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New evidence on determinants of IP litigation:

A market-based approach

Dirk Czarnitzki[a,b,c] and Kristof Van Criekingen[a,b]

a) KU Leuven, Dept. of Managerial Economics, Strategy and Innovation, Leuven, Belgium
b) Centre for R&D Monitoring (ECOOM) at KU Leuven, Belgium
c) Centre for European Economic Research (ZEW), Mannheim, Germany

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Abstract

We contribute to the economic literature on patent litigation by taking a new perspective. In the past, scholars mostly focused on specific litigation cases at the patent level and related technological characteristics to the event of litigation. However, observing IP disputes suggests that not only technological characteristics may trigger litigation suits, but also the market positions of firms, and that firms dispute not only about single patents but often about portfolios. Consequently, this paper examines the occurrence of IP litigation cases in Belgian firms using the 2013 Community Innovation Survey with supplemental information on IP litigation and patent portfolios. The rich survey information regarding firms' general innovation strategies enables us to introduce market-related variables such as sales with new products as well as sales based mainly on imitation and incremental innovation. Our results indicate that when controlling for firms' IP portfolio, the composition of turnover in terms of innovations and imitations has additional explanatory power regarding litigation propensities. Firms with a high turnover from innovations are more likely to become plaintiffs in court. Contrastingly, firms with a high turnover from incremental innovation and imitation are more likely to become defendants in court, and, moreover, are more likely to negotiate settlements outside of court.

Keywords: IP litigation, patenting, innovation, imitation
JEL Classification: O31, O34

Corresponding author:
Kristof Van Criekingen
KU Leuven
Centre for R&D Monitoring (ECOOM)
Naamsestraat 61, 3000 Leuven, Belgium

E-mail: Kristof.vancriekingen@kuleuven.be

1 Introduction

The bulk of economic literature which has focused on patent litigation related the fact of litigation to technological characteristics of the underlying patent (see e.g. Lanjouw and Schankerman, 2001, 2004, Cremers, 2006, 2009, Somaya, 2003, Hall and Ziedonis, 2007, Galasso and Schankerman, 2010, Galasso et al. 2013). In this paper, we take the analysis to the firm level and account for market outcomes of innovation projects. By considering the asymmetric impact market positions regarding imitations and market novelties may have on the propensities of becoming plaintiff or defendant at court, we show that the market valorization of innovations play a significant role in addition to technological characteristics of the challenged intellectual property (IP). We are furthermore able to investigate the occurrence of out of court settlements and retaliation actions in terms of requests for nullification of the underlying IPR. These issues are largely neglected by extant literature.

IP litigation has been regarded as a niche topic in economics in the past. For instance, the number of patent litigation cases compared to the number of issued patents is fairly low. In the United States, for example, 1,706 patent cases were filed at US district courts in 1995. Compared to 114,241 issued patents, the litigation ratio only amounts to 1.5%. By 2005, these numbers, however, had risen to 2706 vs. 165,485 (= 1.6%). According to recent figures (2013), the patent litigation cases peaked at 6,386 (compared to 290,083 patents issued), yielding a litigation ratio of 2.2%. (Sources: USPTO's performance & Accountability Report[1]; US Courts' Judicial Facts and Figures[2]) Even more than the ratios, the absolute numbers show the growing importance of IP litigation: within two decades the number of patent litigation cases has almost quadrupled. It is also important to recognize the importance of IP litigation cases for the involved parties. According to PWC (2015) the annual median damage award ranged in the last 20 years between US$ 1.9 million to US$ 17 million (overall median = US$ 5.4 million). In light of the growing number of litigation cases since the 1990s, these numbers

[1] See http://www.uspto.gov/about-us/performance-and-planning/uspto-annual-reports
[2] See http://www.uscourts.gov/statistics-reports/analysis-reports/judicial-facts-and-figures

unambiguously show the importance of IP. The gravity of the matter becomes apparent when looking at the largest adjudicated damage awards in the last decades. In 2009, the damage award in the case *Centocor Ortho Biotech Inc. vs. Abbott Laboratories* concerning arthritis drugs amounted to US$ 1,673 million, and, in 2007, the case *Lucent Technologies Inc. vs. Microsoft Corporation* concerning MP3 technology amounted to US$ 1,538 million.[3] In addition, plaintiffs and defendants may often settle on their IP disputes. An example where parties settle on a larger scale is Google and Microsoft who settled upon about 20 IP dispute cases in Germany [4]and the United States (October 1st, 2015). A more recent case reported in global news (May, 2016) is Nivdia and Samsung who settled upon all competing patent litigation cases before the U.S. International Trade Commission and U.S. Patent and Trademark Office.[5]

In this paper, we consequently add to the economic literature on patent litigation by taking a somewhat different perspective than the existing studies:

1. The observation that firms battle over bundles of IP rights rather than single patents, for instance, suggests taking the analysis to the firm level rather than the patent level. We thus take portfolio variables at the firm level into account.
2. While scholars mostly focused on specific litigation cases at the patent level and related technological characteristics to the event of litigation, the portfolio debate strongly suggests that not only technological characteristics matter, but that the market positions of firms may play a prominent role as well. Therefore, we will add new product sales of firms, obtained from survey data, to our empirical model of litigation.

[3] Monetary figures adjusted for inflation to 2014 US dollars. The damage awards refer to initial adjudication, i.e. these awards may have been vacated, remanded or reduced, were settled while pending appeal, or are still under appeal.

[4] There is no centralized way to challenge the validity of a European Patent (Infringement is dealt with by the national courts).

[5] As our empirical study is on Belgian data, it seems noteworthy that of course also Belgian firms are involved in litigation cases. Examples are *Lankhorst Composites vs. Samsonite Europe* in 2005, and *Abott Laboratories vs. Janssen Pharma* in 2009.

3. Furthermore, using the sales of innovative products allows to characterize the market position in two ways: first, firms' success with original, novel to the market innovations, and second, firms' positions regarding more imitative and incremental innovations. These asymmetric market positions suggest in turn to differentiate between plaintiffs and defendants in court cases.
4. In addition, survey data also suggests that the analysis of court cases as commonly done in prior literature neglects a large proportion of IP disputes that are settled outside of court.[6] Therefore, the relevance of IP and its enforcement has been largely underestimated in the past. Consequently, we also investigate the occurrence of settlement outside of courts.
5. We can also investigate retaliation actions, that is, nullification suits of IP by defendants against plaintiffs as response to accusation of infringements in court (see e.g. also Schliessler, 2013).
6. Finally, IP disputes take place at a broader level than only patents. According to the US Courts' Judicial Facts and Figures, for instance, 3,169 trademark cases and 3,666 copyright cases were filed with the US district courts on top of the 6,386 patent cases. Especially the non-negligible number of trademark cases emphasizes that market positions of firms may play an important role in the economic analysis of IP disputes (see point 2 above). In robustness checks we therefore also control for other IPRs than patents.

The main data source consists of the Flemish part of the 2013 Community Innovation Survey which was supplemented with questions on IP litigation. The survey data is linked to patent data collected from the PATSTAT database and additional firm level data from BELFIRST of Bureau van Dijk (the Belgian part of the global Orbis database). The sample comprises innovating firms in the manufacturing and business-relevant service sectors. In contrast to many earlier studies, we can identify which firms filed IP infringement cases and which firms were accused of infringing others'

[6] A notable exception is Fournier and Zhuelke (1989).

IPRs. In addition, the survey data also allows to investigate which firms settled outside of court. The survey explicitly asked for settlement before firms went to court. Thus, our settlement variable allows to observe IP disputes that could never be detected with administrative data.[7] The three IP dispute variables can be related to commonly used patent characteristics (mainly counts and forward citations, as measure of the patent portfolio value), but also to the market positions of firms with regard to their innovation performance. This comprises the sales of products novel to the market and the sales of other innovative products that are mainly based on imitation. In addition, other variables collected from the survey, such as registrations of trademarks, industrial designs, and copyrights can be used to control for IPRs beyond patents.

Our data strongly indicates the importance of outside of court settlement for an analysis of IP infringement. About 8% of the companies were involved in a court case whereas nearly as much, 7%, made out of court settlements. Our results indicate that when controlling for the effects of the importance and quality of a firms' IP portfolio, the composition of turnover in terms of innovations and imitations has additional explanatory power regarding litigation propensities. Firms with a high turnover from innovations are more likely to become plaintiffs in court. Contrastingly, firms with a high turnover from imitation and incremental innovation are more likely to become defendants in court, and, moreover, are more likely to negotiate settlements outside of court. The market at stake also seems to play a role in determining firms' propensity to subsequently request nullification of the IP they are accused of infringing upon, i.e. high-volume imitators are more likely to request nullification of the original patent.

The remainder of this paper is structured as follows. Section 2 briefly summarizes the related literature on the determinants of patent litigation, and discusses the development of hypotheses to

[7] Note that settlement e.g. in the Google vs. Microsoft in October 2015 does not refer to outside court settlement. These firms settled on pending court cases. Settling on pending court cases is not considered in our paper. It would be a second stage in an empirical model on suits. For evidence on in-court settlement, see e.g. Cremers and Schliessler (2015) and the references therein.

be tested. In section 3 the data, variables and their descriptive statistics are presented and discussed Section 4 summarizes and discusses the results of the regression analysis. Section 5 concludes.

2 Related literature on the determinants of patent litigation

Intuitively one can expect a positive link between litigation propensity and values at stake. A patent owner may earn monopoly profits in a market that is protect by a patent. If, however, a competitor infringes the patent and competes with the patent owner, both would make duopoly profits. It thus depends on the expected gains from a law suit versus forgone profits whether a patent owner sues a potential infringer. The expected gains from the law suit depend on the expected damage compensation (which will be largely determined by the forgone profits due to infringement) that the plaintiff may get in case of a successful lawsuit and the trial cost, such as court fees, attorney cost, fees for hearing witnesses), and the expected likelihood to win the case. The latter might not be obvious, as some patents may have been granted erroneously by the patent office and competitors also try to "invent around" patented technologies.

Given these tradeoffs between expected gains and cost of litigation, the incentive to engage in litigation depends crucially on the product market. The larger the market for the innovation, the larger will be the incentive to engage as plaintiff in a court trial (cf. e.g. Bebchuck, 1984, and Hirshleifer 1991, Hylton 2002, Schliessler, 2015).[8]

These thoughts also apply to the perspective of a defendant, of course. A firm that achieves high sales with imitation might face higher likelihoods of litigation as IP owners may try to enforce their monopoly rights. The potential infringer might then have a high incentive to file a nullification suit against the IP of the plaintiff.

In empirical studies on litigation, the "value at stake" is thus a critical variable. Scholars have often focused on technological characteristics and (possibly poor) economic value proxies of IPRs to explain

[8] Hylton (2002) emphasizes in his theoretical model that social welfare would increase if damage compensation would actually by higher than foregone profits, as this deters infringement a-priori.

which intellectual assets may be subject to litigation, commonly using citation based measures to relate the value of a patent to litigation propensity.

Lanjouw and Schankerman (2001, 2003, 2004) study the determinants of patent suits by examining the characteristics of litigated patents and their owners, finding that the value of the patent measured by forward citations and claims increases the likelihood of litigation. For Germany, Cremers (2007, 2009) investigates the incidence of litigation and the determinants of settlement of patent litigation in court. Similar to Lanjouw and Schankerman, she finds that more valuable patents are more likely to be involved in patent litigation and smaller firms are more likely to be involved in litigation cases. Her measures for patent value are forward citations, number of claims, and patent family size.[9] Somaya (2003) also explains settlement probabilities conditional on being at court. He shows that the likelihood of settlement in court trials of patent disputes decreases with forward citations and self-citations which also points at the fact that firms tend to insist on their property rights when stakes are high.

While these contributions all focus on the incidence of litigation at the patent level, only very few authors have started looking at the likelihood of being involved in litigation at the firm level; thereby focusing on the firms' entire patent portfolio and other firm characteristics. Lerner (1995) shows that new biotechnology firms are less likely to patent in subclasses with many other (rival) patents when their litigation costs are high. "Patenting" should in this context be understood as not developing products in crowded technological domains. He interprets these results by stating that firms are aware of the potential to infringe upon their rivals' patents and that they are willing to take precautions. In their contribution "The Patent Litigation Explosion" Bessen and Meurer (2005) look at patent litigation hazards for public firms in the US. As others, they approximate the value of stakes by forward citations and claims but also use the market value of the whole firm as an additional measure.

[9] Family size refers to the number of jurisdictions in which patent protection has been sought for the same invention.

Focusing on US semiconductor firms between 1973 and 2001, Hall and Ziedonis (2007) also estimate the probability that firms will be involved in patent lawsuits, either as plaintiffs or as defendants. They find that size, patent stock, and R&D intensity all positively affect the likelihood of litigation. These variables are all expected to correlate positively with values at stake. Comparing their results for semiconductor firms to the broad sample of Bessen and Meurer, they find that the probability of being a defendant for semiconductor firms increases more strongly with a higher level of R&D intensity and size of the firm.

Our paper contributes to the empirical research by measuring the market valuation of firms' innovations more directly. Unlike existing studies, we have information on sales with new products. These can be split into sales with products that are new to the market, i.e. original innovation, and sales with products that are just new to the firm's product portfolio but not new to the market. We refer to the latter as imitation. The central research question addressed in this paper focuses at firm level litigation propensities and can accordingly be summarized as:

> ***RQ.*** *Does a firm's market position with regard to innovation and imitation matter in triggering litigation suits and/or out of court settlement negotiations?*

We contribute to the literature by investigating whether beyond the technological characteristics of IP, the composition of turnover in terms of innovations and imitations has additional explanatory power regarding litigation propensities. As we can observe in our data whether a company acted as plaintiff or defendant in court proceedings and whether firms settled on IP disputes outside of court, we make the following three hypotheses:

> *H1. The likelihood that a firm acts as plaintiff in an IP infringement case increases with its sales with market novelties (=innovations).*

We hypothesize a positive relationship between the sales with market novelties and litigation, as IP owners are more likely to enforce their monopoly right when the patent-protected innovations where successful at the market.

H2. An imitator will more likely be taken to court in an IP infringement case if the sales it generates from its imitations is higher.

A firm that generates high sales with products that are just new to its product portfolio but not new to the market might be more at risk to infringe on existing IPRs owned by others, and thus it can be expected that these imitators are more likely to be involved in a litigation suit as defendants.

H3. Firms are less likely to negotiate settlement deals outside of court if the sales they generate from either innovations or imitations is higher.

Firms may generally first try to settle outside of court to save the trial cost.

In addition to the main hypotheses stated above, this paper explores the relation between firms' responses to the initial lawsuit and our market value measures of innovation and imitation. Once sued for infringement a firm can question the validity of the supposedly infringed upon IP and ask for so called nullification (see e.g. Farrel and Merges, 2004). This request for IPR nullification can be dependent on technological characteristics of the IP and market valuations thereof. If market value of the challenged IP is high, it is reasonable to expect higher nullification propensities when compared to lower market values. Companies might also be inclined to request invalidations to keep the option open to come up with more follow-on innovations later (see Galasso and Schankerman, 2015). From a firm perspective, this translates into the following hypothesis.

H4. A defendant generating higher sales from imitations is more likely to request nullification of the allegedly infringed upon IPR.

3 Data and Variables

The data set used to conduct the analysis originates from the Flemish Community Innovation Survey[10], an inquiry about the innovative activity in the Flemish economy carried out biennially since 1993. The CIS methodological standards comprise a stratified random sampling procedure to ensure representativeness of the sample for the whole economy. The data consists of one cross-section of the Flemish economy surveyed in 2013 about their activities in the period spanning 2010-2012. We use the survey carried out in 2013 since it includes unique questions on IP litigation. The sample covers firms in the manufacturing as well as services sector.

As the subsequent empirical study focuses on IP litigation and innovation, we only retain the subsample of innovating companies. According to the international guidelines for collecting innovation data from the business sector as described by the OSLO manual, an innovation is defined as:

> *An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations. (OECD Publishing, 2005)*

We add to the survey data patent stock, patent quality and technology base fragmentation variables retrieved from PATSTAT. Additionally we also collected information on the firms cash position from the Belgian part of the ORBIS database, Belfirst.

Considering item non-response on the variables used in our specifications and outlier deletion, the final estimation sample counts 733 observations.

[10] This survey is conducted by the Centre for Research & Development Monitoring (ECOOM) on behalf of the Flemish government.

3.1 Dependent variables: IP litigation

Regarding IP litigation, we consider three binary outcome variables measuring different IP infringement litigation modes that companies potentially encountered in the surveyed period. PLAINTIFF indicates whether a company was a plaintiff in an IP infringement case, i.e. the company owned IPRs and accused at least one other firm of infringement. DEFENDANT indicates whether a company was a defendant in an IP infringement case. Whether a company was involved in settlement negotiations or arrangements outside the court of law with the purpose of avoiding IPR disputes is indicated by SETTLE. Note that the three litigation outcome variables are not mutually exclusive.

From the descriptive statistics in table 1 we see that the IP infringement litigation modes considered occur for a relatively small but still reasonable proportion of firms. About 6% of the firms go to court as a plaintiff whereas about 5% are being sued in court as a defendant. Settlement arrangements outside court happened for 7% of firms in the sample.

Additionally, we consider two binary outcome variables indicating the reaction of the defendant to the accusation. If a defendant doubts the validity of the supposedly infringed upon IP, they can file for nullification of the intellectual property rights. PLAINTIFF NULL indicates whether, in response to the initial accusation by the focal company, the defendant filed for nullification of the IPR. This happens in 33% of the cases. Correspondingly, DEFENDANT NULL indicates whether the focal company filed for nullification if it was accused of IP infringement. This happens in 66% of all cases in our sample. As our dependent variables are binary, we subsequently estimate Probit models.

3.2 Covariates of interest: market value measures of innovation and patent portfolio value measures

The main interest of the analysis lies in relating the dependent (IP litigation) variables to market value proxies of innovation, and whether these have additional explanatory power on top of commonly used technological value proxies of the IP portfolio.

Regarding the market value of a company's innovation portfolio three components of turnover can be identified based on the survey: (a) sales from market novelties (i.e. products, goods or services, newly introduced to the market between 2010 and 2012), (b) sales from imitation and incremental innovation (i.e. products introduced in the period 2010-2012 that were new to the firm but not new to the market), (c) sales of unchanged products. The average turnover per employee originating from market novelties, NOVEL SALES, and new-to-firm innovations, IMITATION SALES, are € 23 688 and € 18 671 respectively. From the companies in the sample, 48% generated no sales from market novelties, whereas 52% generated no sales from new-to-firm innovations, i.e. imitation.

We construct three variables from the Patstat database which proxy the importance, quality, and composition of the patent portfolio: depreciated patent stock per employee (PATENT INTENSITY), patent quality (PATENT QUALITY), and fragmentation of prior art (FRAGMENTATION). In calculating these measures the patent application and citation data is truncated at 2010. Patent stock for firm *i* in year *t* was retrieved by applying the following formula:

$$\text{PATENSTOCK}_{it} = (1-\delta)\ \text{PS}_{it-1} + \text{patent applications}_{it}$$

where δ, the constant knowledge depreciation rate, is set to 15%. As the patent stock might be highly correlated with firm size, we use the variable PATENT INTENSITY in the regressions that further scales the patent stock per employee. The patent applications are aggregated on the family level to obtain unique inventions. To mitigate endogeneity concerns this variable enters our specification as measured in 2010, i.e. before the period in which litigation is measured. From the companies in our sample about 10% has a strictly positive patent stock in 2010.

PATENT QUALITY measure average quality of patents, i.e. the average number of forward citations to a patent within the company's patent portfolio, and also enters as measured in 2010. All forward citations from the PATSTAT extract up to 2010 are counted.

$$\text{PATENT QUALITY}_i = \frac{(\text{\# forward citations revieved by firm i within a 5-year citation window})}{(\#\ patents\ filed\ by\ firm\ i)}$$

Ziedonis (2004) calculates a patent fragmentation index by:

$$\text{FRAGMENTATION}_i = 1 - \sum_{j=1}^{J} \left(\frac{\#\text{nbcites}_{ij}}{\#\text{nbcites}_i} \right)^2 , i \neq j$$

where,

nbcites$_i$= total number of backward citations for the patent portfolio of company i

nbcites$_{ij}$= total number of backward citations that the patent portfolio of company i makes to patents of company j.

Our fragmentation index is calculated accordingly for all patents a firm has in its portfolio and might indeed influence litigation propensities as a more fragmented technology base makes infringement more likely (Heller and Eisenberg, 1998).

Since we look at litigation in relation to IP in general (in contrast to the literature on patent litigation in specific) we consider the importance of other IP next to patents in the firms' portfolios. We thus also use trademarks as an appropriation mechanism for innovation (Mendonça et al., 2004). Industrial designs, which are more frequently infringed upon (Weatherall et al., 2009), should also be considered from the broader IP perspective. Dummy variables indicating whether the firm used industrial designs (DESIGN) and trademarks (TRADEMARK) as means of improving their competitive position are also available from the survey.

3.3 Independent variables: other controls

The necessity of R&D intensity as a control variable is apparent as: (a) intensive imitative R&D or (b) original own R&D efforts both increase the potential for infringement cases and thus trigger litigation (cf. Bessen and Meurer, 2006). We measure R&D INTENSITY as intramural R&D spending per employee in 2012.[11]

Further general controls are firm size measured as number of employees (EMPLOYMENT) and age as years elapsed since foundation (AGE). Large and established firms might be more involved in IP litigation given the high cost of such trials (Bessen and Meurer, 2006, Hall and Ziedonis, 2007). We

[11] Ideally, we would have preferred to observe R&D as a stock or at least as lagged value, but we simply do not have that information.

further consider the firms volume of cash and cash equivalent available (CASH) since firms with deep pockets might hesitate less to engage in litigation as the trial cost may not be a significant expense for them. A control for whether a firm handles legal IP issues in a separate department, IPDEPT, is also available. Finally, considering the appropriability literature stressing the diverging effectiveness of patent in different technological areas (e.g. Teece, 1986), sector dummies are used to control for inter-sectorial differences.

3.4 Descriptive statistics

Summary statistics can be found in table 1. The average firm in our sample has about 115 employees and sells good and services of about € 300,000 per employee. Most sales are achieved with products that existed at least three year ago (i.e. before our sample period 2010). On average, firms achieve € 260,000 per employee from unchanged products. The remaining € 40,000 per employee are almost split evenly between market novelties and imitation where market novelties amount to € 23,688 and € 18,671.

Insert table 1 about here

Table 2 shows the correlation matrix. There is no evidence of severe multicollinearity among our variables. The highest correlations between two explanatory variables occur between DESIGN and TRADEMARK with a correlation coefficient of 0.44, and between FRAGMENTATION and PATENT INTENSITY with 0.49.

Insert table 2 about here

Table 4 summarizes the final sample's distribution over the sectors. Most innovative firms in the sample are in knowledge intensive services, i.e. telecommunications, software and engineering

services (202 observations). This is followed manufacture of food products, beverages, textiles and leather.

Insert table 3 about here

Sample splits

In table 4 we further split up the descriptive statistics by the three main outcome variables (PLAINTIFF, DEFENDANT, and SETTLE).

Insert table 4 about here

Companies involved in any kind of litigation or settlement procedure score higher on all right-hand side variables, meaning they generate more turnover per employee from novelties and imitations, are larger and older, are more R&D and patent intensive, have higher quality patents, draw from a more fragmented technology base, and are more likely to use trademarks and industrial designs. PLAINTIFFS tend to generate a higher turnover per employee from market novelties than DEFENDANTS, whereas DEFENDANTS have a higher turnover per employee generated from imitation and incremental innovation. Companies involved in SETTLEMENTS generate, on average, turnovers from novelties and imitations that lie in between the corresponding values of PLAINTIFFS and DEFENDANTS.

3.5 Robustness to sample selection due to non-response and outlier deletion

Given that due to outlier deletion and item non-response the size of the original sample of the survey shrank , we checked whether our results are robust when sampling weights are taken into account. All results below remain valid when running these weighted regressions (Results are not reported).

4 Results and discussion

4.1 Initial litigation propensities (H1-H3)

4.1.1 Main results

In table 5 and 6 we estimate Probit models. For all models, we employ clustered standard errors at the NACE 3-digit industry level (which is more detailed than the included sector dummies) in order to allow for error term correlation across observations within the same industry. It could happen that the models explain IP disputes better (or worse) in certain industries where IPR is very relevant for firms' main business strategies when compared to others where IP plays a smaller role. Clustered standard errors would account for the resulting error term correlation patterns across observations. Initially, in table 5, we regress the outcome variables on total sales per employee and the controls. In table 6, we split the sales per employee into its three relevant components, sales with innovations, sales with imitations and sales with unchanged products.

The first specifications (1)-(3) only include the general firm level control variables next to our variables of interest in the regressions. In the extended specifications (4)-(6) control variables for the patent intensity (= patent stock per employee), patent quality (forward citations per patent), and the fragmentation index are added. In the columns (7)-(9) the design and trademark dummies are added.

Insert tables 5 and 6 about here

In table 5, we find that total sales per employee do only explain the defendant dummy significantly, but not the plaintiff nor the settlement dummy. When the total sales are split into the components of NOVEL SALES, IMITATION, and UNCHANGED in Table 6, interesting differences are found. NOVEL SALES are positively associated with the likelihood to become a plaintiff. We interpret this finding as evidence that firms obtaining higher returns from their market novelties, i.e. their own, internally developed innovations are more likely to enforce their IPRs than firms that have only less successful

innovations. This finding is consistent with the view that the "value at stake" determines litigation events. Accordingly, we also find that the higher the sales with imitation, the more likely firms are to become defendant in an IP dispute. The "value at stake" argumentation also holds in this case. An IP owner may be more likely to enforce IP, the more returns others achieve with related or imitated products. In the case of settlement, we find that sales with imitation are positively associated with settlement, but market novelty sales are insignificant. All these findings are significant at the 5% level and remain robust across all specifications. The unchanged products turn out to be positively significant in the DEFENDANT model only. This might indicate simply that very successful firms, e.g. the market leaders, are more likely to be targets of litigation suits.

In order to interpret the economic magnitude of the estimated effects for the main variables of interest, we calculate the change in predicted probabilities when the right hand side variable changes from its mean value to the mean plus one standard deviation. First, the predicted probability of becoming a plaintiff at the mean value of all regressors is 0.91%. When increasing the value of NOVEL SALES with one standard deviation, this predicted probability becomes 1.55%, i.e. the economic effect is sizable. While litigation, on average, is certainly a rare event still, the increase of a standard deviation in NOVEL SALES increases the likelihood to sue for infringement by about 70% (= 1.55/0.91 1) Second, the predicted probability of becoming a defendant at the mean value of all regressors is 2.01%. When increasing the value of IMITATION SALES with one standard deviation, this predicted probability becomes 2.95%, i.e. a 46% increase. Finally, the predicted probability of being involved in out of court settlements at the mean value of all regressors is 2.3%. When increasing the value of IMITATION SALES with one standard deviation, this predicted probability becomes 3.6%, i.e. a 50% increase.

Regarding the other control variables, the patent intensity is positively and significantly associated with the probability to become a plaintiff in Table 5. This is in line with a large body of previous literature and is also the expected result; a firm owning more IP will also be more likely to enforce (parts of) it. Interestingly, this significant relationship disappears once the market positions of firms enter the models more flexibly, i.e. the sales are split into novel product sales, imitation and

unchanged products. We interpret this as indication that market success is driving litigation and not just IP ownership (that might not lead to significant returns in the market). A result that is statistically significant with a negative coefficient is the patent quality, though. Firms with a patent portfolio that received more citations per patent, all else constant, is less likely to be plaintiff and defendant. In the plaintiff equation, this is somewhat difficult to explain, but the significance level is also just 10%. It is however negative and significant at the 5% level in the defendant specification. If one would interpret patent quality measured by forward citations as having "solid and relevant inventions" it would make sense that the estimated coefficient is negative. Often, however, scholars associate forward citations with economic value and then this result would stand in contrast with the "value at stake" interpretation. We believe that we already control for many other factors that determine "value at stake" and that indeed the negative influence of patent quality in the defendant regression might show that the corresponding firm possess own, relevant and high quality IP and is therefore simply less likely to infringe others' IP and is consequently less challenged. The fragmentation variable correlates positively and significantly with PLAINTIFF and DEFENDANT in Table 6 in models (4) and (5). When DESIGN and TRADEMARK are added to the models, this relationship disappears, though. The DESIGN coefficient itself is positive and significant in all three equations whereas the TRADEMARK is only positively significant in the regression on SETTLE.

With regard to the remaining controls, R&D intensity is positive and significant throughout at the 5% level. This finding is consistent with prior literature (e.g. Bessen and Meurer, 2006) as R&D may serve as proxy for future values at stake. Very R&D intensive firms may critically depend on innovations and their future market success and therefore engage in IP disputes, and they of course might simply have more to dispute about as they conduct high levels of R&D. Firm age is positive and weakly significant in the PLAINTIFF regressions; otherwise insignificant. The CASH variable is positive and significant in most models. This suggests, on one hand, that firms with deep pockets hesitate less to get involved in IP disputes. On the other hand, this result is also consistent with the "value at stake" interpretation if cash holdings are seen as retained earnings that may partly stem from returns of new

product sales (either market novelties or imitation). Firms earning more have more to lose (or "steal" more from others in case of the defendant equation), and therefore are more likely to be in IP disputes. The variable IP department is positive and significant in all regressions. This is not surprising as firms with a dedicated IP department will simply be more active regarding any legal dimension of IPRs. The sector controls are jointly significant in the PLAINTIFF and SETTLE regressions but not in the DEFENDANT regression.

4.1.2 Robustness checks

We also estimated the same specifications using multivariate Probit models, i.e. we account for possible error term correlations across the equations. In comparison to the single equation Probits, one could gain efficiency when error term correlation is taken into account. The results are robust but do not improve significantly. Therefore, these estimations are not presented in detail.

Furthermore, we also tested rare event logit models, as the positive outcomes of our dependent variable are not very frequent. The rare event logit models following King and Zeng (2001) may also lead to more efficient estimates in case of rare positive outcomes. Again our results remain robust but do not really improve in any economically interesting way either. Therefore, we also omit detailed presentations of these regressions.

We also conducted several sample splits. Our results on IMITATION SALES hold for regressions considering: a) only smaller firms, i.e. less than 50 employees, b) manufacturing firms, and c) younger firms, i.e. founded after 1988. The results on NOVELTY SALES are less stable and become less significant when these sample splits are applied. We therefore conclude that even for small and young firms IP disputes are either a relevant threat or also mechanism to defend IP. Even though there are some very prominent global examples of IP disputes in services (e.g. Google etc.), IP disputes seem to be more driven by the manufacturing sector still, and not by services. This is not too surprising when using European data though, as software is not patentable in Europe.

4.2 Requests for nullification (H4)

In table 7 we report regression results explaining requests for nullification of the underlying IP conditional on an IP dispute. There we estimate single equation Probit models using all covariates except the industry dummies as we only have 35 and 39 observations, respectively. We checked the robustness of these results by estimating Full Information Maximum Likelihood (FIML) Heckman selection models for two binary variables (see e.g. Wooldridge, 2002), i.e. conditional on a litigation court suit, the plaintiff or defendant respectively may file a nullification suit against the other involved party (see Table 8). This has the advantage that we can use all 731 and 733 observations, respectively. However, when fitting the Heckman model, it turned out that we have to limit the number of covariates to achieve convergence in this more complex model. We only use the sales variables, the patent portfolio related variables and the age, employment and R&D intensity variables. The fragmentation index is used as exclusion restriction in the regression, i.e. this is included in the first stage on litigation suits (as also done in Tables 5 and 6), but excluded from the subsequent nullification regression.

If companies get sued, they ask nullification more frequently if the stakes they have with regard to sales from imitations are high. The effect is always significant at the 5% level and is indicative of imitators trying to protect their market stakes (supports H4).

Insert table 7 about here

Insert table 8 about here

5 Conclusion

This paper presents new empirical evidence on the determinants of IP litigation at the firm level based on a sample of firms covered by the Flemish part of the 2013 wave of the Community Innovation Survey. Our study has several features that makes it different from the bulk of litigation studies: we

conduct the analysis at the firm level, which has only been done in a few other papers. The firm level analysis allows to control for other factors beyond technological characteristics and other indicators derived from patent data. Our main novelty is the inclusion of the market position of firms regarding sales obtained with innovations, i.e. market novelties or imitation. We also consider retaliation actions through IP nullification suits as response to initial litigation actions. Furthermore, we also account for other IP than patents, namely registered industrial designs and trademarks, that might also lead to IP disputes. Finally, we also consider out-of-court settlements which have been largely ignored by prior literature. Other scholar only considered settlement within court trials. Our data show that out of court settlement occurs basically as frequently as formal litigation.

Market based measures of innovation and imitation seem to be important variables when analyzing litigation propensities. Our results are in line with theoretical models predicting a positive relation between value at stake and litigation propensity (see, among others, Bebchuk, 1984; Hirshleifer, 1991). Next to commonly used citation-based proxies for technological value of innovation, we find that our newly introduced market-based indicators on the value of innovations and imitations matter in explaining firm-level litigation and settlement propensities. We find that firms with a high turnover from innovative goods and services are more likely to sue over infringement of their IP, when controlling for technological importance and quality of the IP portfolio. Contrastingly, firms with a high turnover generated from imitations and incremental innovations are sued more often over IP infringement. Facing fragmented IP in their technological space of activity adds to the likelihood of these firms being sued.

Also, the settling propensity of firms is positively influenced by sales from imitations while controlling for importance and quality of the IP portfolio. Infringers, however, seem also to settle more often when their market stakes involved are high, thereby avoiding costly litigation and uncertain court outcomes.

The nullification suits as response to a court trial are in line with the "value at stake" mechanism. Firms that are generating higher sales with imitations are more likely to respond with a nullification suit against the IP of the plaintiff than firms with less imitation.

Other IP such as trademarks and registered industrial designs have a significant explanatory power in the regressions on IP disputes, suggesting that these IPRs are also important to firms and are being enforced actively.

While we argue to have good measures of firms' market positions regarding their innovations and have a number of other interesting features in our empirical models, our study is of course not without limitations. The main limitation of this research remains possible endogeneity stemming from potential simultaneity between the outcome variables of IP disputes and the market-based measures of innovation and imitation. Addressing this concern appropriately in terms of the econometric approach seems almost impossible though. It would require identifying variables that independently affect the market positions but not the litigation propensity and, at the same time, do not depend on litigation. Commonly used variables that are constructed from information on product market rivals are conceptually ruled out in this case as these might also be involved in the court cases. Governmental regulation in sectors that exogenously affect sales of innovative products might be a solution, and a venue for future research. However, such information is not easy to collect for a sample of firms stemming from a large number of sectors of the economy. It might require detailed data of a few innovative sectors where detailed institutional knowledge about regulation can be exploited for identification.

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Table 1: Descriptive statistics (733 observations)

Variable	Variable description	Mean	Std. Dev.	Min	Max
Main set of Dependent variables (N = 733)					
PLAINTIFF	Dummy = 1 if a company was plaintiff in an IP lawsuit	0.06	0.23	0	1
DEFENDANT	Dummy = 1 if a company was defendant in an IP lawsuit	0.05	0.21	0	1
SETTLE	Dummy = 1 if a company negotiated outside of court for a settlement on an IP dispute	0.07	0.26	0	1
2nd set of dependent variables only observed if plaintiff or defendant take value 1, respectively					
PLAINTIFF NULL	Dummy = 1 if the defendant followed up with a request for nullification of the IP when the variable plaintiff above is equal 1.	0.33	0.48	0	1
DEFENDANT NULL	Dummy = 1 if the variable defendant above was equal to one and they initiated a nullification suit against the respective plaintiff.	0.66	0.48	0	1
Covariates (N = 733)					
SALES PRODUCTIVTY	(Turnover in € 1 000 000) / #employees	0.3	0.33	0	2.95
NOVEL SALES	(Turnover with market novelties in € 1 000 000) / #employees	0.02	0.05	0	0.33
IMITATION	(Turnover with imitation or incremental innovation in € 1 000 000) / #employees	0.02	0.04	0	0.24
UNCHANGED	(Turnover with unchanged products in € 1 000 000) / #employees	0.26	0.32	0	2.95
EMPLOYMENT	# employees	115.05	298.17	3	3828
AGE	2013- year of foundation	27.57	18.03	3	145
R&D INTENSITY	Internal R&D expenditures / # employees	10.67	23.98	0	230.28
PATENT INTENSITY	Depreciated patent stock per employee in 2010	0.01	0.04	0	0.45
PATENT QUALILTY	Average # of forward citations per patent as of 2010	0.28	1.6	0	24
FRAGMENTATION	Measure of patent fragmentation (Ziedonis, 2004) as of 2010	0.19	0.37	0	1
CASH AVAILABLE	Cash and cash equivalent in 2010 (Bureau van Dijck – Belfirst) in € 1 000 000 000	0.01	0.03	0	0.63
IP DEPARTMENT	Indicates whether IP tasks are handled by a separate entity within or outside firm	0.17	0.38	0	1
DESIGN (DUMMY)	Dummy = 1 if firm used industrial designs for improving its competitive position	0.18	0.39	0	1
TRADEMARK (DUMMY)	Dummy = 1 if firm used trademarks for improving its competitive position	0.34	0.47	0	1

Table 2: Pairwise correlation coefficients for sample of 733 observations

	PLAINT~	*DEF~*	*SETTLE~*	*NOV~*	*IMIL~*	*UNCH~*	*EMPL~*	*AGE*	*R&DI~*	*P~INT~*	*P~QU~*	*FRAG~*	*CASH~*	*IPD~*	*DES~*
PLAINTIFF (DUMMY)	1														
DEFENDANT (DUMMY)	0.34	1													
SETTLE (DUMMY)	0.65	0.56	1												
NOVEL SALES	0.18	0.13	0.13	1											
IMITATION	0.08	0.13	0.12	0.19	1										
UNCHANGED	0.02	0.17	0.03	-0.02	0.04	1									
EMPLOYMENT	0.28	0.19	0.25	0.04	0.01	0.18	1								
AGE	0.11	0.03	0.09	-0.04	-0.06	0.17	0.26	1							
R&D INTENSITY	0.23	0.29	0.27	0.32	0.1	-0.08	0.13	-0.12	1						
PATENT INTENSITY	0.24	0.19	0.21	0.21	0.08	0.08	0.06	-0.06	0.31	1					
PATENT QUALILTY	-0.01	-0.02	0.01	0.13	-0.03	0.04	0.02	-0.01	0.07	0.02	1				
FRAGMENTATION	0.25	0.22	0.25	0.13	0.04	0.1	0.28	0.09	0.24	0.49	0.29	1			
CASH AVAILABLE	0.22	0.16	0.21	0.01	0.01	0.08	0.44	0.04	0.09	0.07	0	0.15	1		
IP DEPARTMENT	0.25	0.2	0.3	0.14	0.02	0.11	0.26	0.09	0.19	0.15	0.08	0.3	0.18	1	
DESIGN (DUMMY)	0.29	0.24	0.24	0.16	0.05	0.03	0.15	0.05	0.18	0.15	-0.01	0.27	0.01	0.21	1
TRADEMARK (DUMMY)	0.21	0.14	0.21	0.14	0.11	0.01	0.12	0.08	0.16	0.1	0.04	0.2	0.08	0.25	0.44

Table 3: Distribution over sectors for sample of 733 observations

Sectors	Sector description	Observations
Sec1	food, beverage, tobacco, textile, clothing and leather industries	94
Sec2	Textile, clothing and leather industry	34
Sec3	Manufacture of cokes, chemicals, pharmaceuticals, rubber and plastic	83
Sec4	Manufacture of non-ferro minerals, metals and metal products (no machinery and equipment)	73
Sec5	Manufacture of electrical equipment, IT-products, electronic and optical products	51
Sec6	Manufacture of machinery, equipment, tools and transport	55
Sec7	Wholesale	84
Sec8	Telecomunication, software design and programming, computer-consultancy, information services, architects and engineering, R&D	202
Sec9	Remaining sub-sectors	57

Table 4: Descriptive statistics split by the binary outcome variables

Variable	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
	plaintiff subsample (41 observations)				**defendant subsample (35 observations)**				**settlement subsample (52 observations)**			
PLAINTIFF	1	0	1	1	0.4	0.5	0	1	0.6	0.5	0	1
DEFENDANT	0.34	0.48	0	1	1	0	1	1	0.48	0.5	0	1
SETTLE	0.76	0.43	0	1	0.71	0.46	0	1	1	0	1	1
NOVEL SALES	0.06	0.08	0	0.33	0.05	0.06	0	0.27	0.05	0.07	0	0.27
IMITATION	0.03	0.06	0	0.24	0.04	0.06	0	0.21	0.03	0.06	0	0.24
UNCHANGED	0.29	0.26	0	1.27	0.5	0.62	0	2.39	0.29	0.31	0	1.88
EMPLOYMENT	456.66	763.52	7	3828	367.91	794.27	4	3828	385.73	687.84	5	3828
AGE	35.8	26.09	7	117	30.11	22.55	3	88	33.73	24.41	3	117
R&D INTENSITY	33.38	58.07	0	230.28	41.27	62.93	0	230.28	33.95	54.37	0	230.28
PATENT INTENSITY	0.05	0.09	0	0.45	0.04	0.09	0	0.45	0.04	0.08	0	0.45
PATENT QUALILTY	14.37	29.24	0	151	14.71	35.43	0	151	16.81	33.64	0	151
FRAGMENTATION	0.57	0.47	0	1	0.56	0.47	0	1	0.53	0.48	0	1
CASH AVAILABLE	0.04	0.11	0	0.63	0.03	0.11	0	0.63	0.03	0.1	0	0.63
IP DEPARTMENT	0.56	0.5	0	1	0.51	0.51	0	1	0.58	0.5	0	1
DESIGN (dummy)	0.63	0.49	0	1	0.6	0.5	0	1	0.52	0.5	0	1
TRADEMARK (dummy)	0.76	0.43	0	1	0.63	0.49	0	1	0.71	0.46	0	1
	non-plaintiff subsample (692 observations)				**non-defendant subsample (698 observations)**				**non-settlement subsample (681 observations)**			
PLAINTIFF	0	0	0	0	0.04	0.19	0	1	0.01	0.12	0	1
DEFENDANT	0.03	0.17	0	1	0	0	0	0	0.01	0.12	0	1
SETTLE	0.03	0.17	0	1	0.04	0.19	0	1	0	0	0	0
NOVEL SALES	0.02	0.04	0	0.32	0.02	0.04	0	0.33	0.02	0.04	0	0.33
IMITATION	0.02	0.03	0	0.23	0.02	0.03	0	0.24	0.02	0.03	0	0.23
UNCHANGED	0.26	0.33	0	2.95	0.24	0.3	0	2.95	0.25	0.32	0	2.95
EMPLOYMENT	94.8	230.44	3	3520	102.37	243.36	3	3520	94.38	232.79	3	3520
AGE	27.09	17.35	3	145	27.45	17.79	3	145	27.1	17.39	3	145
R&D INTENSITY	9.33	19.54	0	186.07	9.14	19.02	0	186.07	8.89	18.79	0	186.07
PATENT INTENSITY	0.01	0.03	0	0.4	0.01	0.04	0	0.4	0.01	0.03	0	0.4
PATENT QUALILTY	2.63	16.28	0	274	2.71	15.86	0	274	2.25	15.09	0	274
FRAGMENTATION	0.17	0.35	0	1	0.17	0.36	0	1	0.16	0.35	0	0.99
CASH AVAILABLE	0	0.02	0	0.37	0	0.02	0	0.37	0	0.02	0	0.37
IP DEPARTMENT	0.15	0.35	0	1	0.15	0.36	0	1	0.14	0.35	0	1
Design (dummy)	0.15	0.36	0	1	0.16	0.37	0	1	0.16	0.36	0	1
TRADEMARK (dummy)	0.32	0.47	0	1	0.33	0.47	0	1	0.31	0.46	0	1

Table 5: Litigation propensities - single equation probit estimations – sales per employee not split

b/se	(1) Plaintiff	(2) Defendant	(3) Settle	(4) Plaintiff	(5) Defendant	(6) Settle	(7) Plaintiff	(8) Defendant	(9) Settle
SALES/EMPLOYM.	0.102	0.748***	0.06	-0.337	0.642***	-0.217	-0.422	0.699***	-0.237
	(0.258)	(0.157)	(0.208)	(0.334)	(0.165)	(0.234)	(0.393)	(0.159)	(0.264)
EMPLOYMENT	0.001***	0.000*	0.001***	0.001**	0.000	0.000	0.001**	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
AGE	0.007	-0.002	0.005	0.009**	-0.002	0.005	0.008*	-0.003	0.003
	(0.005)	(0.005)	(0.004)	(0.004)	(0.005)	(0.004)	(0.005)	(0.005)	(0.005)
R&D INTENISTY	0.016***	0.014***	0.016***	0.013***	0.012***	0.012***	0.013***	0.010***	0.011***
	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
PATENT INTENSITY				4.467**	0.404	2.381	5.682***	0.503	2.65
				(2.036)	(1.207)	(1.709)	(2.093)	(1.108)	(1.615)
PATENT QUALITY				-0.008**	-0.001	0.001	-0.009*	0.000	0.002
				(0.004)	(0.004)	(0.003)	(0.005)	(0.004)	(0.004)
FRAGMENTATION				0.412*	0.459*	0.268	0.144	0.289	0.114
				(0.236)	(0.252)	(0.233)	(0.246)	(0.240)	(0.222)
CASH AVAILABLE				2.991**	1.615	2.658**	3.913***	2.472*	3.254***
				(1.202)	(1.452)	(1.224)	(1.221)	(1.456)	(1.236)
IP DEPARTMENT				0.752***	0.555**	0.892***	0.656***	0.437*	0.793***
				(0.218)	(0.238)	(0.187)	(0.249)	(0.251)	(0.198)
DESIGN							0.868***	0.758***	0.504**
							(0.247)	(0.239)	(0.243)
TRADEMARK							0.508*	0.067	0.494**
							(0.261)	(0.225)	(0.233)
Intercept	-2.352***	-2.041***	-1.795***	-2.471***	-2.144***	-1.858***	-3.017***	-2.268***	-2.128***
	(0.347)	(0.271)	(0.210)	(0.393)	(0.272)	(0.227)	(0.445)	(0.289)	(0.237)
Sector- dummies	Incl.**	Incl.	Incl.***	Incl.***	Incl.	Incl.***	Incl.***	Incl.	Incl.***
Pseudo R2	0.218	0.205	0.175	0.326	0.261	0.275	0.414	0.309	0.325
#obs	733	733	733	733	733	733	733	733	733

Notes: Significance levels: *** 1%; ** 5%, * 10%; standard errors clustered at the NACE 3-digit level

Table 6: Litigation propensities - single equation probit estimations – sales per employee split by sales categories

b/se	(1) Plaintiff	(2) Defendant	(3) Settle	(4) Plaintiff	(5) Defendant	(6) Settle	(7) Plaintiff	(8) Defendant	(9) Settle
NOVEL SALES	3.755**	1.098	1.161	4.145**	2.033	0.742	3.756**	1.59	-0.279
	(1.666)	(1.393)	(1.651)	(1.653)	(1.651)	(1.820)	(1.864)	(1.726)	(2.000)
IMITATION	3.287	4.158**	4.230**	2.889	4.051**	4.669**	2.802	4.145**	4.673**
	(2.059)	(1.659)	(1.745)	(2.254)	(1.732)	(1.867)	(2.801)	(1.952)	(2.060)
UNCHANGED	-0.16	0.693***	-0.079	-0.558	0.687***	-0.421	-0.678	0.731***	-0.424
	(0.271)	(0.176)	(0.266)	(0.358)	(0.183)	(0.286)	(0.413)	(0.180)	(0.302)
EMPLOYMENT	0.001***	0.000*	0.001***	0.000*	0.000	0.000*	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
AGE	0.008*	-0.001	0.006	0.009**	-0.002	0.006	0.009*	-0.003	0.004
	(0.004)	(0.005)	(0.004)	(0.004)	(0.005)	(0.004)	(0.005)	(0.005)	(0.004)
R&D INTENISTY	0.013***	0.014***	0.015***	0.010***	0.012***	0.011***	0.010***	0.011***	0.011***
	(0.003)	(0.003)	(0.001)	(0.003)	(0.003)	(0.002)	(0.004)	(0.003)	(0.002)
PATENT INTENSITY				2.475	-1.452	2.306	3.58	-1.105	2.948
				(2.085)	(1.381)	(1.921)	(2.281)	(1.369)	(2.016)
PATENT QUALITY				-0.129*	-0.343***	-0.009	-0.124*	-0.338***	0.003
				(0.077)	(0.111)	(0.056)	(0.073)	(0.109)	(0.058)
FRAGMENTATION				0.550**	0.714**	0.327	0.293	0.536*	0.156
				(0.253)	(0.284)	(0.252)	(0.262)	(0.278)	(0.242)
CASH AVAILABLE				3.111**	1.49	2.756**	4.384***	2.337*	3.420**
				(1.211)	(1.428)	(1.307)	(1.346)	(1.415)	(1.347)
IP DEPARTMENT				0.772***	0.550**	0.912***	0.661***	0.433*	0.810***
				(0.223)	(0.252)	(0.193)	(0.256)	(0.259)	(0.209)
DESIGN							0.888***	0.736***	0.521**
							(0.244)	(0.236)	(0.249)
TRADEMARK							0.432	0.028	0.461**
							(0.264)	(0.213)	(0.230)
Intercept	-2.448***	-2.168***	-1.921***	-2.501***	-2.221***	-1.980***	-3.031***	-2.339***	-2.255***
	(0.399)	(0.274)	(0.211)	(0.432)	(0.252)	(0.225)	(0.478)	(0.279)	(0.240)
Sector- dummies	Incl.***	Incl.	Incl.***	Incl.***	Incl.	Incl.***	Incl.***	Incl.	Incl.***
Pseudo R2	0.244	0.216	0.191	0.349	0.295	0.294	0.43	0.336	0.339
#obs	733	733	733	733	733	733	733	733	733

Notes: Significance levels: *** 1%; ** 5%, * 10%; standard errors clustered at the NACE 3-digit level

Table 7: Subsequent nullification suits - probit estimations

b/se	(1) PlaintiffNull	(2) DefendantNull	(3) PlaintiffNull	(4) DefendantNull	(5) PlaintiffNull	(6) DefendantNull
NOVEL SALES	-1.29	-5.186	-2.957	-3.427	-1.808	-4.112
	(3.194)	(6.961)	(4.132)	(7.878)	(4.139)	(9.453)
IMITATION	6.628	9.202**	6.427	14.267***	6.84	22.132***
	(4.058)	(3.930)	(4.266)	(4.348)	(4.709)	(6.198)
UNCHANGED	-0.254	-0.559	-0.532	-1.123	-1.164	-1.211**
	(1.144)	(0.460)	(1.285)	(0.739)	(1.534)	(0.484)
EMPLOYMENT	0.000	0.002	0.000	0.002	0.001	0.008***
	(0.000)	(0.002)	(0.001)	(0.003)	(0.001)	(0.003)
AGE	0.020**	0.01	0.025**	0.000	0.032***	-0.023
	(0.010)	(0.018)	(0.010)	(0.021)	(0.012)	(0.018)
R&D INTENISTY	0.002	0.01	0.003	0.002	0.007	0.003
	(0.004)	(0.008)	(0.005)	(0.011)	(0.007)	(0.012)
PATENT INTENSITY			6.077	-4.549	9.201*	6.007
			(3.747)	(11.558)	(5.557)	(9.501)
PATENT QUALITY			-0.015	0.045	-0.024	0.000
			(0.019)	(0.058)	(0.025)	(0.052)
FRAGMENTATION			-0.401	-0.436	-0.946	-1.266
			(0.580)	(0.664)	(0.862)	(0.786)
CASH AVAILABLE			-0.388	67.749	1.236	121.447***
			(2.718)	(47.686)	(3.130)	(38.947)
IP DEPARTMENT			0.352	0.658	0.631	1.351*
			(0.461)	(0.623)	(0.500)	(0.780)
DESIGN					0.775	-1.2
					(0.612)	(0.870)
TRADEMARK					-1.035	-1.390*
					(0.952)	(0.838)
Intercept	-1.354**	-0.368	-1.658**	-0.353	-1.739**	0.773
	(0.539)	(0.560)	(0.662)	(0.613)	(0.758)	(0.633)
#obs	39	35	39	35	39	35

Notes: Significance levels: *** 1%; ** 5%, * 10%; standard errors clustered at the NACE 3-digit level

Table 8: Subsequent nullification suits –Probit models with Heckman selection (FIML estimations)

b/se	(1) PlaintiffNull	(2) Plaintiff	(3) DefendantNull	(4) Defendant
NOVEL SALES	-1.557	2.625*	-6.327	0.832
	(3.297)	(1.439)	(6.742)	(1.395)
IMITATION	7.742**	3.143	10.936***	4.247**
	(3.918)	(1.984)	(3.924)	(1.683)
UNCHANGED	-0.687	-0.427	-0.256	0.614***
	(1.101)	(0.301)	(0.773)	(0.162)
EMPLOYMENT	0.001	0.001***	0.002	0.000
	(0.001)	(0.000)	(0.002)	(0.000)
AGE	0.025***	0.010***	0.012	0.000
	(0.008)	(0.004)	(0.017)	(0.004)
R&D INTENISTY	0.004	0.006***	0.013	0.011***
	(0.004)	(0.002)	(0.010)	(0.002)
PATENT INTENSITY	6.997*	3.886***	-1.914	0.169
	(3.773)	(1.388)	(8.668)	(1.155)
PATENT QUALITY	-0.017	-0.008*	0.019	-0.003
	(0.015)	(0.004)	(0.018)	(0.003)
FRAGMENTATION		0.590**		0.640***
		(0.254)		(0.222)
Constant	-2.893***	-2.415***	-1.512	-2.431***
	(0.972)	(0.201)	(2.598)	(0.161)
#obs	731		733	
Censored	39		35	
Uncensored	692		698	
Correlation among eqs.	Insignificant		Insignificant	

Notes: Significance levels: *** 1%; ** 5%, * 10%; standard errors clustered at the NACE 3-digit level

SUPPLEMENTAL MATERIAL

Table S1: Litigation propensities - single equation logit estimations

b/se	(1) Plaintiff	(2) Defendant	(3) Settle	(4) Plaintiff	(5) Defendant	(6) Settle	(7) Plaintiff	(8) Defendant	(9) Settle
NOVEL SALES	8.048***	2.07	2.929	8.493***	3.656	1.805	7.311**	2.36	-0.02
	(3.098)	(2.742)	(3.307)	(3.024)	(3.311)	(3.660)	(3.717)	(3.273)	(4.026)
IMITATION	6.043	8.928***	8.090**	5.596	8.234**	9.157**	5.239	8.680**	9.152**
	(3.807)	(3.417)	(3.247)	(4.736)	(3.391)	(3.585)	(6.408)	(4.059)	(4.030)
UNCHANGED	-0.472	1.388***	-0.221	-1.161	1.337***	-0.804	-1.339*	1.426***	-0.8
	(0.612)	(0.347)	(0.584)	(0.719)	(0.363)	(0.593)	(0.812)	(0.364)	(0.628)
EMPLOYMENT	0.001***	0.001*	0.001***	0.001*	0.000	0.001*	0.001	0.000	0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
AGE	0.017**	-0.002	0.014*	0.018**	-0.006	0.013	0.016	-0.008	0.01
	(0.009)	(0.011)	(0.008)	(0.009)	(0.010)	(0.008)	(0.010)	(0.010)	(0.009)
R&D INTENISTY	0.024***	0.026***	0.026***	0.019***	0.025***	0.021***	0.018***	0.023***	0.020***
	(0.006)	(0.005)	(0.003)	(0.005)	(0.005)	(0.002)	(0.007)	(0.005)	(0.003)
PATENT INTENSITY				3.899	-2.923	3.889	6.624	-2.018	5.346
				(4.337)	(2.679)	(3.989)	(4.836)	(2.968)	(4.315)
PATENT QUALITY				-0.24	-0.610***	-0.049	-0.198	-0.600***	-0.009
				(0.148)	(0.188)	(0.144)	(0.143)	(0.178)	(0.138)
FRAGMENTATION				1.112**	1.509**	0.76	0.553	1.098*	0.394
				(0.546)	(0.648)	(0.505)	(0.570)	(0.605)	(0.503)
CASH AVAILABLE				5.878***	3.041	4.981**	7.872***	4.401*	6.058**
				(1.879)	(2.361)	(2.188)	(2.262)	(2.397)	(2.374)
IP DEPARTMENT				1.446***	0.995*	1.769***	1.200**	0.726	1.551***
				(0.483)	(0.543)	(0.389)	(0.519)	(0.544)	(0.417)
DESIGN							1.618***	1.452***	0.956*
							(0.534)	(0.483)	(0.499)
TRADEMARK							0.865	0.18	0.883*
							(0.603)	(0.457)	(0.485)
Intercept	-4.508***	-4.114***	-3.482***	-4.657***	-4.097***	-3.644***	-5.457***	-4.402***	-4.120***
	(0.889)	(0.638)	(0.446)	(0.984)	(0.555)	(0.474)	(1.041)	(0.605)	(0.497)
Sector- dummies	Incl.**	Incl.	Incl.***	Incl.***	Incl.	Incl.***	Incl.***	Incl.	Incl.***
Pseudo R2	0.238	0.216	0.187	0.343	0.296	0.294	0.417	0.337	0.336
#obs	733	733	733	733	733	733	733	733	733

Notes: Significance levels: *** 1%; ** 5%, * 10%; standard errors clustered at the NACE 3-digit level

Table S2: Litigation propensities – simultaneous equations probit estimations

b/se	(1) Plaintiff	(2) Defendant	(3) Settle	(4) Plaintiff	(5) Defendant	(6) Settle	(7) Plaintiff	(8) Defendant	(9) Settle
NOVEL SALES	4.043**	1.314	1.408	3.649**	1.356	0.555	3.189*	1.097	-0.108
	(1.601)	(1.406)	(1.538)	(1.647)	(1.629)	(1.893)	(1.879)	(1.695)	(1.907)
IMITATION	2.143	3.662**	3.507**	2.525	3.555**	3.711**	2.073	3.701**	3.233
	(2.046)	(1.681)	(1.637)	(2.332)	(1.746)	(1.749)	(2.929)	(1.876)	(1.970)
UNCHANGED	-0.113	0.731***	-0.011	-0.707**	0.593***	-0.381	-0.776*	0.674***	-0.33
	(0.200)	(0.170)	(0.216)	(0.341)	(0.192)	(0.268)	(0.405)	(0.186)	(0.301)
EMPLOYMENT	0.001***	0.000	0.001***	0.001**	0.000	0.000	0.001**	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
AGE	0.007	0.000	0.006	0.008*	-0.002	0.006	0.008	-0.003	0.005
	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)	(0.005)	(0.005)	(0.004)
R&D INTENISTY	0.013***	0.014***	0.016***	0.010***	0.011***	0.012***	0.009***	0.010***	0.012***
	(0.003)	(0.003)	(0.001)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
PATENT INTENSITY				3.953**	-0.311	2.033	4.967***	-0.122	2.074
				(1.928)	(1.454)	(1.951)	(1.843)	(1.409)	(1.996)
PATENT QUALITY				-0.008*	-0.002	0.001	-0.006	-0.001	0.001
				(0.005)	(0.005)	(0.004)	(0.004)	(0.006)	(0.004)
FRAGMENTATION				0.490**	0.596**	0.31	0.232	0.383	0.241
				(0.240)	(0.265)	(0.234)	(0.282)	(0.260)	(0.226)
CASH AVAILABLE				3.232**	1.337	2.691*	4.391***	2.159	3.021*
				(1.378)	(1.483)	(1.481)	(1.366)	(1.453)	(1.662)
IP DEPARTMENT				0.803***	0.603**	0.938***	0.597***	0.507**	0.810***
				(0.211)	(0.241)	(0.184)	(0.220)	(0.248)	(0.179)
DESIGN							0.859***	0.677***	0.425*
							(0.240)	(0.234)	(0.220)
TRADEMARK							0.545**	0.102	0.456**
							(0.231)	(0.214)	(0.208)
Intercept	-2.437***	-2.184***	-1.960***	-2.537***	-2.270***	-2.026***	-3.024***	-2.406***	-2.304***
	(0.376)	(0.272)	(0.195)	(0.411)	(0.252)	(0.230)	(0.476)	(0.294)	(0.223)
Sector- dummies	Incl.***	Incl.*	Incl.**	Incl.***	Incl.	Incl.***	Incl.***	Incl.	Incl.**
#obs	733	733	733	733	733	733	733	733	733

Notes: Notes: Significance levels: *** 1%; ** 5%, * 10%; standard errors clustered at the NACE 3-digit level; all correlation coefficients measuring the error term correlation across equations are estimated to be positive and significant at the 1% level

Table S3: Litigation propensities - single equation rare event logit estimations

b/se	(1) Plaintiff	(2) Defendant	(3) Settle	(4) Plaintiff	(5) Defendant	(6) Settle	(7) Plaintiff	(8) Defendant	(9) Settle
NOVEL SALES	7.800**	2.293	3.115	7.674***	3.647	2.002	6.460*	2.764	0.204
	(3.036)	(2.687)	(3.240)	(2.944)	(3.223)	(3.563)	(3.609)	(3.178)	(3.908)
IMITATION	6.005	8.872***	7.989**	5.349	7.802**	8.749**	4.985	8.099**	8.713**
	(3.731)	(3.348)	(3.181)	(4.610)	(3.301)	(3.490)	(6.221)	(3.941)	(3.912)
UNCHANGED	-0.355	1.325***	-0.135	-0.929	1.254***	-0.663	-1.013	1.320***	-0.627
	(0.599)	(0.340)	(0.572)	(0.700)	(0.353)	(0.577)	(0.788)	(0.354)	(0.610)
EMPLOYMENT	0.001***	0.001	0.001***	0.001	0.000	0.001*	0.001	0.000	0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
AGE	0.017**	-0.001	0.014*	0.016*	-0.006	0.012	0.014	-0.008	0.009
	(0.009)	(0.010)	(0.008)	(0.008)	(0.010)	(0.008)	(0.010)	(0.010)	(0.008)
R&D INTENISTY	0.021***	0.024***	0.024***	0.015***	0.020***	0.018***	0.015**	0.019***	0.018***
	(0.006)	(0.004)	(0.003)	(0.005)	(0.004)	(0.002)	(0.007)	(0.005)	(0.003)
PATENT INTENSITY				3.066	-2.675	3.726	5.913	-1.584	5.346
				(4.221)	(2.608)	(3.883)	(4.695)	(2.882)	(4.189)
PATENT QUALITY				-0.113	-0.445**	0.02	-0.038	-0.434**	0.058
				(0.144)	(0.183)	(0.140)	(0.138)	(0.173)	(0.134)
FRAGMENTATION				1.041*	1.404**	0.688	0.483	1.009*	0.323
				(0.532)	(0.631)	(0.492)	(0.553)	(0.588)	(0.489)
CASH AVAILABLE				4.468**	2.215	3.672*	5.931***	3.163	4.440*
				(1.829)	(2.298)	(2.130)	(2.196)	(2.327)	(2.305)
IP DEPARTMENT				1.356***	0.948*	1.668***	1.099**	0.695	1.446***
				(0.470)	(0.529)	(0.378)	(0.504)	(0.529)	(0.405)
DESIGN							1.426***	1.272***	0.876*
							(0.518)	(0.469)	(0.484)
TRADEMARK							0.75	0.151	0.809*
							(0.585)	(0.444)	(0.471)
Intercept	-4.254***	-3.934***	-3.374***	-4.307***	-3.803***	-3.485***	-4.892***	-3.980***	-3.879***
	(0.871)	(0.625)	(0.437)	(0.958)	(0.540)	(0.462)	(1.011)	(0.587)	(0.483)
Sector- dummies	Incl.***	Incl.	Incl.	Incl.***	Incl.	Incl.***	Incl.***	Incl.	Incl.***
#obs	733	733	733	733	733	733	733	733	733

Notes: Notes: Significance levels: *** 1%; ** 5%, * 10%; standard errors clustered at the NACE 3-digit level;

Survey questions for the dependent variables on IP disputes and Nullification (translated from Dutch into English)

1. Was your company in the period 2010-2012 accused by other companies of infringement of their Intellectual Property Rights (IPR) before the court of law?

No ☐ ▶ Go to question **3**

Yes ☐ ▶ Go to question **2**

2. Was in response to this accusation nullification of the IPR requested?

No ☐

Yes ☐

3. Did your company in the period 2010-2012 accuse other companies of infringement of your IPR before the court of law?

No ☐ ▶ Go to question **5**

Yes ☐ ▶ Go to question **4**

4. Was in response to this accusation nullification of the IPR requested?

No ☐

Yes ☐

5. Did your company, in the period 2010-2012, conduct negotiations or made settlements outside the court of law to avoid litigation concerning IPR.

No ☐

Yes ☐