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專利訴訟與創新

Patents Litigation and Innovation

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摘要

本研究探討專利訴訟與創新之間的關係，以及由專利授權公司 (non-practicing entity, NPE)提起的訴訟如何影響生產公司的創新流程。在建構兩造關係的過程中，筆者收集以 11 筆「常見爭訟專利」為系爭專利，並於西元 2000 年至 2012 年間提出的所有案件。「常見爭訟專利」係由美國 Stanford 大學智慧財產權訴訟相關資料庫 (Stanford Intellectual Property Litigation Clearinghouse, IPLC)整理而成。而後筆者將前述案件和由美國專利及商標局 (United States Patent and Trademark Office, USPTO)、全球專利資訊網 (WEBPAT)，以及 Compustat 所取得的數據相結合，建立本研究的樣本。本研究的實證結果顯示：專利訴訟長期有助於促使生產公司改善其創新流程；若原告為專利授權公司，此等效果較為顯著。由此觀之，政府應保障專利授權公司的專利所有權，藉以增進創新，提升企業研發動能。

關鍵字：專利訴訟、創新、專利授權公司 (NPE)、生產公司、「常見爭訟專利」。

Abstract

This study looks into the relationship between patent litigation and innovation; in addition, how litigation initiated by non-practicing entities (NPEs) impacts on product companies' innovation process is also discussed. In order to construct the plausible relation between the two, I collect cases related to the 11 Most-Litigated Patents listed by Stanford Intellectual Property Litigation Clearinghouse (IPLC), covering the period from year 2000 to 2012. Thereafter, I create my sample by matching these cases with data from the U.S. Patent and Trademark Office (USPTO), WEBPAT and Compustat. The empirical results of this research suggest that litigation can benefit product companies in terms of innovation, improving the overall innovation process. If the plaintiff is an NPE, the effect is greater. Protecting NPE-owned patents, therefore, can increase innovation and improve social welfare.

Keywords: patent litigation, innovation, non-practicing entity (NPE), product company, Most-Litigated Patent.

Patents Litigation and Innovation

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I. Introduction

The rapid growth of patent litigation cases in the U.S. has caught much attention in recent years. According to Stanford Intellectual Property Litigation Clearinghouse (IPLC henceforth), yearly growth rate of cases had never passed 9%; however, started year 2011 it skyrocketed to over 30%, and more than 50% in 2012 (Figure 1). One who notices this phenomenon may wonder: who are the plaintiffs filing these cases?

Literature indicates that, at least for the most part, non-practicing entities (NPEs henceforth) perhaps are the ones to blame. NPEs are individuals or firms rarely or never practicing their patents but instead focusing on earning licensing fees (Shrestha, 2010). Suits filed by NPEs in the U.S. federal courts has been growing year after year (STPI, 2012). Allison, Lemley, and Walker (2009) presented a study of patents which have

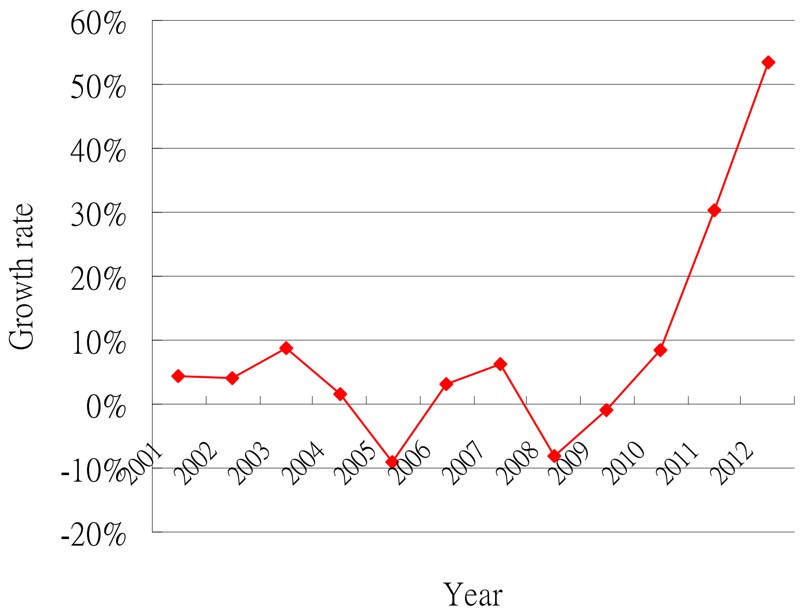

Figure 1 Yearly growth rate of patent litigation (Source: IPLC)

been litigated eight or more times. They found that during 2000 to 2008, more than 80% of the suits related to these patents were brought up by NPEs. The role of NPEs has often been controversial due to their legal action against product companies: some criticize this litigation behavior incurs great loss for “practicing” entities, the other praise them by stating that litigation may intensify competition and enhance innovation. Unfortunately, neither opinion is based on much real data.

The journey of my exploration starts from here. In section II I will review the prior literature which is relevant to this study. In section III I will describe the empirical framework for the research. Section IV presents the empirical results in this research and discusses the findings. Section V concludes.

II. Literature Review

A. NPEs: Threat or Chance?

A simple definition of NPEs is individuals or firms which rarely or never practice their patents but instead focusing on earning licensing fees (Shrestha, 2010). This is a more neutral way to define NPEs. Another popular although highly controversial definition of NPEs focuses more on their troll behavior, emphasizing that they charge downstream manufacturers excessive licensing fees which their patented technology cannot justify (Geradin, Layne-Farrar, and Padilla, 2012). From this definition, one may relate NPEs to patent trolls. Reitzig, Henkel, and Heath (2007) defined patent trolls as individuals or firms seeking to generate profits mainly from licensing or selling their patented technology to manufacturing firms. To do so, trolls claim fees from firms which infringes on the trolls' patents and hence make them under pressure to reach a settlement with the trolls.

At this point, one perhaps wonders whether NPEs are the same as patent trolls. Unfortunately, scholars have yet to reach an agreement on this issue: while most suggest "patent trolls" as a synonym for NPEs, others criticize this definition for being far too broad and advocate for a narrower way to define patent trolls (Denicolò, Geradin, Layne-Farrar, and Padilla, 2008; Geradin et al., 2012; Lemley, 2008). Back to the definition of NPEs, Allison et al. (2009) suggested that based on patent owners, NPEs can be categorized into 10 different "entity status" categories:

- Acquired patents
- University heritage or tie
- Failed startup
- Corporate heritage
- Individual-inventor-started company
- University/Government/NGO
- Startup, pre-product
- Individual
- Industry consortium
- IP subsidiary of product company (p.10)

Since NPEs are infamous for their capability to patent technology before being infringed and file patent lawsuits claiming excessive licensing fees, commonly known as a "holdup" problem, how these litigation activities affects industries and innovation has often received special attention. Many researchers (e.g. Reitzig et al. (2007), Farrell and Shapiro (2008)) have reasoned that NPEs can operate profitably by practicing holdup of their weak patents and warned that the strategic exploitation will dissipate social welfare by mainly reducing manufacturers' incentives to innovate. On the contrary, some argued that the holdup problem is not as pervasive as the majority believe but rather sporadic, showing that there is lack of evidence which the problem has adverse impact on innovation (Denicolò et al., 2008); protecting NPE-owned strong patents, they proposed, can increase innovation, lower downstream prices by increasing competition, and thus improve welfare (Geradin et al., 2012).

Another focal point is the strategies which NPEs adopt to practice holdup. Reitzig, Henkel, and Schneider (2010) laid out two polar scenarios. In the first scenario, NPEs deploy patents of relatively lower quality (or, in other words, less citations received) which will be eventually invalidated. To extract money from defendants, they seek preliminary injunction to build up short-term time pressure, and defendants will be forced into settlement. If patents are of higher quality, this is the other scenario: NPEs bank on exaggerating damage from past infringement, pressing for damage awards.

Empirical evidences are required to examine which scenario is closer to reality. From former studies, Allison, Lemley, Moore, and Trunkey (2004) organized five measurements of patent quality which were traditionally evaluated:

- Patent claims
- Prior art citations made

- Citations received
- Generality and originality indexes
- Patent classifications.

In addition, they also found another three new factors:

- Families of applications and patents
- Prosecution length
- Patent age.

Using data from Patent Statistical Database (PATSTAT) and International Patent Documentation Center (INPADOC) of the European Patent Office (EPO), Fischer and Henkel (2012) identified 565 patents acquired by 39 NPEs. They found that the aforementioned factors all increase NPEs' willingness to acquire a patent, confirming that NPEs own patents of higher quality. Another study carried out by Shrestha (2010) also reached similar conclusion. His data were gathered from the U.S. Patent and Trademark Office (USPTO henceforth) and the IPLC, which contained 287 patents owned by 51 NPEs. He concluded that the quality of NPE-owned patents is higher than other litigated patents, indicating that NPEs hold high-value patents (Shrestha, 2010).

The studies mentioned above do show that NPEs possess high-quality patents; hence, Reitzig et al.'s second scenario is the one supported by real data. However, some questions remain: What is the impact of holdup? How does holdup affect innovation? More real data evidences are needed to clarify these issues. Moreover, Allison, Lemley, and Walker (2010) pointed out that these studies chose a nonrandom set of NPE cases based on firms reported in the press as NPEs. These "NPEs" represent only a small fraction of NPEs, so the findings they obtained maybe result from selection bias.

B. Patent Litigation

Litigated patents are always the core of every patent lawsuit. For this reason, it is worthwhile to gain more understanding of them. Allison et al. (2004) used Bronwyn Hall's database and they applied both comparison of means and logistic regression. From their results, they pointed out that litigated patents are superior to non-litigated ones by showing that litigated patents cite more prior art, receive more citation from others, involve in lengthier prosecution process and contain more claims. Whether a patent is litigated or not, they argued, also implies the intrinsic value of a patent.

So far the research stated all focus on the relationship between NPEs and litigated patents. Different from those studies, Allison et al. (2009) derive attention to another relevant topic: does the relationship differ if patents have been litigated more than once? Data from the IPLC database were used, and they collected patents which have been litigated eight or more times to carry out their empirical strategy. They identified 106 patents litigated multiple times. Then both bivariate comparisons and logistic regression were applied to check the differences in patent characteristics between such patents and once-litigated ones. These characteristics were:

- whether ownership of the patent had been assigned after issuance and before the first litigation of that patent

- whether the patent was initially issued to a small or large entity
- the number of U.S. non provisional applications leading to the particular patent
- the number of forward citations, adjusted for patent age
- the subset of forward citations consisting of self-citations, also adjusted for patent age
- the number of claims
- the number of references to prior U.S. patents
- the number of references to prior foreign patents
- the number of references to nonpatent prior art (pp.11-12)

Similar to what Allison et al. (2004) found, the researchers found that in contrast with once-litigated patents, patents litigated multiple times have more claims, more prior art citations, more citations received, a higher likelihood of assignment before litigation, and larger numbers of continuation applications, showing that such patents are also more valuable (Allison et al., 2009). Their results substantially strengthen the conclusion made by Allison et al. (2004): litigated patents are valuable patents.

In addition, Allison et al. found that litigated patents are asserted in lawsuits soon after they were obtained. As for the assignees or applicants of these patents, most are domestic companies (in this case, U.S. companies), and especially individuals or small companies, supporting the idea that litigated patents are mostly owned by NPEs. Allison et al. (2009) also help us take a closer look of this issue. From 2000 to 2008, over 80% of the suits involving such patents were filed by NPEs, but they accounted for merely about 16% if patents had just been litigated once. Moreover, they also own more than 50% of patents litigated multiple times.

The mean difference which results from patent owners' entity status is one of the main finding discovered by Allison et al. (2009). According to their data, more than one-third of patents litigated multiple times were sold to another owner before the first lawsuit is brought up. If small entities are patent applicants rather than purchasers of their patents, Allison et al. concluded, they tend to litigate less often, even lesser than large entities. For once-litigated patents, product companies represent 83.3% of them; in other words, NPEs do not retain that many "ordinary" patents. However, when it comes to patents litigated multiple times, it is a different story: NPEs hold a significant share of them; product companies, conversely, account for only 45.6%.

Two classes of NPEs truly stand out in the set of patents litigated multiple times: one is licensing companies in the business of buying up and enforcing patents, and the other is individual-inventor-started companies. The former account for 11.7% and the latter for 41.7% of such patents. Nevertheless, this is not the rest of the story. By weighting entity status by the number of suits, Allison et al. (2009) showed that more than 80% of suits related to such patents are brought up by NPEs. Now the NPEs here are individual-inventor-started companies, which account for 74.4% of the cases. NPEs are merely a small share of the suits filed on once-litigated patents, but they represent an overwhelming share when it comes to patents litigated multiple times.

Some perhaps doubt the importance of studying patents which have been litigated more than once; after all, any such patents are virtually outliers because little patents can be sued over multiple times in different courts. But even if such patents are outliers, this does not mean issues about them are irrelevant. “They represent a substantial percentage of patent litigation, and… they may have an even larger influence on the law.” (Allison et al., 2010, p. 710) Putting it another way, such patents are the ones which lead to the “holdup” phenomenon. The above studies carried out by Allison et al. truly help researchers contemplate and refocus on the “patents” requiring more attention. Regrettably, their research still cannot offer a clear picture of the relationship between patent litigation and innovation.

C. Technology and Industry Differences

Unlike litigation, researchers have established some relations between merger and acquisition (M&A henceforth) and innovation already. M&A can be "characterized by the primary objective of gaining dominance and control over various subsidiaries" (Lin and Jang, 2010, p. 120).

Cloodt, Hagedoorn, and Van Kranenburg (2006) analyzed post-M&A innovative performance of acquiring firms in high-tech sectors, and found that relatedness between acquired and acquiring firms' technology has a curvilinear impact on innovative performance of the acquiring. Hall and Bagchi-Sen (2007) unveiled that in the biotechnology industry, acquired firms with higher levels of research and development (R&D henceforth) intensity impact more greatly on acquiring firms' innovation through M&As. Following these studies is Lin and Jang (2010) who investigated effects of M&A strategies on innovative activities. They drew ten medical device companies from the top 20 in the U.S., and then collected data on M&As they undertook and their patenting performance. The results of their study suggested that M&A is only likely to benefit acquiring firms' innovative activities if the technological proximity is high between them and acquired ones (Lin and Jang, 2010).

Similar to M&A, litigation exhibits differences among industries and technologies. Schneider (2011) reported that plant biotech firms holding large patent portfolios are more likely to be sued presumably because the scope and boundaries of plant biotech patents are often uncertain and ill-defined. In addition, Allison et al. (2004) presented that the likelihood of patents on medical devices, computer-related inventions, software, electronics, or mechanics to become litigated patents is higher than the average of all patents issued. A substantial part of litigated patent is composed of semiconductor patents; nevertheless, they are far less frequent to be litigated. The empirical outcomes obtained by the researchers while comparing patents litigated multiple times and once-litigated patents are similar with that of the aforementioned study. 72% and 34% of the patents litigated multiple times are in the computer and communications industries, respectively, but they individually account for only 34% and 8% of the once-litigated patents. In brief, the odds are disproportionately high for IT patents to become patents litigated multiple times. Semiconductor inventions, again, are absent from the list (Allison et al., 2009).

Research on M&A does help shed light on constructing the relationship between litigation and innovation. On the one hand, it points out the significance of technology and industry differences. Just like how technology closeness affects innovation through M&A, it may as well affect innovative performance through litigation. On the other hand, it provides an applicable framework to use: truly it lays down a useful foundation for one to build up possible relations between the two.

III. Empirical Framework

A. Most-Litigated Patents

Allison et al. (2009) has showed the importance of distinguishing patents litigated more than once; hence, setting the "outliers" apart becomes a crticial issue. Initially, I would have used eight or more times as cutoff point as Allison et al. did, but I lacked proper techniques to identify such patents. Thankfully, the IPLC oganizes a list of "Most-Litigated Patents" for research use. Opening in year 2008, the IPLC complies patent lawsuits and related information from 2000 until this time. This list consists of 11 patents[1] which has been litigated more than 100 times[2]. The cutoff point of 100 times may raise curiosity; in fact, it is an inherent limitation. Since patent lawsuits has been increasing rapidly in recent years, the IPLC database can no longer guarantees the accuracy of number of cases related to a patent if it is less than 100. For instance, the database reports number of related cases of patent #5815551 as "99", but there were only 79 suits related to this patent.

Till December 31st, 2012, there are 751 suits related to the 11 patents in total. Among these lawsuits, mostly 2 or 3 patents are litigated in a case. A case is usually brought up by 1 or 2 plaintiff(s), but number of defendants per case has larger variation: the average is between 3 and 4 but both the median and mode are 1. Compared with the

1 Please refer to Appendix I for more details.
2 Without mention, the access date is March 15th, 2013.

finding gotten by Allison et al. (2010), they revealed the average number of defendants is 5.2 per suit per patent, so the figure in this study is a little bit lower. However, I notice that number of defendants reported by the IPLC is sometimes inflated because it may double count the same defendant; to avoid such sampling error, I calculate all of the figures above on my own and they should be better proxies for lawsuits related to patents litigated mutiple times.

Amid the litigants related to these lawsuits, 4 NPEs[3] are identified. NPE-plaintiffs in total account for 415 cases, or 55.3% of the cases; but suits against NPE-defendants were filed by product companies only: no scenario where NPEs sued NPEs. According to Allison et al. (2009), over 80% of such suits are brought up by NPEs; to an extent, the figure reported here is again a little bit lower. Nevertheless, Allison et al. also divulged that 60% of their sample were filed by Ronald A. Katz. This is not the case in my sample: Ronald A. Katz only brought up 13.2% of these lawsuits, and no single plaintiff accounts for more than 40% of the cases. Selection bias, therefore, might be a concern in their data.

[3] Please refer to the Appendix II for more details.

B. Variables

In the rest of this section, i will be used to indicate the defendant and j to denote the plaintiff. Ideally, for stock variables, the length of their accumulation period should be determined by technology development cycle, but the cycle time varies among industries. According to Lin and Jang (2010), the cycle time of medical device industry is about three to five years; in addition, Allison et al. (2004) reported that the likelihood of patents on medical devices to become litigated patents is higher than the average of all patents issued. Thus, I use the cycle time of medical device industry as a proxy for the cycle time of a litigant, and create both stock variables for a litigant, $Patent\_Stock_{i,t}$ and $Plaintiff\_Patent\_Stock_{j,t-2}$ based on a four-year accumulation period.

$Patent\_Stock_{i,t}$ is the dependent variable reporting the innovative performance of the defendant in the post-litigation period. Innovative performance is defined as number of patent applications filed by the defendant, using a four-year stock period from t–3 to current year t based on a 15% annual depreciation rate. Data of patent application are obtained from the USPTO and WEBPAT databases.

$Plaintiff\_Patent\_Stock_{j,t-2}$ is an independent lag variable selected to measure the quantity effect of technology through litigation. This variable is defined as number of patent applications brought up by the defendant, using a four-year stock period from t–5 to t–2 based on a 15% annual depreciation rate. Data of patent application are also obtained from the USPTO and WEBPAT databases.

To understand how NPEs affect the relation interested, D_NPE_j is an independent variable which takes a value of 1 if the plaintiff is an NPE. Information related to this variable is basically extracted from the list of NPEs identified by Allison et al. (2009)[4]. Some perhaps argue that there is the tendency of omitting true NPEs if identifying in this way; however, it is still the preferable method because it is highly likely that the press may exaggrate product companies' "troll-like" behavior, which will eventually lead to wrong identification.

$Case_{i,j,t}$ and $Case\_All_{i,t}$ are independent variables meant to capture the current and long–term effect of a lawsuit. The variables are defined as the cumulative totals of cases which the plaintiff and all plaintiffs brought up against the defendant, respectively. It may concern a few that the formation of *Case* variable will also capture time trend for accumulated cases should grow year after year. In reality, the dataset shows that suits a plaintiff filed against a certain defendant often concentrated within a year. These data can be fetched from the IPLC.

$D\_Technology\_Proximity_{i,j,t-2}$ is an independent lag variable used to measure the technological proximity between each of the defendant and plaintiff. This variable represents the impact of technological proximity on innovative activities by comparing

4 Besides, I also take references of other sources to identify whether a plaintiff is an NPE. Please refer to Appendix II.

the major technological fields associated with each pair of the defendant and plaintiff. Here major technological fields are defined as the top three sections of the International Patent Classification (IPC henceforth) which most patent belong to, using a four-year stock period from year t–5 to t–2. It takes a value of 1 where the plaintiff's four-year stock belongs to the identical major fields as that of the defendant, otherwise 0. Information related to this variable can be acquired from WEBPAT.

$Plaintiff\_Patent\_Diversity_{j,t-2}$, which is defined as the heterogeneity of the plaintiff's patent stocks in year t–2, is a lag control variable designed to analyze the quality influence of technology through litigation. This variable is measured by $1\text{-}HHI_{t-2}$, where HHI_{t-2} represents the technology concentration of the patent stock in terms of patent class in year t–2, and is specified as follows:

$$HHI_{t-2}=\Sigma(n_{j,t-2}/N_{t-2})^2$$

where $n_{j,t-2}$ denotes plaintiff j's total number of patents in an IPC class in year t–2, and N_{t-2} is the grand total of the four-year patent stock in year t–2. $Internal\_Diversity_{i,t-2}$, a lag control variable, is the heterogeneity of the defendant's patent stocks in year t–2. This variable is designed to detect the defendant's indigenous diversity for the full range of technologies, and can generally be inferred as a way of explaining divergence in innovation. It is measured in a fashion similar to $Plaintiff\_Patent\_Diversity_{j,t-2}$.

$Size_{i,t-2}$ is a lag control variable and is the logarithmic value of the defendant's total number of employees in year t–2. It indicates the influence on innovative ability attributable to the scale of the defendant. Finally, $R\&D\_Stock_{i,t-2}$ is a lag control variable which reports the defendant's four-year stock of R&D expenditures, from year t–5 to t–2. This study as well considers the time effect of deterioration by including the diminishing significance of R&D expenditures on innovation through the application of a 15% depreciation rate.

$Plaintiff\_Patent\_Diversity_{j,t-2}$, $D\_Technology\_Proximity_{i,j,t-2}$ and all of the control variables are based on a two-year lag period, i.e. t–2, with regard to the point in time at which the learning effect starts to affect the defendant significantly. The list of variable definitions is in Table 1.

Table 1 Variable definitions

Variable (Source)	Definition
Patent_Stock (USPTO & WEBPAT)	Four-year stock of patent applications to the USPTO by the defendant using a 15% annual depreciation rate.
Plaintiff_Patent_Stock (USPTO & WEBPAT)	Four-year stock of patents applications to the USPTO by the plaintiff using a 15% annual depreciation rate.
D_NPE (Allison et al. (2009))	The variable takes a value of 1 if the plaintiff is an NPE.
Case (IPLC)	The cumulative total of cases which the plaintiff filed against the defendant.
Case_All (IPLC)	The cumulative total of cases which all plaintiffs filed against the defendant.
D_Technology_Proximity (WEBPAT)	The relevance and the closeness, in terms of technological fields, between the individual defendant and the cumulative total of the plaintiff's patents. The cumulative total of the plaintiff comprises only of its four-year stock, with the major technological fields being defined as the top three IPC sections which most patents belong to; a comparison is then made between the defendant and the cumulative total of the plaintiff's patents. If the major fields between the defendant and plaintiff in the four-year period are the same, or very close, the variable for that year takes a value of 1; otherwise 0.
Plaintiff_Patent_Diversity (WEBPAT)	The value of 1-*HHI* for the patent stock of the plaintiff. The calculation of *HHI* is as follows: $HHI_{t-2}=\Sigma(n_{j,t-2}/ N_{t-2})^2$ where $n_{j,t-2}$ represents the total number of patents in an IPC class of firm j in year t–2, and N_{t-2} represents the grand total of the four-year stock of patents in year t–2.
Internal_Diversity (WEBPAT)	The value of 1-*HHI* for the patent stock of the defendant.
Size (Compustat)	The number of employees hired by the defendant each year (in logarithmic value).
R&D_Stock (Compustat)	Four-year stock of the defendant's R&D expenditure using a 15% annual depreciation rate.

C. Modeling

In this research, I would like to look into the relationship between patent litigation and innovation, and especially how litigation initiated by NPEs can impact on product companies' innovation process. In order to gain a basic understanding of litigation and innovation, I estimate the following least squares regression:

Equation 1

$$\ln(Patent\_Stock_{i,t}) = \beta_0+\beta_1 Year_{i,t}+\beta_2 Case_{i,j,t}+\beta_3 Case\_All_{i,t}+\varepsilon \quad (1)$$

where $Patent\_Stock_{i,t}$ represents the non-negative integer-valued dependent variable for the defendant's innovative performance, measured by number of patent applications filed and accumulated to the current year t since the year t–3. Given the discrete nature of patent stock data, the natural logarithmic form is used as dependent variable. If the conjecture is correct, there should be a positive causal relation existing between $Case_{i,j,t}$ ($Case\_All_{i,t}$) and $Patent\_Stock_{i,t}$.

After estimating the causal effect of litigation, how other aspects influence the relationship will be considered. Research on M&A has identified a variety of factors that may attribute to a firm's innovative performance. Among many others, some are more important, which include: R&D intensity, firm size, market structure, accumulated experience in innovation and technology variety.

Based on Equation 1, I further conjecture that litigation may give a boost to the quantity and quality of defendants' patenting and technology base, enhancing its subsequent development. Nevertheless, when it comes to measuring innovative output of firms, it is common amid prior studies to adopt either R&D inputs or number of patents issued (or applied for) as the numerical metric. Here I measure innovative capacity using number of patent applications filed with the USPTO.

To analyze the factors which influence defendants' innovative performance, and particularly, to confirm litigation can impact innovation and unveil some details behind it, I follow Lin and Jang (2010) by using pooled time-series data and crosssectional information from various sources, and estimate the least squares regression[5]as follows:

Equation 2

$$\ln(Patent\_Stock_{i,t}) = \beta_0+\beta_1\ln(Plaintiff\_Patent\_Stock_{j,t-2})+\beta_2 D\_NPE_j$$
$$+\beta_3 Case_{i,j,t}+\beta_4 Case\_All_{i,t} +\beta_5 D\_Technology\_Proximity_{i,j,t-2}$$
$$+\gamma_1 Plaintiff\_Patent\_Diversity_{j,t-2}+\gamma_2 Internal\_Diversity_{i,t-2}$$
$$+\gamma_3 Size_{i,t-2}+\gamma_4 \ln(R\&D\_Stock_{i,t-2})+industry\ dummies+\varepsilon \quad (2)$$

In the equation, $Plaintiff\_Patent\_Stock_{j,t-2}$, D_NPE_j, $Case_{i,j,t}$, $Case\_All_{i,t}$ and $D\_Technology\_Proximity_{i,j,t-2}$ are independent variables. The remaining variables: $Plaintiff\_Patent\_Diversity_{j,t-2}$, $Internal\_Diversity_{i,t-2}$, $Size_{i,t-2}$ and $R\&D\_Stock_{i,t-2}$ are

[5] Given the discrete nature of patent stocks data, OLS may not be an appropriate method. Please refer to Appendix III for an alternative estimation of Equation 2 using generalized least squares.

control variables. β_1 to β_4 and γ_1 to γ_4 are the respective estimated coefficients of these independent and control variables, and β_0 is a constant intercept to the y-axis.

Up to this point, I have introduced the 751 cases related to the 11 Most-Litigated Patents and variables going to use, as well as the modeling. In the next section, real data will be used to present the empirical results in this research.

IV. Empirical Results

A. Data

My dadaset is a combanation of data from several sources: the IPLC, the USPTO, WEBPAT and Compustat. There are 1,345 cases related to the 11 Most–Litigated Patents from year 2000 to 2012. Deleting double-counted cases resulted in 751 cases. After deleting cases brought up by counter–plaintiffs (18 cases) and cases in which all defendants were not legal entities (75 cases), 658 cases were obtained.

To match these data, I had no choice but to sacrifice some of the lawsuits related to the 11 Most-Litigated Patents. Before matching, the 658 cases can form 2,680 firm pairs; matching resulted in 1,377 firm pairs. Firm pairs which contain NPE-defendants were then dropped to discuss the impact of litigation initiated by NPEs on product companies' innovation process. Further, if a plaintiff filed multiple suits against the same defendant within a year, only one firm pair was kept for that year. At last, the dataset contains 280 cases, forming 885 firm pairs; during 2000 to 2012, the research period, there are 11,505 firm–pair–years.

A summary of the dataset and a table of correlations among independent and control variables are provided in Table 2 and 3, along with a flowchart which depicts the data cleaning process (Figure 5)[6].

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[6] Due to the missing value problem in *Size* and *R&D_Stock* variables, only 7,774 firm-pair-years are used to estimate Equation 2.

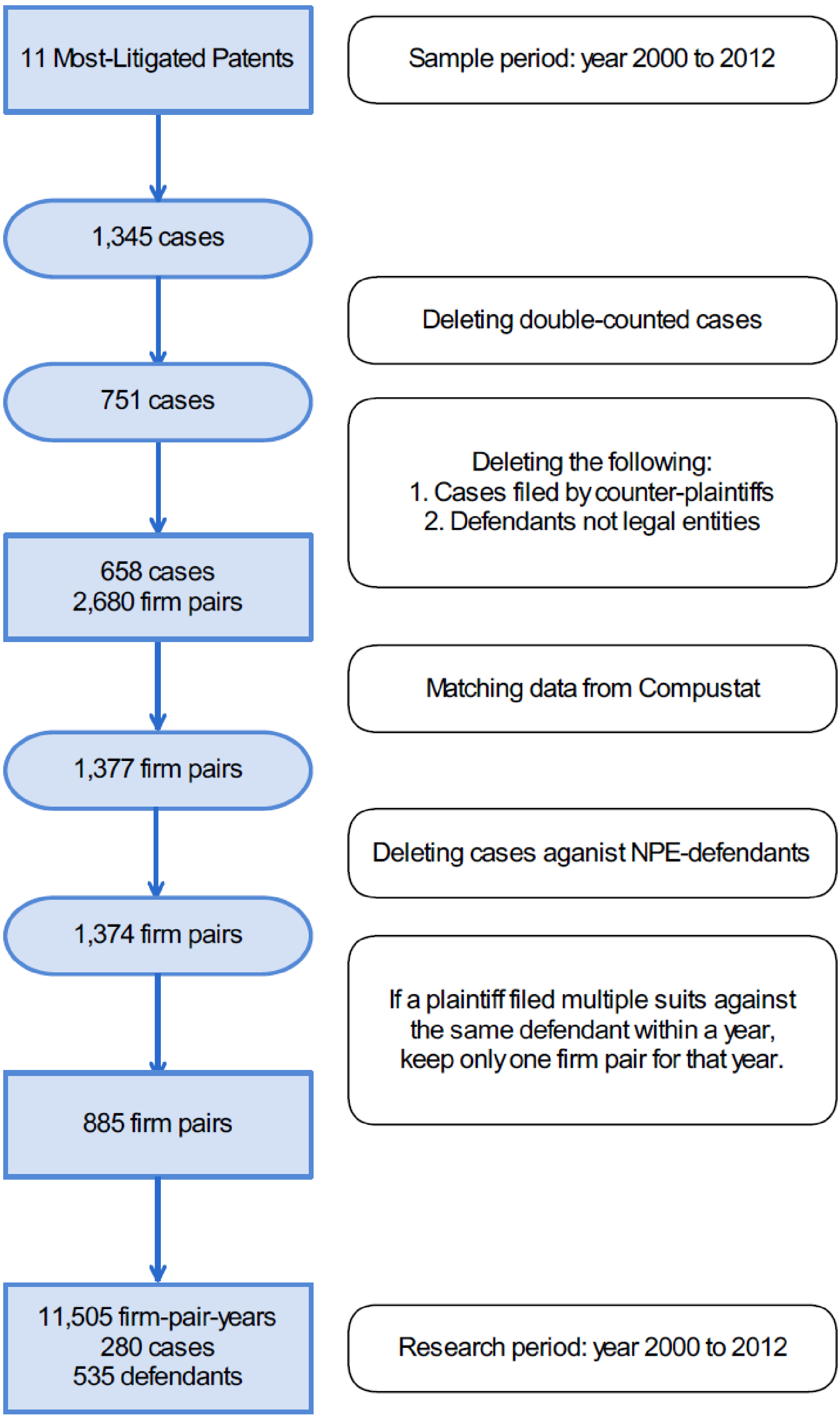

Figure 2 Data cleaning process

Table 2 Descriptive statistics

Varibale	Mean	SD	Minimum	Maximum
Patent_Stock	50.4	542.2	0	17608.7
Plaintiff_Patent_Stock	1.0137	5.4674	0	257.7
D_NPE	0.4588	0.4983	0	1
Case	0.4686	1.1264	0	20
Case_All	1.1288	3.0323	0	44
D_Technology_Proximity	0.3430	0.4747	0	1
Plaintiff_Patent_Diversity	0.3107	0.3552	0	0.9679
Internal_Diversity	0.3397	0.4232	0	1
Size	2.6919	1.8506	-14.5558	7.7518
R&D_Stock	65099.6	1768356	0	86200000

Table 3 Correlation matrix (In **Bold**: highly or moderately correlated)

	Patent_Stock	*Plaintiff_Patent_Stock*	*D_NPE*	*Case*	*Case_All*
Patent_Stock	1				
Plaintiff_Patent_Stock	0.0118	1			
D_NPE	-0.0424	0.1026	1		
Case	0.0084	-0.0126	0.1952	1	
Case_All	0.0045	-0.0182	0.1293	**0.4991**	1
D_Technology_Proximity	-0.0576	-0.0546	**-0.3113**	-0.0426	-0.0668
Plaintiff_Patent_Diversity	-0.0372	0.1859	**0.9403**	0.1302	0.0839
Internal_Diversity	0.1593	0.0583	0.0993	0.0611	0.1405
Size	0.0678	0.0141	0.0633	0.1142	0.2258
R&D_Stock	-0.0014	-0.0053	-0.0248	0.0087	0.0032

	D_Technology_Proximity	*Plaintiff_Patent_Diversity*	*Internal_Diversity*	*Size*	*R&D_Stock*
D_Technology_Proximity	1				
Plaintiff_Patent_Diversity	-0.3075	1			
Internal_Diversity	-0.3305	0.1246	1		
Size	-0.0875	0.0683	0.1813	1	
R&D_Stock	0.0472	-0.0231	-0.0259	0.0443	1

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The aforementioned matching process actuaaly allows a deeper cognizance of the litigants on the other side, the defendants. These defendants, composed of 535 product companies, cover a number of industries. By applying the 2-digit Standard Industrial Classification (SIC), it is clear that most of them belong to retail (24.9%), transportation (22.8%) and manufacturing industries (18.1%).

The concentration of industries defendants belong to may surprise a few: though a considerable share of defendants is in the manufacturing industry, many belong to retail and transportation industries. As for those in the transportation industry, the 2-digit SIC reveals that many are communications firms. One may doubt whether retail firms can ever file any patent applications; indeed, they can, and they file a lot. First, they can develop their unique sales process. The patent stock in 2012 of Walgreen Co. (GVKEY: 011264), a pharmethetical retialer, is equal to 28.3. It patented methods and systems for seperating and distributing pharmacy order processing, refilling prescriptions, ordering prescriptions, etc. Not only that, they can also design their own merchandise. Staples Inc. (GVKEY: 015521), an office supply retailer filed applications to patent its designs for pens, ribbon dispensers, tab folders and so on. Its patent stock in 2012 equals 8.15.

Categorizing defendants based on type of plaintiffs, NPEs sued 275 and product companies sued 350, wheras both filed suits against 90 of them. The analysis of this part is presented in Table 4 below:

Table 4 Defendants categorized by type of plaintiffs

Industry	Total		Sued by NPEs	Sued by product companies	Avergae patent stock in 2012
All	535	100%	275	350	96.10
Retail	133	24.86%	34	125	7.57
Transportation	**122**	**22.80%**	**114**	**30**	**36.53**
Manufacturing	97	18.13%	40	67	249.12
Finance	85	15.89%	40	67	16.74

What happens in the transportation industry is quite interesting: though plaintiffs of product companies sued more defendants as a whole, NPEs sued substantially more firms in the transportation industry. The average patent stock of this industry is quite high compared with other industries; thus, I suppose NPEs tend to target at firms which have participated heavily in innovative activities. On the contrary, product companies focus considerably more on firms in the retail industry. Considering its low average patent stock, these lawsuits perhaps mainly arise from improper use of patented technologies. As for manufacturing and finance industries, the differences between the two are not as significant as the industries mentioned above.

According to Allison et al. (2009), NPEs file more lawsuits related to patents litigated mutiple times than product companies did. After analyzing the dataset, I further illustarte that even they both file lawsuits related to such patents, their behaviors still differ. In sum, the analysis of defendants not only confirms the necessity of including the *D_NPE* variable, but also highlights the role of industry and technology differences.

B. Regression Results

Table 5 Regression results: Equation 1

Variable	Coefficient	SE
Intercept	-71.1189	9.7843***
Year	0.0358	0.0049***
Case	0.0289	0.0201
Case_All	0.0600	0.0071***
Number of observations	11505	

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The estimation results of Equation 1 are reported in Table 5, which shows that except *Case* variable, all estimated coefficients of the explanatory variables are all very significant.

The yearly growth rate of patent stock is 3.58% on average; after a lawsuit is filed against the defendant, the growth rate will soar by 6%. Moreover, the coefficient is significant at 1% significance level. Thus, the effect should more likely result from patent litigation itself rather than any incident happened in year 2007. As Table 3 reveals, The variables *Case* and *Case_All* are moderately correlated; hence, though one may conclude that suits filed by the same plaintiff is not as effective as suits filed by a different one, this may be a sign of multicollinearity.

Table 6 Regression results: Equation 2

	(1)	(2)	(3)	(4)
Dependent variable		ln(*Patent_Stock*)		
Plaintiff-related variables				
ln(*Plaintiff_Patent_Stock*)	-0.0802*	-0.0861*	-0.0896**	-0.109***
	(0.0445)	(0.0440)	(0.0417)	(0.0413)
D_NPE		0.239**		0.167*
		(0.101)		(0.0971)
Defendant and plaintiff relationship				
Case	0.0618***		0.0590***	
	(0.0184)		(0.0178)	
Case_All	0.0194***		0.0311***	
	(0.0074)		(0.0072)	
D_Technology_Proximity		0.135***		0.116***
		(0.0341)		(0.0334)
Control variables				
Plaintiff_Patent_Diversity	-0.0775	-0.309**	0.0479	-0.0860
	(0.0612)	(0.152)	(0.0614)	(0.144)
Internal_Diversity	2.244***	2.313***	2.118***	2.195***
	(0.0451)	(0.0458)	(0.0425)	(0.0434)
Size	0.0784***	0.0895***	0.0900***	0.105***
	(0.0076)	(0.0074)	(0.0080)	(0.0079)
ln(*R&D_Stock*)	0.0014	0.0012	0.0091*	0.0074
	(0.0040)	(0.0041)	(0.0048)	(0.0048)
Intercept	-0.119***	-0.203***	0.0839	-0.0129
	(0.0245)	(0.0342)	(0.0745)	(0.0803)
Industry dummies	N	N	Y	Y
N	7774	7774	7774	7774
adj. R^2	0.369	0.366	0.408	0.402

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The estimation results of Equation 2 are reported in Table 6. First take a look at the logarithmic form of *Plaintiff_Patent_Stock*. Its coefficient is significant at 1% significance level. This value indicates that, ceteris paribus, a 1% increase in *Plaintiff_Patent_Stock* can reduce a defendant's patenting intensity by about 9%. This outcome actually reflects the essence of NPEs, which I will explain it shortly.

From the results of Equation 1, the positive effect of being sued on innovation has been confirmed. Here Equation 2 further strengthens the results by showing that *Case* variable is also strong: 5.9% at 1% significance level. Notice that the coefficient is much greater than what is obtained in Equation 1. Not only that, *Case_All* still remains its significance. The estimates of Equation 2 can be viewed as the true effect of a plaintiff filing a case since multicollinearity is less of a concern: a suit brings a 3% growth to the defendant's patent stock from that year on; if the suit is filed by the same plaintiff, its patent stock grows by more than 9% in total. After all, being sued is a blessing in disguise: temporal loss on profits is actually a chance to boost innovation.

Models 1 and 3 are basically extension of Equation 1; compared with the former, models 2 and 4 help provide deeper understanding of the "suing" effect. Types of plaintiffs impact on innovation greatly: if the plaintiff is an NPE, its lawsuit causes a defendant's patent stock to increase by 16.7%. For an NPE, its main intention to own a patent is to earn licensing fees rather than apply the patent in its production line. Hence, unlike a product company which has to maintain a high level of patent stock to continue its operation, there is no need for an NPE to do so–all it has to do is just own a handful of high-value patents. These patents of high quality are the core factor why a lawsuit filed by an NPE is so effective on encouraging innovation. This nature can also explain the negative effect of *Plaintiff_Patent_Stock*: NPEs' level of patent stock is not as high as product companies, but suits which they file do have a greater impact on defendants, triggering more investment in innovation.

As for the variable *D_Technology_Proximity*, the prior study by Lin and Jang (2010) pointed out that increase in proximity of the field of technology between the two parties in an M&A deal will raise the acquiring firm's patent stock. As regards the estimated coefficient of *D_Technology_Proximity* here is also of statistical significance, with a value around 0.116. This estimate suggests that if the technological proximity between both litigants in the firm pair was high, it will result in an additional increase in the defendant's innovative capacity.

The control variables offer a different angel to realize the relationship between patent litigation and innovation. The negative influence of *Plaintiff_Patent_Diversity* on a defendant's patent stocks is insignificant. On the other hand, *Internal_Diversity* has a strong and positive influence on innovation, which indicates that ceteris paribus, a 2% average improvement in a defendant's R&D yields can be achieved in year t as a result of a single-unit increase in its internal diversity in year t–2. The expansion of *Size* increases patent stock is not as surprising regarding the economist Joseph Schumpeter's well-known hypothesis that large firms stimulate innovation: if a defendant is willing to increase its human capital by 1%, two years after its effort will induce a 10% growth in its patent stock. As for *R&D_Stock* variable, although it presents positive influence on innovative performance, the effect is a weak one considering the fact that a 1% change in R&D can only increase the patent stock by less than 1%. The inefficient use of R&D spending, presumably, might be quite common among the defendants in patent lawsuits.

V. Conclusion

Many researchers have devote much attention to NPEs and the patent cases they filed against product companies; they even revealed that litigated patents, especially those litigated multiple times, are almost always of high quality. Nevertheless, the fact that NPEs possess high-value patents cannot justify their litigation behavior: although they contribute to innovation directly, the problematic holdup they practicing literally brings huge losses to product companies, raising serious concerns that it may do harm to innovation to a greater degree.

From the view point of innovation, this study contributes to the literature by pointing out the positive side of patent litigation. First of all, this research unveils the fact that litigation does encourage product companies to innovate: a firm's patent stock increases by more than 3% after a suit is filed against it. Moreover, if the plaintiff is an NPE, its case will cause a defendant's patent stock to increase by about 17%, which affirms that NPE-initiated lawsuits are more effective on motivating product companies to innovate. Not only that, if in this case the plaintiff with patents in closer proximity to the defendant's own technology fields, the defendant will benefit more from litigation, further enhancing its innovation process.

One last thing should be mentioned here is that since I have to match cases which are related to the 11 Most-Litigated Patents with data from Compustat, regrettably I must exclude all of the product companies which cannot be found in Compustat. Hence, the inferences stated in this study are only applicable to public-traded companies and cannot be applied to private-traded ones. To understand how patent litigation, or in particular, NPE-initiated litigation affects product companies as a whole, research into linking up litigation and private companies is suggested to fill the void in the literature.

All in all, though patent litigation causes financial losses for product companies temporarily, it in fact benefits them in the long run by improving the overall innovation process. Protecting patents owned by NPE, this research proposes, can surely increase innovation, and thus improve social welfare.

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Appendix I: List of Most-Litigated Patents

#	IPC	Description
5352605	C12N005/00; C12N015/00; C07H021/04	Chimeric genes for transforming plant cells using viral promoters
5412730	H04L009/00	Encrypted data transmission system employing means for randomly altering the encryption keys
5930474	G06F017/30	Internet organizer for accessing geographically and topically based information
5974120	H04M011/00	Telephone interface call processing system with call selectivity
6714859	G01C021/26; H04Q007/20	System and method for an advance notification system for monitoring and reporting proximity of a vehicle
6904359	G01C021/26; G08G001/123	Notification systems and methods with user-definable notifications based on occurance of events
6952645	G01C021/26	System and method for activation of an advance notification system for monitoring and reporting status of vehicle travel
7030781	G08G001/123	Notification system and method that informs a party of vehicle delay
7400970	G01C021/26	System and method for an advance notification system for monitoring and reporting proximity of a vehicle
7836141	G06F015/16	Systems and method for storing, delivering, and managing messages
7934148	G06F01700; H04M001658; H04N00100	Systems and method for storing, delivering, and managing messages

(Access date: March 15th, 2013; source: IPLC)

Appendix II: List of Non-Practicing Entities

Non-practicing entities (NPEs) as plaintiffs:

Acacia Research Corp.
Arrival Star, Inc.
Ronald A. Katz Technology Licensing, LP

NPEs as defendants:

Verizon Communications Inc.

The identification was mainly based on the list of NPEs identified by Allison, Lemley, and Walker (2009). Besides, I also take references of the following sources to identify whether a plaintiff is an NPE.

1. Shrestha, S. K. (2010). Trolls or Market-Makers? An Empirical Analysis of Nonpracticing Entities. *Columbia Law Review*, *110*(1), 114-160.

2. List of Private Companies Worldwide, Letter – Businessweek	http://investing.businessweek.com/research/common/symbollookup/symbollookup.asp?lookuptype=private
3. PatentFreedom	https://www.patentfreedom.com/
4. Science & Technology Policy Research and Information Center	http://www.stpi.narl.org.tw/STPI/index.htm

Appendix III: Equation 2 using generalized least squares

	(1)	(2)	(3)	(4)
Dependent variable		ln(*Patent_Stock*)		
Plaintiff-related variables				
ln(*Plaintiff_Patent_Stock*)	-0.100^{***}	-0.119^{***}	-0.103^{***}	-0.121^{***}
	(0.0227)	(0.0230)	(0.0227)	(0.0229)
D_NPE		0.650^{***}		0.719^{***}
		(0.117)		(0.120)
Defendant and plaintiff relationship				
Case	0.0655^{***}		0.0659^{***}	
	(0.0130)		(0.0130)	
Case_All	0.0282^{***}		0.0293^{***}	
	(0.00407)		(0.00406)	
D_Technology_Proximity		-0.0444		-0.0438
		(0.0286)		(0.0285)
Control variables				
Plaintiff_Patent_Diversity	-0.396^{***}	-0.950^{***}	-0.345^{***}	-0.924^{***}
	(0.0909)	(0.117)	(0.0935)	(0.117)
Internal_Diversity	1.121^{***}	1.147^{***}	1.102^{***}	1.131^{***}
	(0.0542)	(0.0547)	(0.0540)	(0.0545)
Size	0.144^{***}	0.168^{***}	0.154^{***}	0.176^{***}
	(0.0162)	(0.0162)	(0.0162)	(0.0162)
ln(*R&D_Stock*)	0.0401^{***}	0.0422^{***}	0.0370^{***}	0.0416^{***}
	(0.00723)	(0.00730)	(0.00768)	(0.00772)
Intercept	0.00149	-0.117	0.267	0.0862
	(0.0708)	(0.0754)	(0.187)	(0.188)
Industry dummies	N	N	Y	Y
N	7774	7774	7774	7774
adj. R^2	0.470	0.475	0.512	0.515

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Although the least squares estimation of Equation 2 has provided a clear picture of the relationship between patent litigation and innovation, given the discrete nature of patent stock data, OLS may not be an appropriate method for estimating Equation 2. To account for this shortcoming, here I estimate the equation for the dependent variable using the generalized least squares method (GLS). The estimation results of Equation 2 are reported in the table above.

For independent variables, the results are qualitatively the same, but almost all the variables become stronger. This is especially true for *D_NPE*. When Equation 2 is estimated using OLS, the estimated effect of NPE-initiated lawsuits is 16.7% at 10% significance level. Nevertheless, the results here reveal the effect is actually much larger and more significant: 71.9% at 1% significance level. The only exception is the variable *D_Technology_Proximity*: it flips sign and becomes insignificant. The true effect of technological proximity between both litigants in the firm pair may not be as strong as the literature suggested.

As for control variables, all the variables are statistically significant. The negative influence of *Plaintiff_Patent_Diversity* is consistent with the fact that suits filed by NPEs are more effective. In addition, a 1% change in R&D can increase the patent stock by about 4%. The inefficient use of R&D spending, after all, may be less of a problem.