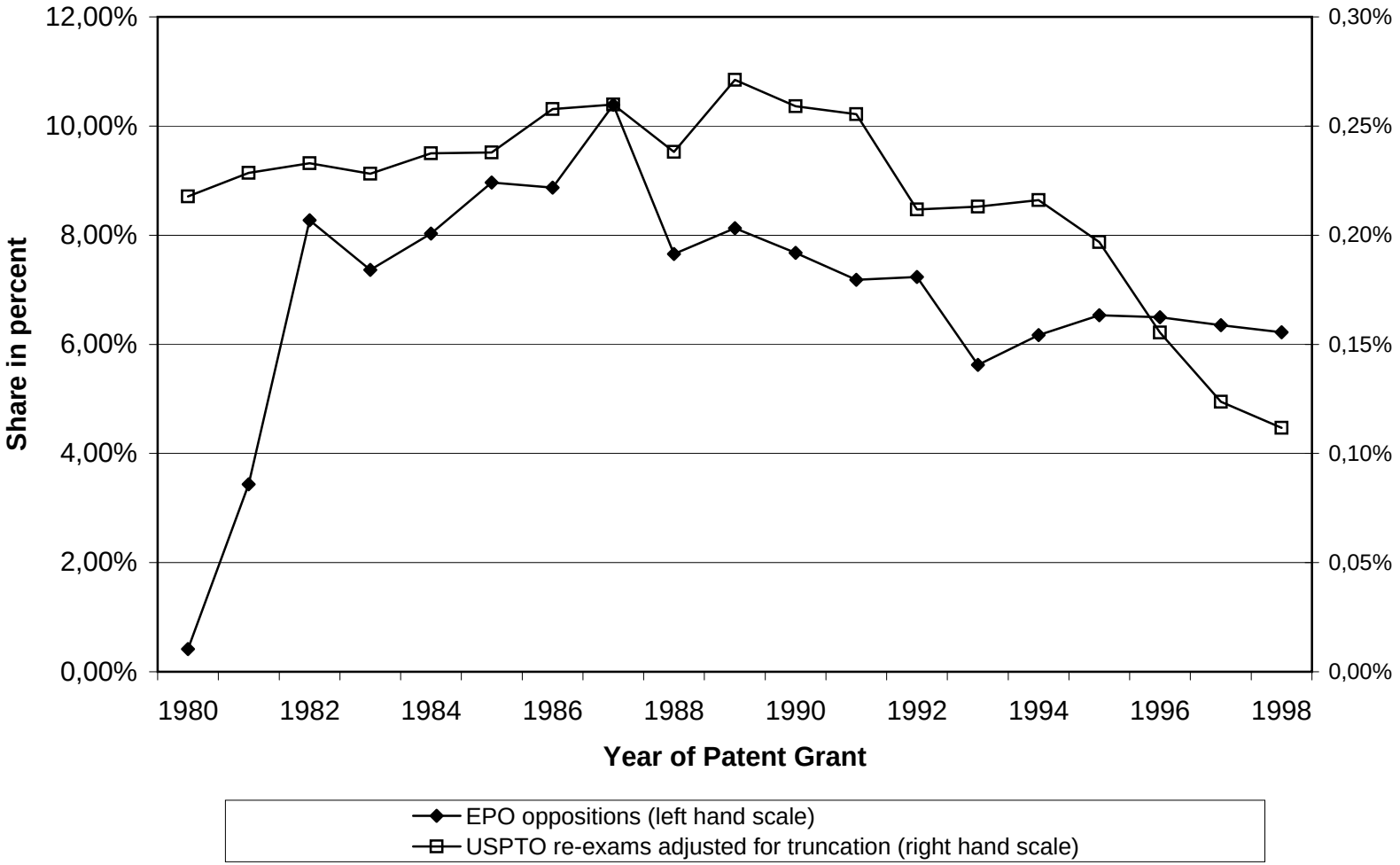
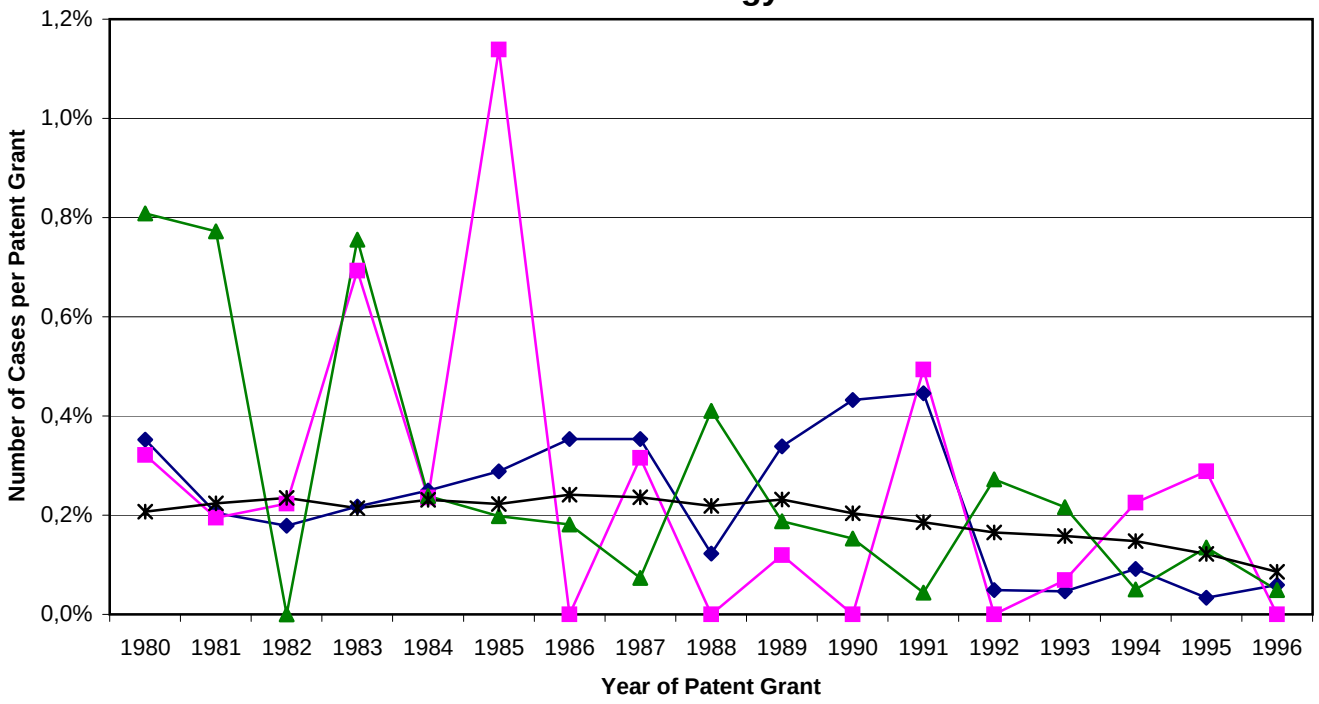

EPO System
USPTO System
Invention
1 year
First to file
First to invent
Patent Application
Patent Application
18 mos
Secrecy
Rejected
Publication
Disclosure
Secrec
y
2-3 years
Rejected
Patent Issues
Patent Issues
Re-issue
Disclosure
Opposition9
mos
Re-examination
20 years
Litigation in
all relevant
states
Litigation

Figure 2
USPTO Re-exams and EPO Oppositions
by year of patent grant



## Figure 3
## USPTO Re-examinations by Grant Year 1980-1996
## Selected Technology Classes




## EPO Oppositions by Grant Year 1980-1996
## Selected Technology Classes

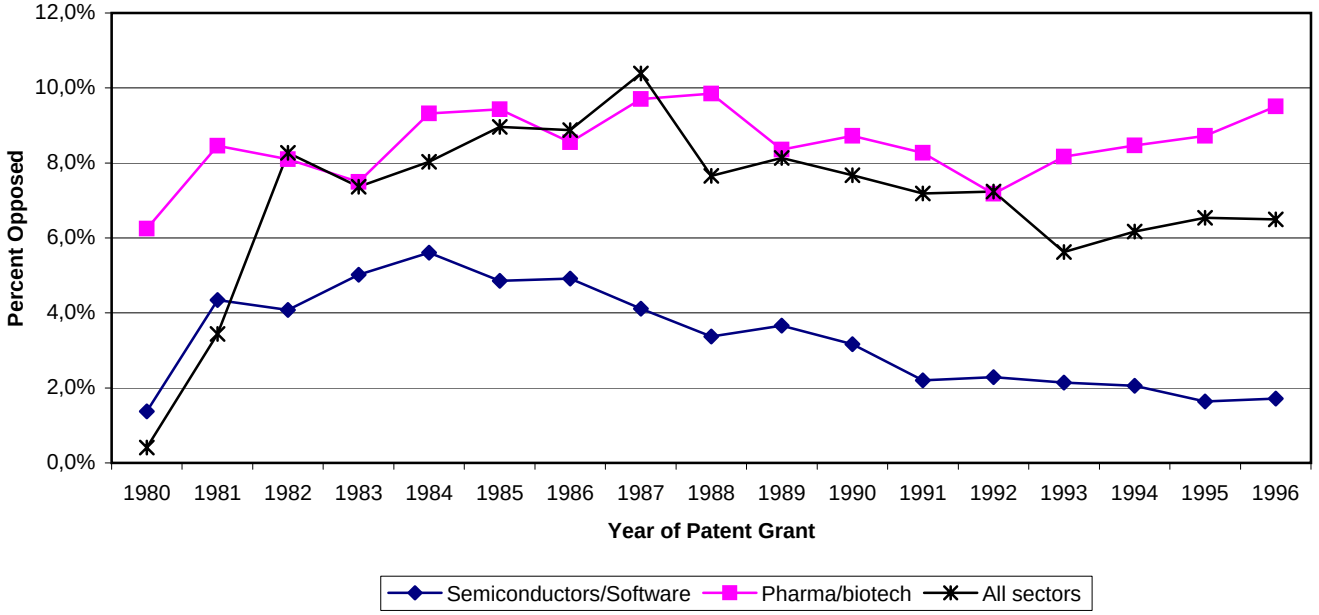
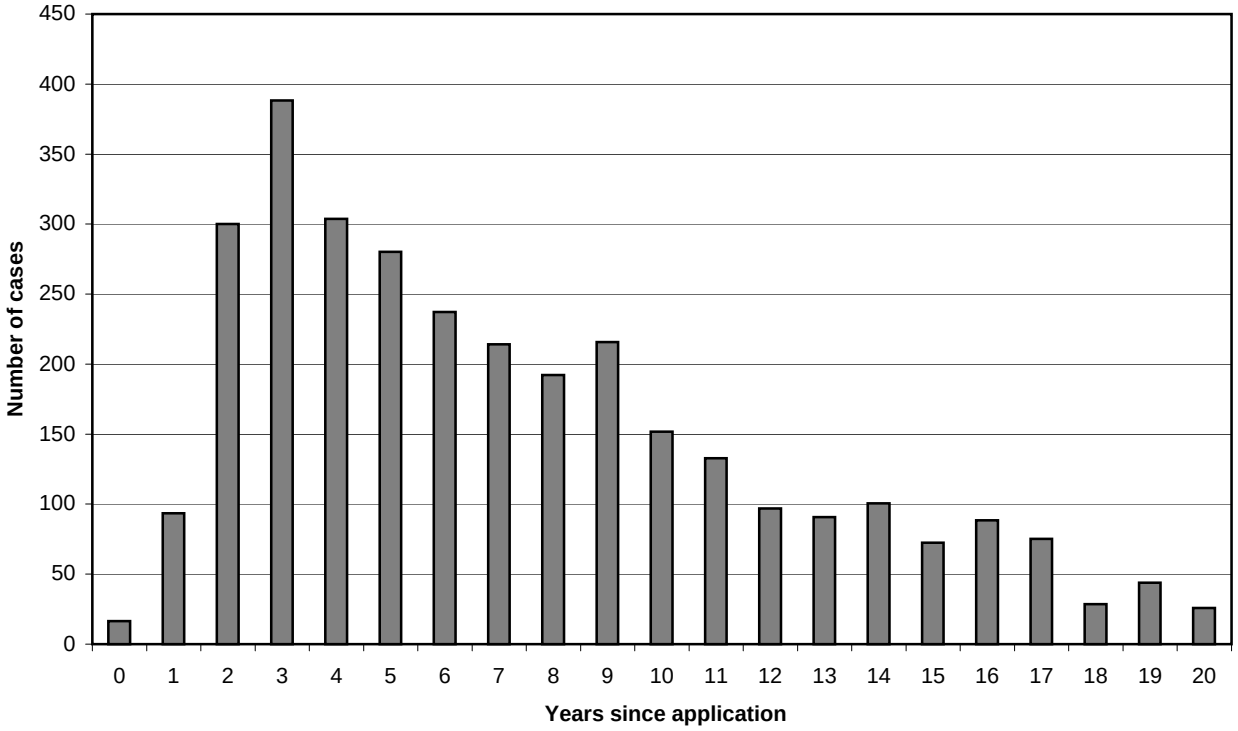


**Figure 4**
**Lag between Application and Re-examination (adjusted)**
**USPTO 1981-2000**




**Lag between Application and Opposition**
**EPO 1978-1999**

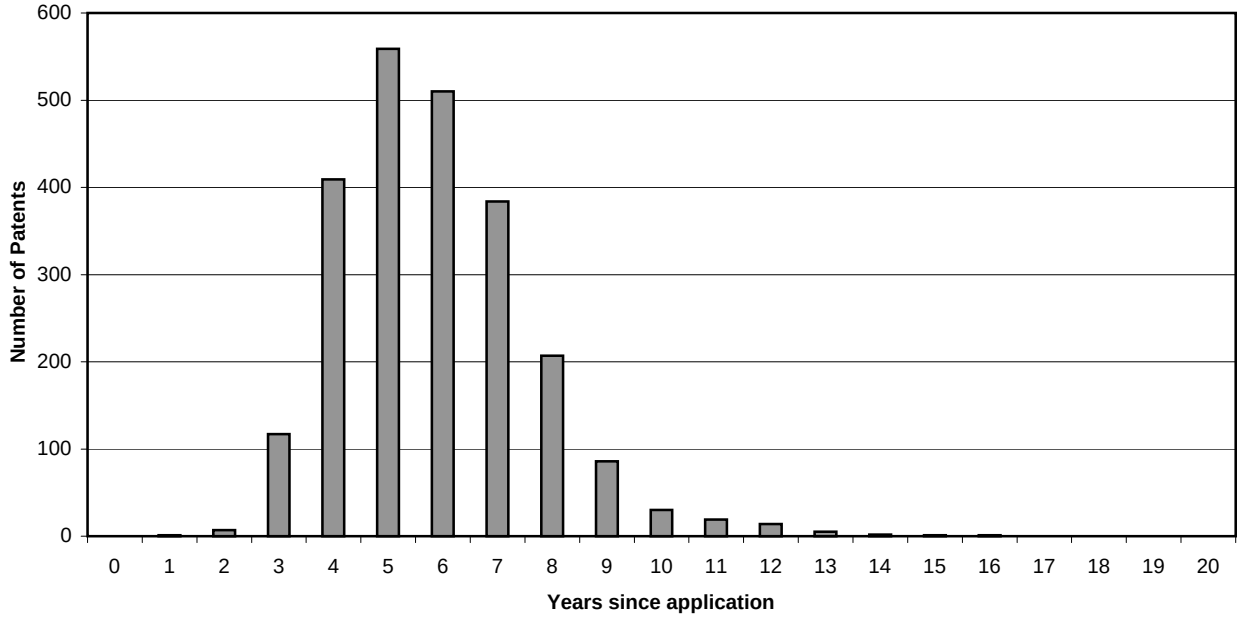
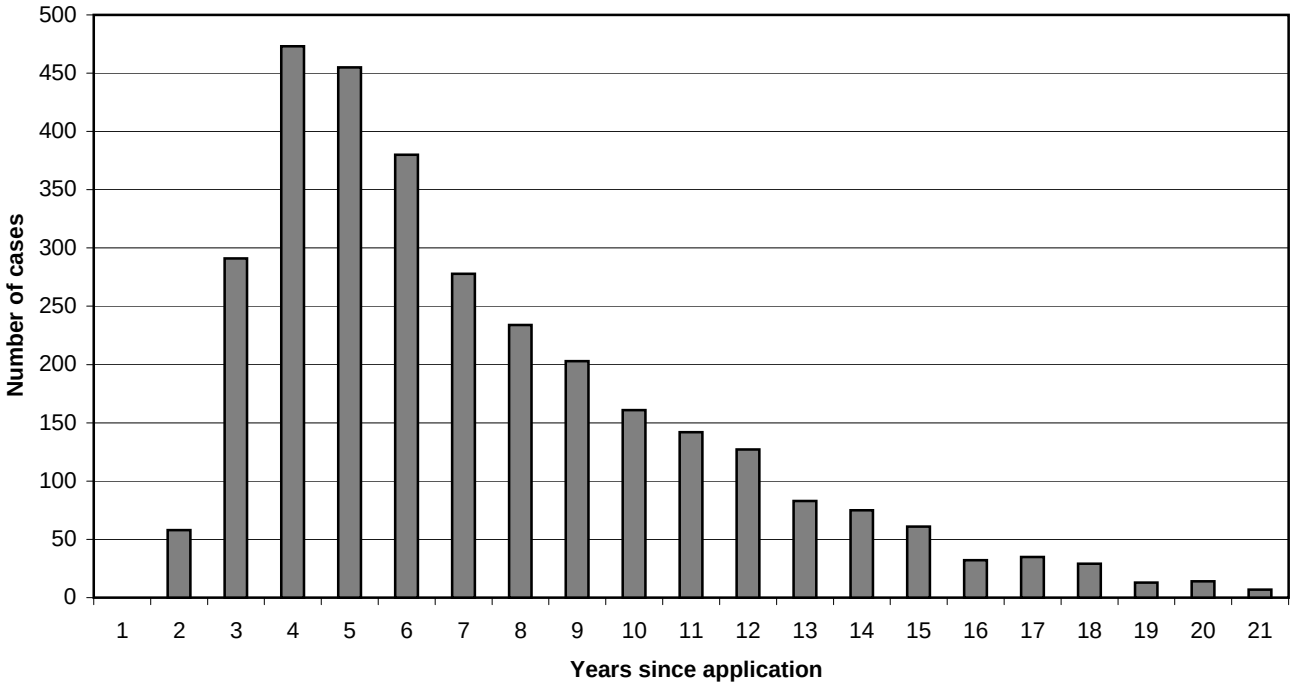


**Figure 5**
**Lag between Application and Final Re-examination Outcome**
**USPTO 1981-2000**




**Lag between Application and Final Opposition Outcome**
**Biotech/pharma/semiconductor/software classes only**
**EPO 1978-1999**

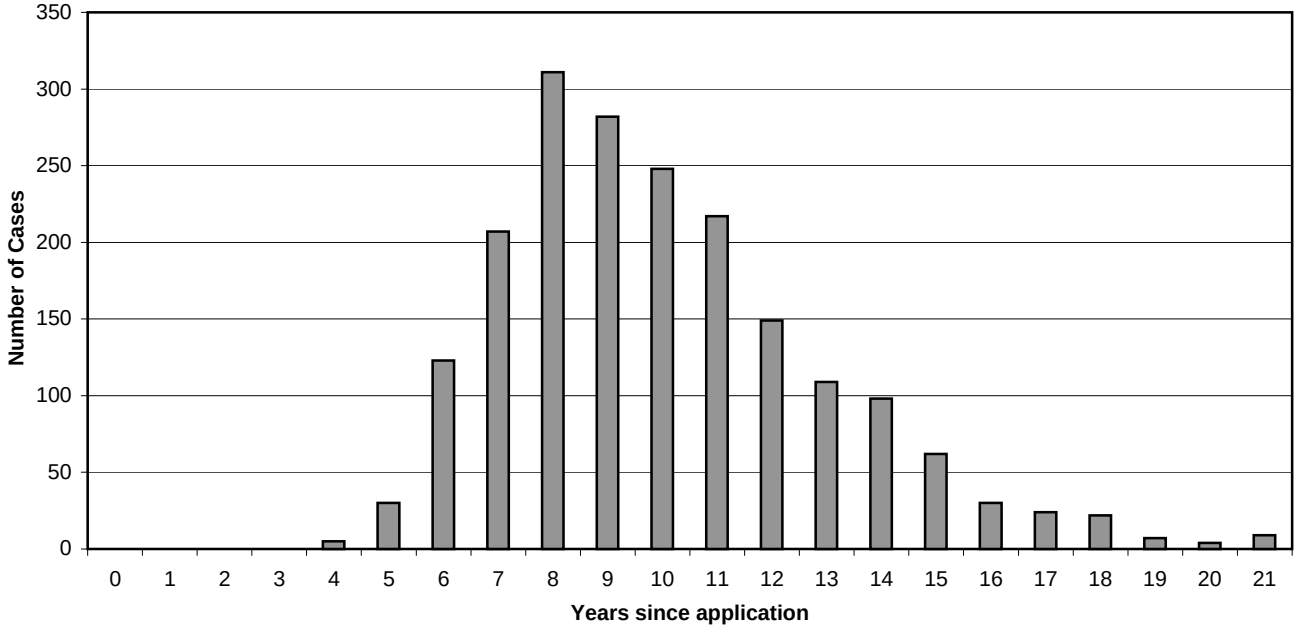
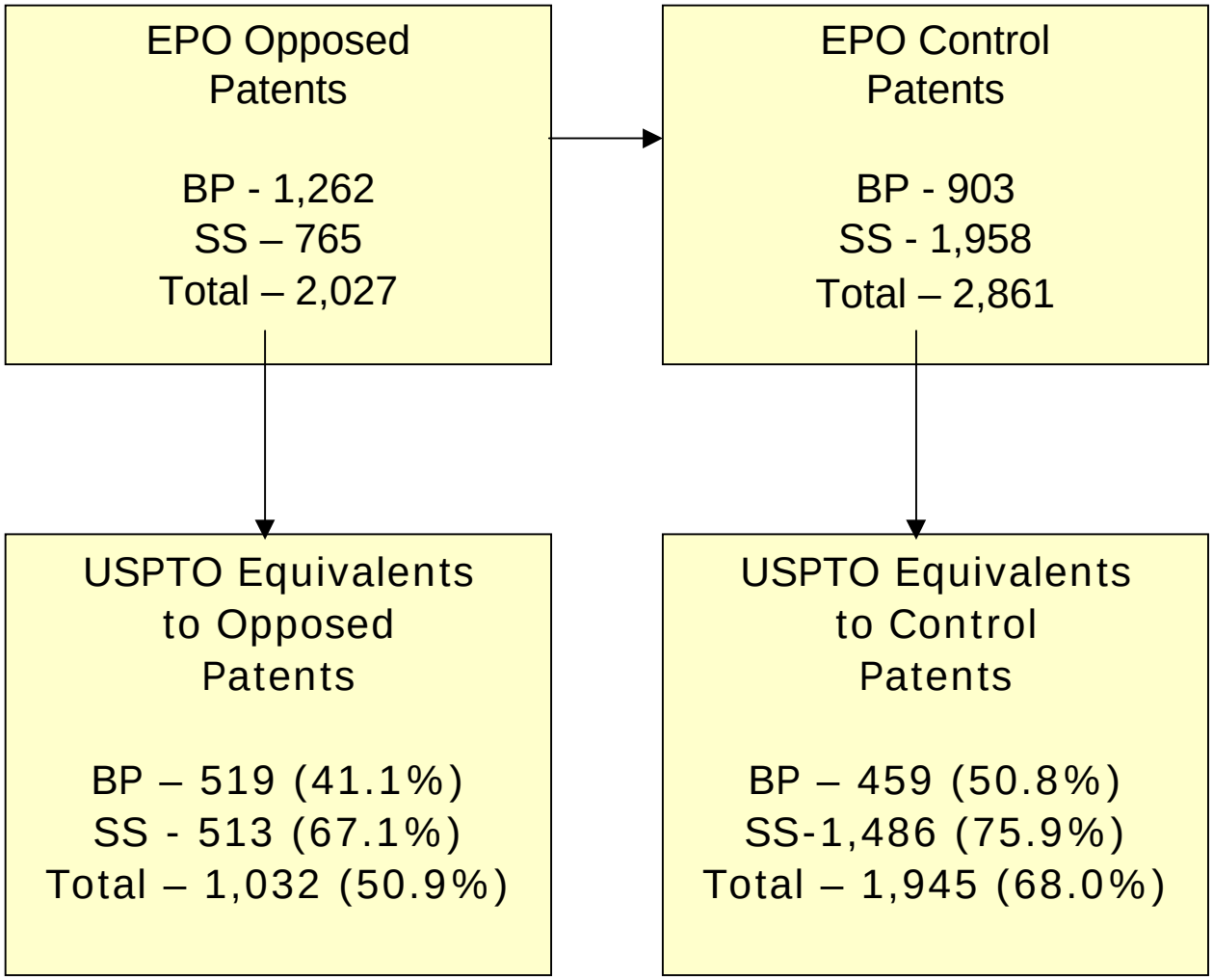


Figure 6
EPO-USPTO Twin Study
Sampling Strategy




BP = biotechnology/pharmaceuticals
SS = semiconductors/software/computers