Small firms, patent infringement, and innovation deterrence: Survey results for Europe

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ABSTRACT

We use the results of a 1999 survey of European SMEs with at least one patent granted between 1994 and 1997 to investigate the effect of the relative size of the infringer compared to the patent holder on the level of action taken against the infringer. We find that SMEs that face infringement by a large firm do not take legal action as far as when they face infringement by a firm of equal or smaller size. A second analysis looks at the fear of high patent defense costs on deterring investment in invention. Firms with a negative experience with defending their patents (greater damage or less able to create a credible threat of legal action) report a greater deterrence effect.

INTRODUCTION

The protection provided by a patent is only as good as the ability of the patent holder to provide a credible threat of legal action against infringement. Anecdotal and indirect empirical evidence suggests that the ability to mount a credible threat partly depends on the relative financial resources of the defendant and the plaintiff, with redress through the courts biased in favour of the financially stronger partner.

An imbalance in the resources available to firms in a patent dispute can play out in two different ways. First, a financially strong patent holder could use the courts to intimidate a financially weak infringer, for instance by requesting a costly preliminary injunction. If the infringed patent is of questionable validity, the ability to intimidate infringers could have the undesirable effect of increasing consumer costs by maintaining the monopoly rights of the patent holder. Lanjouw and Lerner's (2001) analysis of 252 patent lawsuits in the early 1990s finds that large patent holders are twice as likely as small patent holders to request a preliminary injunction. However, the patent holders were not significantly larger than the infringers. The results therefore show that a strategy of intimidation is more likely to be available to large than to small patent holders, but the results do not show that small firms are more likely to be the target of this type of intimidation.

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This paper evaluates the opposite case, when a small patent holder lacks the resources to defend its patent from infringement by a larger firm. If this is common problem, it could have serious consequences for the ability of a patent to provide an incentive for small firms to invest in innovation. One would expect that small firms that use patents as an appropriation mechanism would either be able to finance litigation internally or find other methods to protect their patents, such as through a collaborative agreement in which a larger firm can back the patent (as is common in biotechnology) or by purchasing patent insurance. However, anecdotal evidence, such as Kingston's (2001) series of interviews with small European firms, finds that many small firms cannot afford the high litigation costs necessary to defend their patents. Suggestive evidence is also available from an analysis of several thousand R&D performing manufacturing firms that responded to the first European Community Innovation Survey (Arundel, 2001). Using R&D expenditures as a measure of firm size and controlling for R&D intensity and sector effects, the study found that small firms were more likely than large firms to find secrecy to be more valuable than patents as an appropriation method for product innovations. This result suggests that small firms were less able than large firms to make effective use of patents. One possibility, which could not be explored in this data set, was that small firms had to rely more on secrecy because they lacked the ability to effectively protect their patents from infringement.

Several other innovation surveys have provided additional indirect evidence on this issue. Both Cohen et al (1999) and Cordes et al (1999) report that a higher percentage of small than large firms (or business units) cite high 'patent enforcement' or 'patent defense' costs as an important barrier to patenting. Although neither study provides direct evidence on whether or not this concern actually reduced the propensity of these firms to patent, or if the high defense costs were due to potential infringement by a larger firm, these results suggest that small firms may not patent because they do not believe that they can mount a credible threat of legal action against infringement. Lerner's (1995) study of patenting by biotechnology firms also suggests that enforcement costs could be a problem because poorly-capitalized firms are less likely to patent in technology classes where well-capitalized firms are active.

A series of recent studies have matched the US PTO's patent litigation records, based on linking patent data with the Federal Judicial Center (FJC) records of patent litigation suits, to a control group of non-litigated patents. These studies are able to follow the history of patent infringement cases that reach the court and thereby illuminate some of the factors that influence litigation.

Three of these studies find that small plaintiffs more aggressively defend their patents against infringement than large plaintiffs. Ziedonis (2002) determined the patent litigation rate among publicly-traded firms in the US semiconductor industry, which consists of mostly small design firms, 80% of which had less than 250 employees, and mostly large firms that fabricate semiconductors. The patent litigation rate among the smaller design firms was ten times higher than the rate for the larger fabricators. Lanjouw and Schankerman (2001a) report that the litigation rate for individual patent owners is 16% higher than the litigation rate for patents owned by firms. A second study by Lanjouw and Schankerman (2001b) reports that small firms are more likely than larger firms to start legal action against an infringer. However, they define a 'small' firm as having less than the median number of 5,425 employees, which means that many of these small firms are substantially larger than small and medium-sized enterprises (SMEs), which by definition have fewer than 500 employees.

The analyses of the US PTO patent litigation data identified several other important factors that influence litigation. Lanjouw and Schankerman (2001b) find that firms with a large patent portfolio are less likely to file an infringement suit, either because they have more patents to trade, or because they have developed a reputation for defending their patents. However, they find that several factors, such as the type of firm, the size of the patent portfolio, and a proxy for patent quality, influence the decision to file an infringement suit, but have no effect on the outcomes once the suit is filed. They argue that the 'threat of court action (suits) is the primary mechanism' for dealing with infringement and that a viable threat avoids additional costly litigation. Somaya (2001) looked at the effect of the stakes on the evolution of the dispute, as proxied by the value of the patent to the patent holder. Court cases went further when the stakes were higher.

Although none of the studies based on the USPTO patent litigation data evaluate the relative size of the infringer compared to the patent holder, the results generally conflict with our assumption that small firms will be less likely than large firms to pursue a patent infringment suit. However, this apparent conflict could be due to either two factors: sector effects and a major limitation with the USPTO data.

The first factor is due to well-known sectoral differences in the importance of patents as a means of appropriation (Arundel and Kabla, 1998; Cohen et al, 1999). In sectors where patents play a vital role, both small and large firms should be more willing to pursue infringement in court than firms active in sectors where patents are a relatively unimportant appropriation method. These sector effects could partly explain why Ziedonis (2002) finds much higher infringement rates among semiconductor design firms

compared to fabricator firms. Somaya (2002), in an analysis of the US PTO records for selected sectors, finds higher litigation rates among chemical and medical technology firms than among the telecom and computer equipment firms. He suggests that litigation could be less likely in sectors characterized by complex products, such as telecom and computer equipment, where infringement is solved through cross-licensing, compared to chemicals and medical technologies. Furthermore, small firms active in sectors where patents play an important role in appropriation might initiate patent litigation in order create a reputation for defending their patents. Over the long term, this could reduce their total patent defence costs.

The second factor is due to a limitation with the USPTO patent litigation records. As noted in several of the studies that use this data, the records only observe infringement actions that reach the courts. Since the costs of pursuing an infringer increases over the litigation process, with an estimated 50% of the 1 to 3 million US cost in legal fees due to late stage court hearings and trial (Somaya, 2001), a financially weak firm has a large incentive not to go to court. Consequently, many small firms could settle before filing a suit or even abandon their case. This will introduce a selection bias against such small firms in the US PTO patent litigation records.

This paper uses a new data set for Europe that solves several of the problems with previous empirical research on infringement among SMEs. The survey obtained information on both infringement outcomes before a suit was filed and on the relative size of the patent holder and the infringer. We find that the relative size of the infringer has a significant effect on how far SMEs pursue action against an infringer.

METHODOLOGY

The survey, using a one-page questionnaire, was conducted in late 1999. All Europeans SMEs (less than 500 employees) that had been a granted a USPTO patent between 1994 and 1997 were included in the survey, plus a sample of firms that had been granted an EPO patent[3].

The survey was designed to identify firms for in-depth interviews and therefore only used one mail-out of the questionnaire. This resulted in a low response rate of 15%[4], with 670

[3] Further details on the survey are available in Kingston (2001).
[4] For comparison, the study by Lanjouw and Schankerman (2001b), using the US PTO litigation records, covers 35.8% of the estimated number of litigation cases. The losses are due to the failure of the FJC

responses, of which 10 were excluded because they were incomplete or from a public sector institution and 21 were excluded because they had over 1000 employees at the time of the survey. We retained 15 firms with between 500 and 1000 employees to allow for growth between the time of the patent grant and the time of the survey. The remaining sample includes 639 firms.

We obtained data on the sector of activity of the firm from published sources or from telephoning the firm. We were unable to identify the sector at the two-digit level for 11.1% of the firms, while 70.6% were in manufacturing and 18.3% in services. Most of the service sector firms are in research-intensive areas, such as engineering, R&D services, computer and software services, business services; or are specialized suppliers to research-intensive sectors such as biotechnology, pharmaceuticals and engineering.

The questionnaire focused on infringement and asked if any of the firm's patents had been copied. Two key questions form the subject of this paper. The first key question asks if the firm took legal action in response to infringement, and if yes, how far this action went. In addition to no action, four other options were provided in the questionnaire: abandoned, pre-court settlement, trial of action, and appeal. The second key question asks about the deterrent effect on investment in innovation from a fear of heavy patent defense costs. Three response options are provided: very large, moderate, or unimportant. Additional questions asked about the severity of damage from infringement (very serious, bearable, or unimportant), whether or not the firm had any problems learning about the infringement (yes or no), and the firm's number of employees. Of note, the results could refer to patents that were granted before 1994. The interviews found that the oldest reported infringement cases began in the late 1980s.

Due to the low survey response rate, we expect that self-selection bias is likely to have influenced the sample of respondents. SMEs with commercially valuable patents and which experienced problems with infringement could have been more motivated to reply than similar SMEs that experienced little or no infringement. This outcome is supported by the fact that a high percentage of the respondents agreed to be interviewed – 86% of respondents from Germany – and approximately 50% of the respondents from other EU countries. On the other hand, self-selection bias would be mitigated by the fact that many patents are never commercialized and are of little economic value. Many of the non-respondents probably fell within this group and would have had no experience with infringement, and consequently little motivation to respond to the questionnaire. In

(Federal Judicial Center) to report litigation to the US PTO and due to a lack of information on whether or not the case concerned infringement or patent validity.

addition to respondent selection bias, there is a truncation bias because a patent granted in 1997 would have had less opportunity to be infringed than a patent granted in 1994 or earlier.

Due to the strong probability of self-selection and truncation bias, the survey cannot provide reliable point estimates of the percentage of SMEs that experience infringement. Consequently, all analyses are limited to a maximum of 448 eligible SMEs that reported infringement.

Our data set currently lacks information on the total patent portfolio of each firm, which has been shown to influence litigation (Lanjouw and Schankerman (2001b). We are currently collecting this information and will be able to include it in a revised version of this paper in the near future.

DESCRIPTIVE RESULTS

Firms from all but two of the 15 EU countries, Portugal and Luxembourg, are included among the 448 firms that reported infringement. However, 89.3% of these firms are from six countries: Germany (36.4%), the UK (18.3%), the Netherlands (12.3%), Sweden (9.2%), Italy (7.1%) and Finland (6.0%). The large majority of these firms, 87.1%, had less than 250 employees, while 12.9% had over 250 employees.

There are three possible outcomes for infringement. The respondent firm could report that the infringer was larger than itself, of equal or smaller size, or that both a larger firm and an equal/smaller firm infringed one or more of its patents. We are largely interested in copying by firms that are larger than the respondent's firm. Therefore, we combined the possible responses on the size of the infringing firm to create two options. After excluding 3.1% of the respondents who did not know the relative size of the infringer, 50.7% of the firms were infringed by a larger firm, while 49.3% only report infringement by a firm of equal or smaller size.

If SMEs have greater difficulty in protecting their patents from infringement by larger compared to smaller or equal-sized firms, we would expect the level of damage to be greater in the former case. Table 1 gives the respondents' qualitative estimates of the severity of damage by the relative size of the infringer. As expected, the level of damage is substantially greater when the infringer is larger than when the infringer is of equal size or smaller ($X^2 = 47.6$, $p < .000$). For example, 45.9% of respondents with a larger

infringer report severe damage, compared to 15.5% of respondents with an equal or smaller infringer.

Table 1. Severity of damage by the relative size of the infringer

Size of infringer	N	little	bearable	severe	
Equal or smaller firm only	214	25.4%	59.2%	15.5%	100.0%
Larger firm	220	13.6%	40.5%	45.9%	100.0%
Total	**434**	**19.4%**	**49.7%**	**30.9%**	**100.0%**

Note: totals can vary between tables due to missing values.

Table 2 provides the distribution of legal action by the size of the infringer. The difference by the size of the infringer is only of borderline statistical significance (X^2 = 8.3, p < .08), but firms that face a larger infringer are slightly more likely to take no action and less likely to reach a pre-court settlement, although they are also more likely to appeal. The latter effect is largely due to German firms, which are three times more likely to go to appeal than firms from other countries (the appeal rate is 22.7% for German firms versus 7.4% for all other firms). In contrast to firms from other countries, the appeal rate for German firms is higher, at 29.6%, when the infringer is a larger firm than the rate of 16.9% when the infringer is an equal sized or smaller firm. The higher propensity of German firms to take infringers to court could be due to the lower cost of patent litigation in Germany compared to other EU countries. Alternatively, German patents could be more valuable and worth the extra costs of defending them in court.

Table 2. Level of legal action by size of the infringer

	N	None taken	Abandoned	Pre-court settlement	Trial of action	Appeal	
Equal/smaller	214	23.8%	15.4%	29.0%	21.5%	10.3%	100.0%
Larger firm	220	29.1%	14.1%	19.5%	20.9%	16.4%	100.0%
Total	**434**	**26.5%**	**14.7%**	**24.2%**	**21.2%**	**13.4%**	**100.0%**

Note: totals can vary between tables due to missing values.

Table 3 looks at the relationship between the level of damage and the level of legal action. We expect firms to pursue legal action farther when the level of damage is greater. This is definitely what happens (X^2 = 45.1, p < 000). 44.1% of firms that report little damage took no action, compared to 26.5% of firms that report bearable damage and

16.3% of firms that report severe damage. Conversely, the percentage of firms that went as far as a trial of action or an appeal increases with the level of damage.

Table 3. Level of legal action taken by level of reported damage

Damage	N	None taken	Abandoned	Pre-court settlement	Trial of action	Appeal	
Little	93	44.1%	14.0%	24.7%	14.0%	3.2%	100.0%
Bearable	219	26.5%	15.5%	28.3%	18.3%	11.4%	100.0%
Severe	135	16.3%	14.1%	17.0%	30.4%	22.2%	100.0%
Total	**447**	**27.1%**	**14.8%**	**24.2%**	**21.0%**	**13.0%**	**100.0%**

Note: totals can vary between tables due to missing values.

Effect of deterrence on innovation investment

We expect a fear of heavy patent defence costs to act as a "deterrent to investment in invention". Table 4 shows that the deterrence effect increases with the level of reported damage from past infringement ($X^2 = 17.7$, p = .001). For example, 11.4% of firms that reported little damage report a large deterrence effect from patent defence costs, compared to 27.1% of firms that reported severe damage. Overall, 41.9% percent of firms report a small deterrence effect, 40.4% report a medium effect, and 17.7% report a large effect.

Table 4. Deterrence effect by level of damage from infringement

		Deterrence effect			
Damage level	**N**	**Small**	**Medium**	**Large**	
Little	86	51.2%	37.2%	11.6%	100.0%
Bearable	207	45.9%	39.6%	14.5%	100.0%
Severe	125	28.8%	44.0%	27.2%	100.0%
Total	**418**	**41.9%**	**40.4%**	**17.7%**	**100.0%**

Note: totals can vary between tables due to missing values.

Table 5 evaluates the relationship between the level of action taken and the reported degree of deterrence. There is a statistically significant ($X^2 = 23.4$, p = .003) difference in the distributions. Firms who take legal action further are more likely to report a small deterrence effect than firms that take no action or abandon legal action. For example, 52.7% of firms that went to appeal report a small deterrence effect while only 7.3% report

a large effect. In contrast, among firms that too no action, 31.2% report a small deterrence effect and 18.3% report a large effect.

Table 5. Deterrence effect by level of action

		Deterrence effect			
Action taken	**N**	**Small**	**Medium**	**large**	
None taken	109	31.2%	50.5%	18.3%	100.0%
Abandoned	61	27.9%	42.6%	29.5%	100.0%
Pre-court settlement	104	51.0%	32.7%	16.3%	100.0%
Trial of action	90	47.8%	35.6%	16.7%	100.0%
Appeal	55	52.7%	40.0%	7.3%	100.0%

Note: totals can vary between tables due to missing values.

REGRESSIONS

Both of our independent variables of interest, the level of legal action taken and the effect of patent defense costs on investment in invention, are ordinal variables. We therefore use an ordered logit model with unknown thresholds. The model assumes that the dependent variable y is generated by a continuous latent variable y^* whose values are unobserved. The model assumes a set of ordered values (μ_1, μ_2, .. μ_{n-1}) and a variable y^* such that:

$$
\begin{aligned}
& y = 1 \quad if \quad y^* < \mu_1 \\
(1) \quad & y = k \quad if \quad \mu_{k-1} < y^* < \mu_k \quad for \quad 1 < k < n \\
& y = n \quad if \quad \mu_{n-1} < y^*
\end{aligned}
$$

The unobserved variable y^* is modelled as a linear function of the (N,k) vector of exogenous variables X:

$$(2) \qquad y_i^* = \beta X_i + \varepsilon_i, \quad i = 1,....N,$$

Given the characteristics X_i of individual i, the probability that y_i is found in category k is:

$$
\begin{aligned}
(3) \qquad & \text{Prob } (Y_i = 1 / X_i) = F(\mu_1 - \beta X_i) \\
& \text{Prob } (Y_i = k / X_i) = F(\mu_k - \beta X_i) - F(\mu_{k-1} - \beta X_i)
\end{aligned}
$$

$$\text{Prob}\ (Y_i = n / X_i) = 1 - F(\mu_{n-1} - \beta X_i)$$

with n number of categories.

Our best results for the regression for the level of action uses a Cauchit link function (extreme outcomes more probable) while the regression for the effect of defense costs on investment in invention uses a negative log-log link function (lower outcomes more probable).

Level of legal action

The dependent variable in this regression, the level of legal action, consists of 'no action taken' plus four levels of consecutive action, as shown in Table 5. Our main hypothesis is that firms that are infringed by a larger firm will not take legal action as far as firms that are infringed by a smaller or equal sized firm. The variable INFRSIZE = 1 when the infringer is larger than the patent holder and zero otherwise. We also control for the effect of the size of the patent holder (FIRMSIZE = 1 when the firm has over 250 employees and zero otherwise) because larger firms, even when faced with an even larger infringer, could still have more financial resources to litigate than smaller SMEs. The model also includes a categorical variable for the amount of damage (BEARDAMage and SEVere DAMage, with little damage as the reference category), since Table 3 shows a positive correlation between the level of damage and the level of action. We also control for difficulties with monitoring infringement (MONITOR = 1 if yes, zero otherwise). Firms that experience monitoring difficulties, for example if the patent is infringed in a manufacturing process, could be less aware of serious infringement.

We include country dummies to account for differences in the legal system. For example, it is widely believed that it is much less expensive to litigate over infringement in Germany than in most other EU countries, while such litigation is comparatively costly in the UK and inexpensive but extremely time consuming in Italy (Ladas and Parry, 2002). Preliminary analysis showed that German firms take legal action further than firms in other countries and are less affected by the size of the infringer. We therefore added an interaction term for German firms with INFRSIZE (GER*INFRSIZE). These country effects could hold even when the infringement occurs outside of the firm's domestic base. For instance, firms in different countries could develop different patent defense strategies that partly reflect their experiences in their home country[5].

[5] Previous research using the PACE data found that German firms had significantly higher patent propensity rates than firms in other European countries. This was partly due to national differences in

Somaya (2001) and Lanjouw and Schankerman (2001b) found that a proxy variable for the value of the patent to the firm was a predictor of the level of legal action. In our model, we assume that both the dummy variable for the firm's sector of activity and the level of damage suffered act as a proxy for the value of the patent. The stakes should be highest in high technology sectors such as pharmaceuticals and information technology where patents are important to appropriation, and lowest in sectors where other appropriation methods are more valuable. We therefore expect firms in high technology sectors to take legal action further than firms in sectors where patents are less important for appropriation. To avoid empty cells due to a small numbers of firms in some sectors, we created four main sector categories: high technology manufacturing (where patents should be most valuable), low technology manufacturing (the reference category), low technology services, and high technology services[6].

The results are given in Table 6 for the full model with 390 firms (58 firms are excluded due to missing data on size or sector). The coefficient for INFRSIZE is negative, as expected, and statistically significant (p = .000). These results show that these firms are less likely to take legal action farther when the infringer is larger than they are, except for German firms[7]. In addition, 'larger' patent holders (250 to 1000 employees) take legal action further than smaller patent holders. As expected, the level of legal action increases with the severity of the damage. The probability of taking legal action further is highest when the damage is severe (SEVDAM) and intermediate when the damage is bearable (BEARDAM), compared to the reference category of little damage.

Surprisingly, there are no statistically significant differences by sector. One explanation is that the effect of sectoral differences on patenting strategies occurs earlier, during the decision to patent an invention. Once the decision to patent an invention is made, the sector has little effect on the level of action in the face of infringement. This conclusion is supported by the results (not shown) of a simpler dichotomous logit model. The main difference is between firms that took legal action to a pre-court settlement or further, compared to firms that took no action or which abandoned their case. We suspect that

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sectoral distributions, but part of the effect was unexplained and could be due to differences in patent systems or a pro-patent 'culture'.

[6] The NACE (3rd revision) codes for each category is as follows: low tech manufacturing includes NACE 15, 17, 21, 22, 25, 26, 27, 28, and 36; High tech manufacturing includes NACE 24 and NACE 30-35; low tech services includes NACE 51, 52, 65, 70, 90 and 93, while high tech services includes NACE 45 and NACE 72-74. Other methods of aggregating the sectors, such as for 'complex' and 'simple' technologies, made little difference to the results.

[7] In an ordered regression limited to German firms, the coefficient for INFRSIZE is *positive* (0.57) and of borderline statistical significance (p =.061), whereas when the regression excludes German firms, the coefficient for INFRSIZE is negative (-0.78) and significant (p = .000).

pre-court settlement appears on the side of legal action because firms must be able to develop a credible threat of further action in order to obtain a pre-court settlement.

Table 6. Ordered regression results for the level of legal action taken against an infringer

Variables	B	Std. Error
FIRM SIZE	0.61**	0.241
INFRSIZE	-0.8***	0.226
MONITOR	-0.22	0.178
BEARDAM	0.52**	0.233
SEVDAM	1.78***	0.301
GER*INFRSIZE	1.39***	0.365
Sector dummies (reference category is low tech manufacturing)		
HIMANUF	-0.29	0.203
LOW-TECHSERV	-0.16	0.385
HI-TECHSERV	-0.19	0.29
Country dummies (reference category is Germany)		
FRANCE	-0.07	0.465
ITALY	-0.24	0.361
HOLLAND	0.03	0.313
UK	-0.41	0.297
SWEDEN	-0.92**	0.378
FINLAND	-0.56	0.432
OTHER	0.13	0.382
Number of cases	390	
Model Chi-square	80.555***	
Pseudo R-square	0.195	
Threshold values (μ)	-.918***	0.322
	-1.35	0.309
	.902***	0.319
	2.644***	0.403

*** = $p < 0.01$; ** = $p < 0.05$; * = $p < 0.1$

Deterrence to investment in invention

The second ordered logit regression, given in Table 7, uses the three outcomes for the question on the deterrence effect on investment in innovation from heavy patent defense costs, where 0 = unimportant, 1 = moderate, and 2 = a large deterrence effect. The

independent variables include firm size, the level of damage experienced, problems learning about infringement, sector dummies, country dummies, and a variable for the level of action taken (COURT), entered as a dichotomous variable, with 1 = pre-court settlement or further action. We assume that firms that are capable of mounting a credible threat will be less intimidated by heavy defense costs. The model, using a negative log-log link function, provides a good fit (chi-square = 98.6, p = .000, with a pseudo r-square of 0.27). As expected, firms that can mount a credible threat of action, as shown by COURT, are less likely to report a large deterrence effect (coefficient of –.61, p = .000) from the fear of heavy patent defense costs.

Table 7. Ordered regression results for innovation deterrence from high patent defense costs

Variables	B	Std. Error
FIRM SIZE	-0.57**	0.262
MONITOR	0.52***	0.151
BEARDAM	0.44**	0.21
SEVDAM	0.89***	0.227
COURT	-0.61***	0.156
Sector dummies (reference category is low-tech manufacturing)		
HIMANUF	-0.47**	0.178
LOW-TECHSERV	-0.87**	0.370
HI-TECHSERV	-0.26	0.242
Country dummies (reference category is *Germany)*		
FRANCE	1.2**	0.401
ITALY	1.09***	0.276
HOLLAND	0.84***	0.235
UK	0.79***	0.209
SWEDEN	0.24	0.301
FINLAND	0.39	0.366
OTHER	0.59**	0.286
Number of cases	373	
Chi-square	98.578***	
Pseudo R-square	0.266	
Threshold values	0.495*	0.267
	2.21***	0.293

*** = p < 0.01; ** = p < 0.05; * = p < 0.1

As expected, the size of the patent holder decreases the probability of reporting a large deterrence effect. The difficulty in monitoring infringement significantly increases the deterrence effect, probably because firms that experience difficulties in learning about infringement are more concerned about any attempt to copy by a competitor. The other two variables related to the firm's previous experience with infringement issues are also significant. The measure of past damage from infringement increase the probability of deterrence, with the deterrence effect higher for severe damage (SEVDAM) than for bearable damage (BEARDAM) in comparison to the reference category.

Contrary to the previous model, all but two of the country dummies are statistically significant (although this model does not contain an interaction term). Except for Sweden and Finland, firms from countries other than Germany are more likely to report a large deterrence effect than German firms. This could be due to lower litigation costs in Germany than in other European countries.

In contrast to the previous regression for the level of action, the firm's sector of activity does influence the deterrence effect. Compared to a reference category of low technology manufacturing sectors, both high technology manufacturing and low technology service firms are significantly less likely to report a large deterrence effect, while there is no difference for high technology service firms. This result could reflect differences by sector in the importance of innovation to firm survival. Firms in high technology manufacturing sectors may have no choice but to invest in innovation and to adopt other appropriation methods, such as secrecy, if they are unable to defend their patents.

CONCLUSIONS

Our survey results show that small European firms are less likely to pursue litigation to defend their patents when the infringer is relatively larger than they are. The subsequent fear of high patent defence costs also reduces their willingness to invest in innovation. The analyses of the 'level of legal action' also suggest that the main division is between firms that take no action or abandon any action, and firms that reach a pre-court settlement or pursue litigation. This suggests that the ability to reach a pre-court settlement partly depends on making a credible threat to pursue litigation, if necessary.

These results should be of concern for European policy because the inability of many small firms to defend their patents could result in less than optimal investment in R&D. The problem for policy is how to 'level the playing field'.

The questionnaire asked about two options that might provide a solution to the ability of large firms to intimidate smaller firms from taking legal action. However, the most frequently discussed option in the literature, patent insurance, was used by only 12.1% of the 448 firms that reported infringement. Of these 12.1%, only 17%, or nine firms, made a successful claim. These results suggest that patent insurance is, so far, neither particularly attractive nor effective for SMEs. The second option is a voluntary patent pool. Almost half of the 448 firms (48%) expressed some interest in this option, although interest was higher among firms with less than 250 employees compared to firms with 250 to 1000 employees. This suggests that voluntary patent pools are unlikely to succeed in many sectors because larger firms will not willingly take part.

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