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Evidence from Opposition

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Evidence from Opposition Filings

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Abstract

This paper describes and analyzes the occurrence and extent of oppositions initiated against plant biotechnology patents granted by the European Patent Office (EPO). The opposition mechanism is a legal procedure that allows any third party to challenge the validity of patents awarded by the EPO. Results indicate that the opposition rate is far greater in plant biotechnology than in other emerging industries. Consistent with theoretical predictions, the empirical findings suggest that opposed patents are disproportionately those that score high on features that proxy for their “value” or “quality”. In contrast to previous findings, however, the results show that large-volume applicants are more likely to be opposed. Because the boundaries of plant biotech patents are ill-defined, large patent portfolios do not promote cooperative behavior such as licensing or settlements. The analysis rejects the hypothesis that awardees are subject to “nuisance” or “frivolous” oppositions. Instead, the opposition procedure serves as an error correction mechanism.

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1. Introduction

Genetic engineering of plants has a wide array of applications ranging from resistant crops to pharmaceutical products and alternative sources of energy. Despite the claimed benefits of genetic engineering, it is a highly contentious issue subject to stringent regulation. Public policies have fundamentally altered the conditions under which innovations are patented and pursued. The competitive and regulatory environment of plant biotechnology provides therefore an opportunity to analyze the management of innovation and rivalry between firms in this nascent technology.

This paper analyzes the occurrence and extent of oppositions initiated against plant biotechnology patents granted by the European Patent Office (EPO). The opposition mechanism is a legal procedure that allows any third party to challenge the validity of patents awarded by the EPO. Previous literature shows that the breadth of patent protection in plant biotechnology is characterized by high levels of uncertainty (Graff et al., 2003). The opposition mechanism is therefore crucial to determine the boundaries of patent awards.

The paper discusses patent oppositions in plant biotechnology within the framework of theoretical models of legal dispute. The paper shows that the opposition rate is far greater in plant biotechnologies than in other emerging industries. Consistent with theoretical predictions, the empirical findings show that opposed patents are disproportionately those whose proxy variables for "value" or "quality" are high. However, in contrast to previous findings, results show that large-volume applicants are more likely to be opposed. Because the boundaries of plant biotech patents are ill-defined, large applicants resort to legal actions against technological rivals as an alternative to cooperative solutions such as licensing or settlements. Finally, the paper examines the possibility that awardees are subject to "nuisance" or "frivolous" oppositions and reject this hypothesis.

Instead, the opposition procedure serves as a correction mechanism of errors made in the examination process.

The paper is organized as follows. Section 2 gives a short overview of the plant biotechnology industry structure. Section 3 presents the application and opposition procedures at the EPO. Section 4 reviews the relevant literature and discusses the predictions from the theoretical literature. Section 5 describes the construction of the dataset. Section 6 carries out the empirical analysis and Section 7 concludes.

2. Industry structure and patenting activity in Plant Biotechnology

The structure of the plant biotechnology sector is characterized by two trends. First, it is a heavily concentrated industry. A large number of mergers and acquisitions since the 1990's have resulted in few multi-national companies dominating the market, abusive business practices and a decline of entry by new firms (Brennan et al., 2000; Harhoff et al. 2001).

Second, it is a heavily regulated industry. Because of consumers' opposition to genetically-modified (GM) foods and fear of environmental hazards, governments exercise regulatory oversight of new varieties of genetically engineered crops and in some cases even banned the cultivation of new GM crops.

Innovation in plant biotechnology often requires the input of several first-generation "research tools" and the range of technologies necessary to bring a new product to the market is usually controlled by several firms. Therefore, an innovator may have to acquire a disparate set of outside technologies to bring a new product to the market by negotiating licenses with several parties.

However, bargaining may break down, putting the second generation product in jeopardy (Heller and Eisenberg, 1998).

Ziedonis (2004) shows that in the U.S. semi-conductor industry, firms tend to patent more aggressively when the ownership rights to outside technologies are widely distributed among different organizations. Because these firms are concerned about "hold-up", the strategic value of patents for use in ex-post bargaining and licensing agreements increases. In addition, Hall and Ziedonis (2001) observe that the semi-conductor industry has witnessed a substantial vertical disintegration as stronger U.S. patent rights have stimulated entry by specialized firms.

Although patenting in the plant biotechnology sector also requires access to complementary intellectual assets, the industry has witnessed a comprehensive consolidation through mergers and acquisitions (M&As). Why did the market respond differently in plant biotech than in e.g. the semi-conductor industry? Graff et al. (2003) argue that patents in the plant biotech sector are often uncertain and ill-defined. It seems to be difficult for Patent Offices (PTOs) to define the scope and boundaries of these patents in a reliable way. Therefore licensing agreements will be inhibited, because coordinating uncertain property rights raises transaction costs and makes contracting over patent rights less desirable.

Graff et al. (2003) argue that the reorganization of the industry can be explained by the desire to exploit complementary intellectual assets owned by different parties. M&As may have avoided situations in which two parties hold mutually blocking technologies. Marco and Rausser (2008) show that patent statistics can effectively predict the timing of M&A in plant biotech. The literature points to the fact that plant biotech firms tend to exploit the complementarities between intellectual assets internally, through M&As, whereas in other industries, such as the semi-conductor, firms tend to exploit them externally through licensing or bargaining.

3. Application and opposition procedures at the EPO

The EPO was founded in 1978 as the result of the European Patent Convention (EPC). Within this framework, a single and centralized application is made, designating the signatory states of the EPC in which protection is sought for by the applicant. Therefore, a patent provides the applicant with protection in all the designated states. If patent protection is sought for in more than three EPC countries, an EPO patent application is less costly than direct applications in each national patent office. If a European patent is granted, competence is transferred to the designated contracting states, where the patent affords the same level of legal protection as a national patent and is valid for 20 years from the date of filling, if it is consecutively renewed.

Once a patent is granted by the EPO, the applicant has to enforce it in each state designated in the application, according to the national legislations. However, the opposition procedure at the EPO allows any third party to challenge the validity of a patent centrally within nine months after the announcement of the grant. An opposition may only be filed on grounds relating to the patentability of the invention (EPC art. 100). The plaintiff will have to demonstrate that the opposed patent lacks novelty, does not involve an inventive step, does not have an industrial application or that disclosure is insufficient. More details on the opposition procedure are provided in Harhoff (2005).

Because patents in plant biotechnology are poorly defined, opposition proceedings are an important institutional mechanism to delineate the boundaries of patents.

4. Theoretical background

This Section discusses the hypotheses pertaining to the empirical analysis

4.1. Modeling patent oppositions

The economic analysis of legal disputes predicts that the occurrence and outcome of a lawsuit will be a function of expected payoffs (Priest and Klein, 1984). Four factors were found to increase the probability of a legal dispute taking place (Cooter and Rubinfeld, 1989): The likelihood that the offence is detected by a potential plaintiff; Asymmetric expectations or diverging expectations between the parties about the outcome of the lawsuit (i.e. higher uncertainty); The size of the stakes under dispute; The cost of settlement relative to the cost of trial.

These considerations were taken forward to the case of patent litigation in the U.S. (Lanjouw and Schankerman, 2001, 2004a; Lerner, 2008) and patent opposition at the EPO (Harhoff and Reitzig, 2004). Based on the four factors enumerated before, we would expect the likelihood of opposition to increase in the following situations: First, the extent to which low legal quality is detected may be a function of the characteristics of the patent. Examiners at the EPO are in charge of searching prior art and classify them into different categories according to their relevance. Therefore, the classification of references in "critical" categories may attract the attention of plaintiffs (Harhoff and Reitzig, 2004).

Second, Gans et al. (2008) show that longer reviews at the patent office create uncertainty. Therefore the grant lag (the number of years the application was under review at the EPO) may be positively associated with the likelihood of opposition, as it exacerbates uncertainty and reflects the complexity of the subject matter (Harhoff and Reitzig, 2004).

Third, the size of the stakes or the value of patents can be captured by several proxies identified in the literature, such as forward citations (Trajtenberg, 1990), backward citations (Harhoff et al., 2003), the family size of the patent (Lanjouw et al., 1998) or the number of claims (Lanjouw and Schankerman, 2004b).

Fourth, the cost of settlement relative to that of trial can be proxied by the identity of the patentee, as differences are likely to arise between corporate patentees and individuals or small firms (Lanjouw and Schankerman, 2001, 2004a).

Moreover, Lanjouw and Schankerman (2004a) and Harhoff and Reitzig (2004) show that prolific patentees hold potential advantages in legal disputes. First, large patent portfolios make cooperative solutions such as licensing or cross-licensing an alternative option to opposition by allowing patentees to trade their intellectual assets. Second, patentees with large portfolios are likely to be involved in repeated interactions, which will make settlement solutions more desirable. Third, any patent part of a larger portfolio will only have a marginal impact both on the defendant and the plaintiff's payoffs if it is revoked (or narrowed down). Consequently, a cooperative outcome is more likely.

4.2 Strategic oppositions

Alternative models of legal disputes discuss situations in which a potential plaintiff might file a suit that has a negative expected value (Bebchuk, 1988; P'ng, 1983; Rosenberg and Shavell, 1985). These models of "nuisance", "frivolous" or "sham" litigation imply that legal disputes are used by plaintiffs to attain strategic objectives such as the extraction of a settlement offer. Plaintiffs might therefore bring opposition cases for strategic reasons, such as deterrence of future entry, or to establish a reputation for toughness (Harhoff, 2005).

If this behavior is prevalent in the Plant Biotech sector, then we should observe high shares of judgments in favor of the defendant in opposition cases.

5. Data and descriptive statistics

5.1. Construction of the sample

Patents: The "Espace Bulletin" database provided by the EPO contains procedural information for all patent applications. The empirical analysis uses all patents awarded between 1978 through 2007. Plant biotechnology patent awards were selected according to the International Patent Classification (IPC) and European Classification (ECLA) systems.[1] The dataset contains the main features of the patent awards and information on the occurrence of opposition.

Claims: The number of claims for each patent award is available on the EPO's online search engine.[2]

Citations: The "EPO/OECD Patent Citation Database" contains all references from the EPO search reports, for patents applied for in the period 1978 through 2006 (see Webb et al., 2005). The empirical analysis uses the forward and backward citations for each patent.

Identification of applicants: Patentees were identified manually, using various online sources,[3] and the patents were classified into different categories, according to the type of organization listed as the applicant.

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[1] Patents were selected if their ECLA code is: C12N15/82C "Phenotypically and genetically modified plants via recombinant DNA technology"

[2] http://ep.espacenet.com/

[3] Amadeus and Orbis were the main data sources. If the organization was not found in these databases, I consulted their website.

5.2. Variables

Number of claims. The application contains a set of claims delineating the boundaries of the patent by describing the precise features of the invention. Empirical evidence shows that the number of claims is correlated with the value of a patented invention.

Number of backward citations. The search report published by the EPO contains a list of prior art relevant for the assessment of a patent application. Empirical evidence show that backward citations are correlated with the value of a patent (Harhoff et al., 2003), which suggests that the number of citations corresponds to the extent of patenting in a given technological area (Lanjouw and Schankerman, 2001) and therefore to the potential profitability of inventions falling into that domain. Everything else equal, patents with more backward citations should be opposed more often.

Share of X and Y backward citations. Backward citations at the EPO are classified into different categories by the examiner during the search procedure, according to their relevance for the evaluation of the patentability of the invention. Two interesting categories for the evaluation of the novelty of an invention are:

- *"Type X" citations*. References classified into this category indicate material that is potentially harmful to the novelty or inventive step requirements of the claimed invention.

- *"Type Y" citations* indicate material that is potentially harmful to the inventive step requirement of the claimed invention, when the referenced document is combined with one or more other documents of the same category, such a combination being obvious to a person skilled in the art.

The empirical analysis uses the sum of X and Y citations, relative to the total number of backward citations. This measure is (inversely) correlated with the degree of novelty and/or inventive step of the claimed invention and a high share of those critical references is therefore likely to attract the attention of potential plaintiffs (Harhoff and Reitzig, 2004).

The Number of forward citations is defined as the number of citations received by a focal patent from any subsequent patent application and measures the “importance”, the “quality” or the “significance” of a patented invention. Previous studies show that forward citations are highly correlated with the social value of the patented invention (Trajtenberg, 1990, for the computer tomography industry) and with its private value (Harhoff et al., 1999, Hall et al., 2005). Furthermore, forward citations reflect the economic and technological “importance” as perceived by the inventors themselves (Jaffe et al., 2000) and knowledgeable peers in the technology field (Albert et al., 1991).

The likelihood of opposition is expected to increase with the economic and technological importance of a given patent, as the size of the stakes increase for both parties.

Number of designated states. EPO applicants have to specify the states member of the European Patent Convention (EPC) in which protection is sought for. Harhoff et al. (2003) and Lanjouw et al. (1998) show that the size of the target market is correlated with the value of the patent.

The grant lag (in years) measures the time elapsed between the dates of application and grant of a focal patent. The duration of the examination procedure is, among other things, influenced by the complexity of the invention and the intensity of negotiations between the examiner and the applicant (Harhoff and Wagner, 2005). Therefore, the probability of opposition is expected to increase with the grant lag, because longer pendencies will lead to higher levels of uncertainty (Gans et al., 2008).

Patent scope is defined as the number of non-identical international patent classes (IPC), at the 4-digit level, assigned to the patent. Lerner (1994) suggests that the broader a patent, the more potential opponents it may have. However, Harhoff and Reitzig (2004) find that the likelihood of opposition decreases with the number of IPC assignments. They argue that broader patents are more general and have less immediate relevance for market outcomes.

The Portfolio size is the count of patent awarded to each firm. The measure follows Lanjouw and Schankerman (2004a) who define the relevant portfolio as the number of patents awarded to the applicant within five years in either direction of the application year of the focal patent. All estimations presented in the paper are robust to alternative specification of the patent portfolio size.

Ownership. Awardees are classified into five categories: large firms (with more than 1000 employees), small firms (less than 1000 employees), universities and public research institutes (PRIs), public-private partnerships (i.e. involving a university and a corporation) and others (mainly individuals).

Grant years. Finally, dummies for grant year intervals control for any remaining unobserved fluctuation over time.

5.3. Descriptive statistics

5.3.1. Major trends

Figure 1 shows that the number of plant biotechnology patents exhibits a rapid growth through 2000. In 1999, the European Union (EU) member States agreed to suspend the approval of new GM crops, which curbed the inflow of patent fillings from 2000 onwards.

Figure 1: Number of plant biotech applications and awards

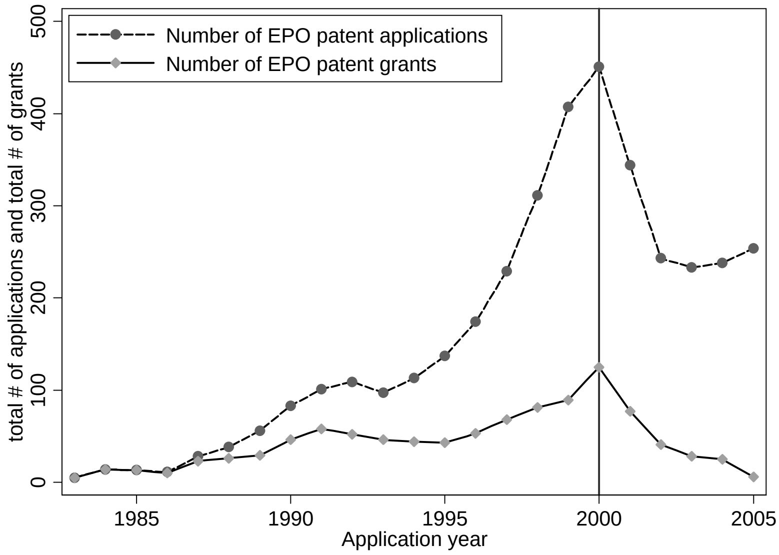
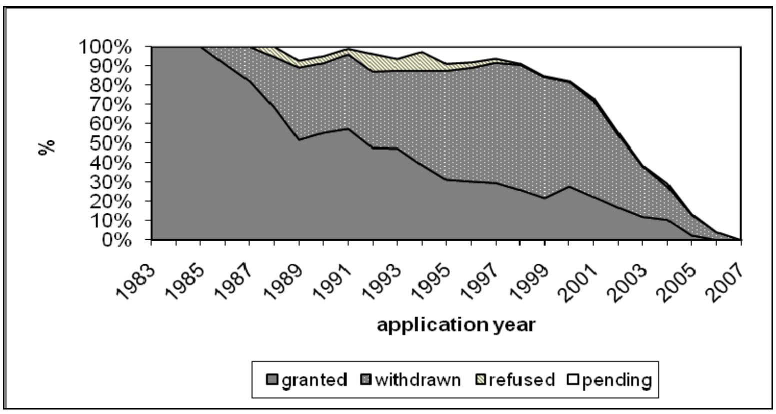


Figure 2 shows that the grant rate of plant biotech patents has been declining steadily over time, while the number of applications still under review at the EPO by 2008 increased substantially. Figure 2 also shows that decisions for some applications filled in the beginning of the 1990's are currently still pending, while the overall grant rate is indeed much smaller than for patents as a whole (Harhoff and Wagner, 2005). These trends reflect the uncertainty that characterizes plant biotech patents, arising from the difficulty of assessing the novelty of an invention and of establishing the appropriate state of the art.

Figure 2: Outcome of patent applications



5.3.2. Summary statistics

Table 1 provides an overview of the patents included in the sample. Several patterns emerge.

While the average application was filed in the middle of the period under review, patent awards are concentrated in the second half of the sample with the mean grant year in 2002. This reflects the long decision lags faced by applicants. The average grant lag (6.7 years) is indeed much higer than in other emerging technologies such as biotechnology and pharmaceuticals (4.8 years, see Harhoff and Reitzig, 2004) or financial methods (4.9 years, see Hall et al., 2009). On the other hand, opposed patents are concentrated in the first half of the sample, with the average application year in 1991, suggesting that early awards were more likely to be opposed.

Plant biotech patents score very high on all features that proxy for their “value” or “quality”, compared to e.g. biotechnologies (Harhoff and Reitzig, 2004). They are heavily cited by and citing other patents and they are broader as they appear to be more expansive both in the number of claims and the number of IPC assignments.

Plant biotech patents are opposed at a rate almost twice as high than patents as a whole. While most patents are not opposed, few of them are extensively so. One patent was attacked simulteanously by ten different organizations.

Universities, PRIs and government intitutes own a larger fraction of patents in plant biotech than in any of the other industries mentioned before, confirming that basic science played a critical role in the birth of the industry.

Table 1: Summary statistics

	All patents				Opposed patents		Non-opposed patents	
Variable	Mean	S.D.	Min.	Max.	Mean	S.D.	Mean	S.D.
Patent characteristics								
Application year	1995.341	4.891	1983	2005	1991.276	4.992	1995.848	4.638
Grant year	2002.085	4.878	1986	2007	1998.143	5.400	2002.576	4.581
Opposition	0.111	0.314	0	1				
# plaintiffs/opposition	0.216	0.856	0	10	1.949	1.807		
# designated states	15.521	5.042	1	28	13.520	3.896	15.770	5.114
# claims	20.145	14.339	1	128	22.582	16.849	19.841	13.978
# backward citations	3.012	2.632	0	18	3.316	2.787	2.975	2.612
# Backward citations/claim	0.228	0.322	0	5	0.257	0.527	0.225	0.286
# Forward citations	3.643	4.720	0	30	7.469	7.036	3.166	4.111
# Forward citations/claim	0.247	0.361	0	2.5	0.462	0.488	0.220	0.333
Share of X & Y citations	0.396	0.405	0	1	0.366	0.384	0.399	0.407
Grant lag	6.744	2.580	2	17	6.867	2.431	6.728	2.599
Number of IPC4 assignments	2.334	0.989	1	6	2.184	0.912	2.353	0.997
Applicant characteristics								
Portfolio size	18.394	19.481	1	66	20.316	17.538	18.155	19.706
Large firm (>1000 employees)	0.572	0.495	0	1	0.745	0.438	0.550	0.498
Small firm (<1000 employees)	0.141	0.348	0	1	0.112	0.317	0.145	0.352
University/PRI	0.150	0.358	0	1	0.051	0.221	0.163	0.369
Public-private partnership	0.044	0.205	0	1	0.031	0.173	0.046	0.209
Others	0.093	0.290	0	1	0.061	0.241	0.097	0.296
Number of observations	885				98		787	

Table 2 reports the opposition rate (the number of opposed patents relative to the total number of patents) for different types of assignee. There are striking differences with the results found for opposition or litigation in other sectors. Contrary to these previous results, it is the patents owned by large firms - and not by small firms or individual - that have the highest likelihood of being legally attacked. On the other hand, university and PRIs patents have the lowest opposition rate, confirming the more basic nature of their inventions.

Table 2: Opposition rate by type of assignee

Type of assignee	*Opposition rate*
Large firms	14.40%
Small firms	8.80%
University/PRI	3.73%
Public-private partnership	7.69%
Others	7.23%

6. Empirical analysis

This Section presents estimation results of probability models to explain the occurrence of patent oppositions in the plant biotech industry. These estimations employ two alternative dependent variables. The first one is a dummy variable that takes on the value one if the focal patent was opposed within nine months after the date of the award, the legal deadline to file an opposition. The second variable is a count of the number of oppositions that were filed against a focal patent. All regressions include the controls suggested by the theoretical literature outlined earlier.

The empirical analysis employs three different approaches. First, Table 3 features a probit model on the likelihood of opposition.

Second, Table 4 displays Poisson Quasi-Maximum Likelihood estimates (QMLE) with the number of plaintiffs as dependent variable.

Third, Table 5 reports the result of a "zero-altered" (or "zero-inflated") Poisson model to account for the prevalence of zero counts in the data (Greene, 2008). This model assumes that there are two latent groups of patents. The first group has an outcome of zero oppositions with probability one, whereas patents in the second group have a nonzero probability to have a positive count of oppositions. The regime-splitting mechanism is estimated with a probit model that indicates the likelihood of being in the group of patents that are never opposed, whereas the conditional count variable is assumed to follow a Poisson distribution.

In each Table, the columns labeled (1) contain the patent related variables and the columns labeled (2) add dummies for each type of organization.

Consistently with theoretical predictions and previous empirical findings, "important" patents as proxied by the number of claims and the number of forward citations are more likely to be opposed and more extensively so.

The number of backward citations is only marginally significant on both the probability and the intensity of opposition. In the same vein, the share of critical references (X and Y citations) does not appear to have any effect on either the occurrence or the extent of oppositions. This is consistent with the view that prior art in plant biotech is difficult to assess leading to patents with unclear boundaries.

The grant lag appears to be an important determinant of opposition. Decision lags are influenced by the complexity of subject matters and the length of negotiations between applicants and examiners. Longer pendencies therefore exacerbate the uncertainty surrounding patent rights.

The number of IPC assignments negatively affects the number of oppositions filed against a patent. This result indicates that it is more difficult for a potential plaintiff to detect opposable patents when the claimed invention is assigned to diverse technology areas.

Surprisingly, the number of EPO countries in which protection is sought for has no impact on the likelihood of opposition. In earlier studies this variable was yet found to be highly correlated with the private value of patents and therefore to be a major driver of patent oppositions. A potential explanation is that the plant biotech industry faces a disparate set of national legislations within the EPO member states, with some countries having stringent restrictions on GM crops, while others have more liberal legislations. This is consistent with the view that regulation affects entry strategies into geographical markets (Kyle, 2007). The number of countries designated in the application is therefore a noisy signal and is unlikely to be an accurate proxy of the private value of patents in the plant biotech case.

Earlier findings point to the fact that small firms and firms with small patent portfolios might be at a comparative disadvantage in protecting their intellectual assets as their patents were found to be disproportionately involved in legal actions. The results presented here paint a different story. First, patents parts of large portfolios are more likely to be opposed and face more legal attacks. Second, there is no statistical difference between large firms, small firms, and the residual category of assignees in the likelihood and extent of opposition.

The literature shows that large patent portfolios confer an advantage to their owners as cooperative solutions such as licensing, trading patents or settlements outside of court are alternatives to legal suits. Because individual patents are highly complementary and because the boundaries of patents are ill-defined, this conjecture does not hold in the Plant Biotech industry. The results show that potential plaintiffs are more likely to resort to legal actions against prolific patentees as opposed to cooperative solutions.

Table 3: estimation results (1) – Probit model of patent opposition

	(1) Probit				(2) Probit			
	Coef.		S.E.	dF/dX	Coef.		S.E.	dF/dX
Patent characteristics:								
log # claims	0.522	***	0.135	0.073	0.535	***	0.137	0.072
log # forward citations per claim	1.332	***	0.345	0.187	1.366	***	0.350	0.184
# Forward citations=0	0.219		0.185	0.033	0.214		0.187	0.031
log # backward citations per claim	0.763	*	0.425	0.107	0.733	*	0.431	0.099
# Backward citations=0	-0.271		0.234	-0.033	-0.223		0.236	-0.027
Share of X & Y citations	-0.046		0.171	-0.006	-0.014		0.174	-0.002
log # designated states	-0.173		0.153	-0.024	-0.170		0.157	-0.023
log # IPC assignments	-0.193		0.152	-0.027	-0.216		0.154	-0.029
log grant lag	0.352	*	0.196	0.049	0.359	*	0.198	0.048
log portfolio size	0.104	**	0.050	0.015	0.096	*	0.053	0.013
Type of organization (base: university/PRI)								
Small firm					0.610	**	0.295	0.112
Large firm					0.488	*	0.267	0.063
Public-private partnership					0.116		0.405	0.017
Other					0.661	**	0.328	0.129
Year dummies - test of joint significance	$\chi2(6)=36.45$***				$\chi2(6)=35.51$***			
Constant	-3.809	***	0.696		-4.317	***	0.741	
Number of observations	885							

Note: ***(**,*) indicate a significance level of 1% (5%, 10%).

Table 4: estimation results (2) - Number of opposition fillings per patent

	(1)				(2)			
	Poisson QMLE				Poisson QMLE			
	Coef.		S.E.	dF/dX	Coef.		S.E.	dF/dX
Patent characteristics:								
log # claims	0.835	***	0.219	0.180	0.814	***	0.210	0.176
log # forward citations per claim	1.755	***	0.404	0.379	1.657	***	0.412	0.358
# Forward citations=0	0.088		0.306	0.019	0.111		0.298	0.024
log # backward citations per claim	1.569	*	0.835	0.339	1.474	*	0.829	0.318
# Backward citations=0	-0.546		0.404	-0.118	-0.472		0.363	-0.102
Share of X & Y citations	0.049		0.327	0.011	0.139		0.334	0.030
log # designated states	-0.349		0.380	-0.075	-0.369		0.373	-0.080
log # IPC assignments	-0.575	**	0.265	-0.124	-0.637	***	0.263	-0.138
log grant lag	0.686	**	0.346	0.148	0.774	**	0.352	0.167
log portfolio size	0.364	***	0.118	0.079	0.344	***	0.141	0.074
Type of organization (base: university/PRI)								
Small firm					1.184	**	0.547	0.255
Large firm					1.040	**	0.498	0.224
Public-private partnership					-0.512		0.789	-0.110
Other					1.076	*	0.617	0.232
Year dummies - test of joint significance	$\chi2(6)$=41.71***				$\chi2(6)$=42.00***			
Constant	-6.752	***	1.369		-7.691	***	1.321	
Number of observations	885							

Note: ***(**,*) indicate a significance level of 1% (5%, 10%).

Table 5: estimation results (3) - Number of opposition fillings per patent

	(1)							(2)						
	Zero-inflated Poisson							Zero-inflated Poisson						
	Probit			Poisson QMLE			dF/dX	Probit			Poisson QMLE			dF/dX
	Coef.		S.E.	Coef.		S.E.		Coef.		S.E.	Coef.		S.E.	
log # claims	-0.642	***	0.237	0.509	**	0.206	0.222	-0.614	**	0.272	0.613	***	0.215	0.226
log # forward citations per claim	-3.948	***	1.049	-0.567		0.441	0.564	-4.956	***	1.148	-0.671	*	0.421	0.616
# Forward citations=0	-1.263	***	0.469	-0.882	**	0.356	0.028	-1.544	***	0.548	-0.872	**	0.378	0.049
log # backward citations per claim	-2.199	**	1.123	0.650		0.576	0.524	-2.246	*	1.232	0.963	*	0.619	0.552
# Backward citations=0	-0.355		0.494	-0.800	*	0.429	-0.112	-0.818		0.568	-0.991	**	0.402	-0.088
Share of X & Y citations	0.632	**	0.323	0.359		0.276	-0.032	0.588	*	0.360	0.356		0.283	-0.013
log # designated states	0.076		0.295	-0.422		0.287	-0.105	0.065		0.315	-0.398		0.294	-0.096
log # IPC assignments	-0.670	**	0.322	-1.354	***	0.250	-0.177	-0.938	**	0.404	-1.518	***	0.256	-0.183
log grant lag	-0.366		0.381	0.173		0.410	0.101	-0.306		0.402	0.253		0.381	0.102
log portfolio size	-0.054		0.120	0.238	**	0.109	0.061	0.173		0.174	0.356	***	0.137	0.050
Small firm								-0.675		0.668	0.704		0.712	0.255
Large firm								-1.534	**	0.689	-0.103		0.655	0.213
Public-private partnership								-2.187	*	1.176	-1.813	*	1.061	-0.055
Other								-0.957		0.787	0.409		0.852	0.235
Year dummies - test of joint significance	$\chi2(6)$=14.42**			$\chi2(6)$=39.77***				$\chi2(6)$=14.16**			$\chi2(6)$=50.70***			
Constant	3.371	**	1.441	-2.626	*	1.358		4.451	***	1.578	-3.265	**	1.490	
Number of observations							885 (zero observations: 787)							

Note: ***(**,*) indicate a significance level of 1% (5%, 10%).

An alternative explanation is that large volume applicants may find opposition of their patents more costly than do early-stage patentees, possibly because of the risks of damage to their reputation or to other lines of business (Lerner, 2008). In that event, prolific applicants may be subject to nuisance or frivolous oppositions and targeted by early-stage patentees with lower opposition costs. The following analysis explores this possibility.

A first possibility is that large-volume applicants are targeted by smaller entities. Table 6 reports the five most frequently represented firms in the sample along three dimensions: their number of patents, the number of their patents that were opposed and the number of opposition proceedings in which they are defendants. Strikingly, the same names appear in each category, suggesting that the opposition procedure is a game between the largest patentees in the industry. This result is in stark contrast with the findings in other industries. For example, Lerner (2008) shows that in the US, the most frequent financial patentees are ICT companies, while litigators are dominated by patent holding companies and litigated patents are disproportionately those of established financial institutions.

Table 6: Most frequently represented assignees

	Patentees	*# patents*	*Plaintiffs*	*# patents*	*Defendants*	*# patents*
1.	Bayer	88	Bayer	20	Syngenta	31
2.	Syngenta	85	Syngenta	20	Bayer	30
3.	Pioneer Hi-Bred	76	Monsanto	16	Monsanto	27
4.	Monsanto	64	BASF	14	BASF	13
5.	Calgene[4]	41	Mogene	9	Calgene	13
			Pioneer Hi-Bred	9		

A second possibility is that large-volume applicants are subject to nuisance or frivolous opposition. Table 7 summarizes the frequency of the various outcomes of the opposition proceedings. If frivolous opposition is a common practice, then the EPO should reject most of these opposition fillings. Table 7 shows that this is not the case. Although the high share of cases that are still pending precludes definitive conclusions, these figures are still informative. More than half of the opposition fillings result in either an amendment or a revocation of the patent. The distribution of opposition outcomes contrasts with the aggregated trend, since each outcome represents roughly one third of all decisions in opposition proceedings at the EPO (excluding pending cases, see Harhoff, 2005). Because of the large share of amended and revoked patents, opposition fillings in plant biotech seem to act as an important correction mechanism of errors from examination decisions, rather than being a strategic tool.

[4] Calgene was acquired by Monsanto in 1996.

Table 7: outcome of opposition proceedings

Outcome	*Frequence*	*Percent*
Opposition rejected	12	12.24%
Patent amended	25	25.51%
Patent revoked	30	30.61%
Opposition terminated	6	6.12%
Still pending	25	25.51%
Total	98	100%

7. Conclusion

This paper analyzes the occurrence and extent of oppositions initiated against plant biotechnology patents granted by the European Patent Office (EPO).

Results show that the opposition rate is far greater in plant biotechnology than in other emerging industries and that opposed patents are disproportionately those that score high on features that proxy for their “value” or “quality”. This finding is consistent with theoretical predictions from the literature on legal disputes and with earlier results from the literature on patent litigation and opposition.

However, contrary to previous results, the paper shows that the various types of assignees face the same likelihood of opposition (compared to universities). Instead, the size of the patent portfolio has a larger impact both on the likelihood and the intensity of opposition. Contrary to previous findings, large portfolios do not promote cooperative behavior, because coordinating uncertain property rights raises transaction costs and makes contracting over patent rights or settlements less desirable relative to the cost of opposition.

Finally, the paper investigates the possibility that awardees are subject to “nuisance” or “frivolous” oppositions and the analysis rejects this hypothesis. Instead, it seems that the opposition procedure serve as an error correction mechanism.

These results suggest avenues for future research. Much remains to be understood about the dynamic and reputation-building aspects of patent oppositions. Moreover, it is unclear whether the structure of the plant biotech industry and the high levels of oppositions are detrimental or favorable to innovation and social welfare.

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