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Abstract

The recent sensationalizing of litigation in the smart phone industry has fostered several concerns, in particular those relating directly to the so-called standard essential patents (SEPs). It has been argued that the smart phone industry has seen a dramatic rise in litigation, driven by SEPs whose owners can cause potential "patent hold-up" of downstream manufacturing firms implementing the standards via the threat of seeking an injunction in courts for their patent rights. Yet, no clear evidence has been offered by the literature regarding any systematic effects of these so-called SEPs on litigation, disputes, or market outcomes. This study explores novel empirical evidence by creating and examining a unique data-set on recent litigation in the smart phone industry, to inform the debate on the smart phone wars by understanding how they relate to SEPs and other relevant industry factors. We find that the litigation in the smart phone industry is primarily driven by patents that are not related to the standards, i.e., on implementation or design specific features of mobile devices. Moreover, litigation outcomes are driven by patent quality rather than the type of patents (SEPs or not). Finally, the recent explosion in smart phone litigation may be explained by a disruption in the mobile wireless ecosystem due to new and large industry entrants, and that this litigation trend may be on a decline. These findings suggest that in the realm of smart phone wars, the focus specifically on SEPs needs to be revisited, the litigation outcomes are based on the quality of litigated patents, and that recent litigation activity in this industry may be explained by industry dynamics rather than related to patents. Concerns about SEPs and smart phone litigation need to be examined empirically prior to proposing policy measures.

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1 Introduction

The technology news reports in the recent years are filled with references to the multitude of patent infringement lawsuits amongst competing firms in the mobile wireless industry, popularly termed as the smart phone wars[1]. The mobile wireless industry has been accused of becoming increasingly litigious, and these conflicts are sometimes called out as a part of the wider "patent wars" between multinational technology and software corporations[2]. Commonly used rhetoric suggests that the "strategic use" of patents has reached alarming significance in the smart phone industry.

One concern that stands at the center of the controversy is the quality of patents involved in litigation. For example, shortly after dismissing a high-profile Apple vs. Motorola lawsuit, Judge Richard Posner questioned the value of patents to society, and cited poor examination at the U.S. patent and trademark office (USPTO) and a proliferation of "low quality" patents as a real problem[3]. However, a recent empirical study conducted at the USPTO examining some recent smart phone patent lawsuits including those between Apple and Motorola demonstrates that most of the patents involved in these cases fared well in terms of validity and proper examination[4]. Another concern that has captured the attention of influential scholars, government commissions, enforcement agencies, and courts, is the alleged "patent hold-up" caused by the so-called standards essential patents or SEPs. It is important to note at the outset what this term refers to. Many standard setting organizations (SSOs) require their members to declare patents that are potentially essential to the standard. However, the SSOs do not act as enforcers or evaluate the disclosures reported by their members for essentiality, and therefore, using the term SEPs is not technically correct[5]. Moreover, not all patents declared as potentially essential to the standard are truly essential to the standard. Nevertheless, for the sake of brevity, we will use the term SEPs to describe patents that are declared as potentially essential to the standard, even though the issue of essentiality must be decided by a court and not an SSO. The concern is that SEP owners can hold-up infringing downstream implementers via the threat of

[1]See, example, press release from ITU, "High-level ITU talks address rampant patent litigation", July 2012, available at: `http://www.itu.int/net/pressoffice/press_releases/2012`.

[2]See, example, Charles Dhigg & Steve Lohr, "The Patent, Used as a Sword", New York Times, Oct 7, 2012, explaining the recent developments in smart phone patent litigation.

[3]Richard A. Posner, "Why there are too many patents in America", The Atlantic, July 12, 2012.

[4]Stuart Graham and S. Vishnubhakat, "Of Smart Phone Wars and Software Patents", Journal of Economic Perspectives, 27(1), 67-85 (2013).

[5]SSOs and their participants understand well that the process results in the disclosure of patents that may not be in fact essential.

seeking an injunction[6]. To understand this concern, a short description of Standard Setting Organizations (SSOs) is in order. SSOs are industry groups that set common standards in a variety of technology areas, to allow compatibility between products made by different manufacturers. Therefore, implementers of products compliant with an industry standard may need to enter into a licensing agreement for the patented technologies that are selected for inclusion in the standard. For this reason, SSOs have adopted rules for obliging its members to publicly declare any intellectual property that is potentially essential to implementation of the standard, and to make licenses available on "fair, reasonable and non-discriminatory terms" (FRAND). Notwithstanding these rules, there has been a lively debate over an alleged increased potential of "patent hold-up" and excessive royalty demands by SEP holders, and call for scrutiny into the operation of SSOs. The theory is that the SEP owners can exploit their bargaining power vis-a-vis downstream implementers under the threat of seeking an injunction for their patent rights in court. The existing literature on this topic on both sides of the debate includes (Shapiro (2001), Lemley (2002), Lemley and Shapiro (2007), Sidak (2008)), as some examples[7]. Antitrust agencies all over the world are discussing these concerns, which often focus on the mobile wireless standards, such as third generation (3G) cellular technologies at the heart of the smart phone industry[8]. In this atmosphere of intense scrutiny, there is a surprising lack of empirical evidence of the alleged problem resulting from SEPs in the smart phone patent wars, and whether injunctions have been a substantial threat in cases involving SEPs.

The recent attention over litigation in the smart phone industry offers a unique opportunity to examine the litigation data to explore the potential effects of these SEPs. This paper explores novel empirical evidence by creating and examining a unique data-set representing the recent

[6]Mark A. Lemley & Carl Shapiro, "Patent holdup and royalty stacking", 85(7) Texas Law Review, 1991-2049 (2007). See, also, Joseph Farrell, John Hayes, Carl Shapiro, and Theresa Sullivan, Standard setting, patents, and hold-up, 74(3) Antitrust Law Journal, 603-670 (2007).

[7]See, example, See Carl Shapiro, "Navigating the patent thicket: Cross licenses, patent pools, and standard setting", 1 Innovation Policy and the Economy 119150 (2000); Mark A. Lemley, "Intellectual property rights and standard-setting organizations", 90(6) California Law Review 1889-1980 (2002)., Lemley and Shapiro (2007) supra note 5, Gregory J. Sidak, "Holdup, royalty stacking, and the presumption of injunctive relief for patent infringement: A reply to Lemley and Shapiro", 92(3) Minnesota Law Review 714-748 (2008).

[8]Report from the Federal Trade Commission, "The evolving IP marketplace: Aligning patent notice and remedies with competition", (2011). See, also, Official Journal of the European Commission, "Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the EU to horizontal cooperation agreements", (2011). This is also highlighted in the DG Comp order finding against Motorola, DG Comp maintained that "A previous commitment to license SEPs on FRAND terms and recourse to injunctions harms competition." Available at: `http://europa.eu/rapid/press-release_MEMO-13-403_en.htm?locale=en`.

smart phone litigation, to inform the debate on the smart phone wars and how they relate to SEPs and other relevant industry factors. Specifically, for the exhaustive list of all the smart phone manufacturers that have been active in the U.S. from 2000-2012, a list of twenty firms, we examine over 2,746 cases filed in the United States District Courts (USDC) between 2001-2013 (to-date) and in the International Trade Commission (ITC) at any time. Amazingly, for cases filed between these firms, only 111 cases were patent cases or contract FRAND cases, related to smart phone specific technologies (this is explained in more detail in Section 2). We focus on whether the asserted patents were classified as relating to standards or not, and how this classification relates to case outcomes such as: findings of infringement, validity, and time-to-terminate. These questions relate to what role SEPs play as a driving force behind the smart phone litigation and its outcomes, and to what extent the quality of patents impacts these cases. First, we examine raw data to understand how many SEPs are represented within the universe of smart phone litigation, and if they were ever granted an injunction (an important question in light of the perceived "threat of injunction" causing potential "hold-up"). Next, we conduct targeted statistical analysis to identify whether a patent is an SEP or not has any effect on several relevant case outcomes, such as determination of validity, infringement, and time-to-termination of the case involving one or more SEPs.

Our key findings include the following:

- Less than one-third of the patents involved in smart phone litigation can be characterized as SEPs. The majority of the patents driving the litigation between smart phone suppliers are not related to standards, i.e., are not plead as potentially essential to a standard *or* disclosed as potentially essential to any of the major wireless standards.
- No injunctions have been granted for any patents that were determined to be an SEP. However, injunctions have been granted for patents that are not essential to standards.
- The case outcomes such as the determination of validity and infringement can be explained by the patent quality metrics (such as received citations and geographic coverage of the patents), and not by whether the patents are related to standards or not. In addition, cases involving SEPs reach a faster conclusion, from the date of filing to the date of reaching some sort of settlement or judgment.
- The increase in patent cases between smart phone suppliers appears to be short-lived and not indicative of a long-term trend. The data suggests that the recent spike in litigation between the smart phone suppliers is now resolving, and may have occurred primarily due to the entry of late and highly successful entrants in the mobile wireless ecosystem, causing a temporary disruption in the market equilibrium.

These findings indicate that the smart phone wars are primarily being driven by patents unrelated to the underlying wireless standards. The focus on the threat due to injunctions that may be granted to SEPs needs to be re-addressed, in light of the fact that the majority of asserted patents were not related to standards, and no asserted SEP resulted in an injunction in any of the smart phone related cases. In fact, the recent spike in litigation occurred *after* the underlying standards were set for sometime, and coincides with the entry of recent entrants in the market for mobile wireless devices that implement features that build on top of standards. In addition, the litigation apparatus appears to be working as it should be, i.e., the case outcomes are highly dependent on the quality of the patents asserted in litigation. The policy measures that focus primarily on SEPs in the ICT and smart phone industry need to consider these facts.

This study reveals the small number of patent cases between smart phone suppliers litigated in the United States, which limits the data set for study and characterization. For understanding the role of SEPs in the overall mobile wireless industry that includes other types of mobile wireless technology manufacturers (components, infrastructure, servers,...) and network operators etc., the data-set must be expanded. This poses a challenge of where to draw the boundary for including patent litigation related to mobile wireless technologies. In a follow-up study, we expand the litigation data-set to include all the patent litigation activity in the U.S. among over 500 firms that participated in the 3G wireless cellular standards generated by the third generation partnership project (3GPP). These ubiquitous standards are well-attended by a variety of firms representing the spectrum of the mobile wireless industry value-chain[9]. This allows us to understand the role of SEP related litigation among the makers, users, and sellers of technologies building upon 3G wireless cellular standards, and infer broader insights than focusing solely on smart phone wars.

The rest of the paper is organized as follows. Section 2 outlines the research methodology employed for collecting the data in this study, and presents the descriptive statistics about the data set. Section 3 discusses the results from raw examination of the data. Section 4 presents the statistical analysis relating case outcomes to relevant patent characteristics. Section 5 concludes with some policy implications and potential questions for further study.

[9]A large number of firms participate in 3G standard setting are technology implementers for manufacturing standards compliant products. See, example, Kirti Gupta, "The process and data behind standard setting in wireless communications", Working paper, 2013, available at: `http://www.law.northwestern.edu/research-faculty/searlecenter/events/entrepreneur/documents/Gupta_standard-setting-process-3gpp.pdf`

2 Data and descriptive statistics

Our goal is to analyze smart phone litigation and its characteristics by focusing on the patent related cases litigated in the U.S. District Courts (USDC) and the International Trade Commission (ITC), that involve smart phones. We generate a unique data-set characterizing the smart phone litigation in the U.S. market based on a collection of multiple data sources.

2.1 Firms constituting the smart phone litigation

In order to examine smart phone litigation, we had to first come up with a definition of the term. This included defining: what constitutes of the product termed as a smart phone, which technologies to focus on among the numerous technologies that are incorporated in smart phones, and therefore, which are the relevant parties are involved in these so called smart phone wars.

We start out with the most logical definition for smart phones as the manufacturing of high computing mobile wireless devices including cell phones and tablets. We capture all the mobile wireless device manufacturers active in the U.S. between the years 2000-2013, since we can safely assume that smart phones, as we understand them today, did not commercially exist before the year 2000. For identifying the universe of these firms, we rely on several industry analyst reports, notably Strategy Analytics and Gartner. Based on our research, we identified 22 firms (including several subsidiaries that roll up to these firms), that represent the universe of active device manufacturers in the U.S. between the years 2000-2013. Out of these, two were not involved in any litigation during the time period. The only exception is Interdigital, which does not manufacture or supply devices, but is included due to its large relevant wireless standards related portfolio and recent litigation activity with some smart phone manufacturers including Nokia, Samsung, Huawei, and ZTE. Therefore, our data-set on smart phone litigation comprises of any USDC or ITC case filed amongst between the twenty firms in the last thirteen years (2001-2013), as listed in Table 1.

Firm	No. smartphone patent cases as Plaintiff	No. smartphone patent cases as Defendant	No. unique patents asserted
Apple	20	27	71
Audiovox	1	2	-
Curitel	0	0	0
Ericsson	7	0	45
Google	1	0	-
HTC	5	15	19
Huawei	0	4	0
Interdigital	12	3	18
Kyocera	1	3	3
LG	0	3	0
Microsoft	3	11	23
Motorola	26	11	62
Nokia	19	6	73
Pantech	0	1	0
RIM (now Blackberry)	3	7	9
S3 Graphics (now HTC)	3	1	10
Samsung	6	15	54
Sanyo	0	1	0
Sony	3	0	15
ZTE	0	1	0

Table 1: Firms involved in smart phone litigation

2.2 Litigation data

For building the data-set on the cases involved in litigation, we focus on all the cases *amongst* the rival smart phone manufacturers, i.e., the firms listed in Table 1. This is done in order to define a logical boundary for what constitutes a smart phone related litigation within the universe of these firms. For example, firms such as Samsung, Microsoft, LG, and some others have several lines of businesses. In order to avoid the inclusion of the litigation these firms may be involved in for businesses apart from smart phones in our data-set, we must limit the cases amongst the universe of the firms that are all active smart phone manufacturers, with the expectation that those cases would most be related to what is generally meant by the smart phone wars (or smart phone litigation). The searches for cases and investigations were performed for all the firms in Table 1. All the public substantive pleadings have been collected for each case from multiple

sources, including: Docket Navigator, Lexis, and PACER.

We collected 2,746 cases at the outset for all types of cases that these firms were involved in. The goal of this study is to address the smart phone wars as they are broadly perceived, of large firms that are makers of smart phones entangled in a web of patent related litigation between each other. Therefore, we focus on the cases that are related to patents or FRAND related contracts[10] that were filed between these firms, i.e., including only the firms in the data-set of 22 active device suppliers[11]. These filters result in 186 cases. In order to ensure that the cases were indeed related to smart phone litigation, we also reviewed by hand the collected pleadings to ensure that each selected case that entered the data-set involved mobile devices. This was an exhaustive step requiring hours of review to determine whether any of the directly infringed products in a cases included any type of mobile device. This filter narrowed our data-set to only 111 cases that can be characterized as involving patents alleged to be directly infringing products that can be called as smart phones. Finally, our data-set on smart phone litigation comprises of 83 USDC lawsuits and 28 ITC investigations filed between the twenty firms in the last ten years (2003-2013) listed in Table 2.

For each case, all the case-specific information is collected, such as when the case was filed, whether the case is still pending or has been concluded, and the outcome of the case if concluded or terminated (along with the date of termination), if the case went to trial, and whether and when a Markman hearing occurred, etc. The data on remedies sought and obtained is also recorded for each case. Finally, data is collected to record all the patents that are asserted in each case, and each patent is classified as whether the patent was plead in the case as potentially essential to a standard or not.

These cases involved 402 unique patents, which have been asserted 851 times (some patents were asserted in multiple cases). A summary of relevant case specific information is presented in Table 2. Notably, 80% (88 out of 111) of the cases had already reached a conclusion at the time this data was collected, and 20% are still pending. Out of the concluded cases, only 8 cases involved patents that were granted an injunction and 1 involved damages remedies.

[10]We used the case-type to determine whether the cases were related to patents. We included cases with the case-type = 830 as coded by Pacer to reflect a patent/infringement case. We also included all the case with case-type = 190 representing contract cases, however, we went through the contract cases and included those in the data-set only if they were related to FRAND commitments, since they involve patents.

[11]The cases that included only one firm in the data-set in litigation with another firm outside of the data-set are therefore not counted

	Total	USDC	ITC
No. of cases filed	111	83	28
No. of pending cases	22	16	6
No. of concluded cases	88	57	31
Settled	20	9	11
Trial verdict	10	1	9
Dismissed	45	34	11
Other (e.g: administrative closing)	13	13	0
No. of cases with patent(s) found infringed	7	1	6
No. of cases granted an injunction	8	2	6
No. of cases granted damages	1	1	0
No. of cases with some form of adjudication	14	5	9
No. of cases with Markman hearing	20	9	11
No. of cases with one or more patents plead as SEP	35	26	9

Table 2: Summary table for smart phone litigation cases

2.3 Standards declaration and Patent characteristics data

One of the main goals of the study was to understand to what extent are the smart phone wars driven by patents that may be declared as potentially essential to the standard.

In order to understand whether the asserted patents may be SEPs or not (i.e., declared as potentially essential to a standard or not), we created a large data-set of declared essential patents from a number of SSOs that are responsible for the creation and standardization of some of the foundational wireless technologies that the smart phone manufacturers incorporate in their devices for providing wireless connectivity; these include the following standards bodies: Alliance for Telecommunications Industry Solutions (ATIS), Association of Radio Industries and Businesses (ARIB), European Telecommunications Standards Institute (ETSI), Institute of Electrical and Electronics Engineers (IEEE), Internet Engineering Task Force (IETF), International Telecommunications Union (ITU), Open Mobile Alliance (OMA), Telecommunications Industry Association (TIA). Together, these SSOs represent second, third, and fourth generation wireless cellular technologies, Wifi technologies, and some other upper layer technologies widely implemented in smart phones.

Additionally, for each of these 402 unique patents involved in smart phone litigation, we incorporated a large number of patent characteristics that may be indicators of a patent's value. We rely on past research to identify these potential characteristics (add citation). Therefore,

we supplemented the patent data with the publicly available patent characteristics such as: forward (received) citations, backward citations (made) to patents and other scientific literature, the number of claims, patent age, geographic coverage of the patents, etc. , and other possible characteristics include the patents' geographic coverage, patent and non-patent (backward) citations made by the patent, and the number of claims. This data is used for the regression analysis in Section 4.

3 Facts and trends related to smart phone litigation

One of the explicit goals of our paper is to understand what role SEPs play in smart phone litigation. Towards that end, we make several notable observations from the data.

3.1 Patents and cases involving SEPs

We first make this determination based on the legal case information, i.e., if in a lawsuit pleading a patent is plead as an SEP or not. For cases where the parties identify some patents as SEPs in their pleadings and not others, those others are not likely to be SEPs. However, there are some cases where the parties do not plead any patents as SEPs, which could be intentional (i.e., none of the patents were asserted as essential to any standard) or may represent missing information, leaving the characterization of patents as SEPs or non-SEPs in these cases unknown. Based solely on the case pleadings, we found that 33% of the patents (i.e. about 1/3rd of the total number of unique patents) were asserted as SEPs and 36% were asserted as non-SEPs. However, for 137 out of the 402 unique asserted patents, the data from the case filings does not indicate any patent as SEP or not, and as a conservative estimate of missing information, we record these as "unknown".

We then match our list of 402 unique patents with the patents that have been declared as potentially essential to one or more of the major SSOs defining wireless standards, listed in Section 2, in order to determine whether the patents can be characterized as potential SEPs or not. After running through this additional filter, we still find only 144 (36%) of the unique patents asserted in these cases can potentially be characterized as SEPs. Additionally, less than one-third of the cases involve at least one patent that was plead as or declared to an SSO as a potential SEP.

Therefore, we conclude that majority of the cases or patents asserted in the cases representing smart phone litigation were unrelated to any major wireless standard.

	SEPs	non-SEPs	Unknown
Indicated in pleadings	134	131	137
Indicated in pleadings and standard declarations	144	258	0

Table 3: Potential standards essentiality of patents asserted in smart-phone litigation (2000-2013)

3.2 Owners of SEPs

Based on our analysis of patents and matching them to SSO declarations, we also found that 87% of the patents found to be potential SEPs were declared to second or third generation (2G or 3G) wireless cellular standards as defined by the Third Generation Partnership Project (3GPP), a collaboration of ARIB, ATIS, CCCA, ETSI, TTA, and TTC[12].

Per the summary statistics in Table 1, 12 firms asserted patents in the 110 lawsuits captured in the data-set. Figure 1 depicts the break-down of these patents by SEPs vs. non-SEPs for each of these firms. Apple Inc. tops the chart for the number of unique asserted patents, the vast majority not related to standards.

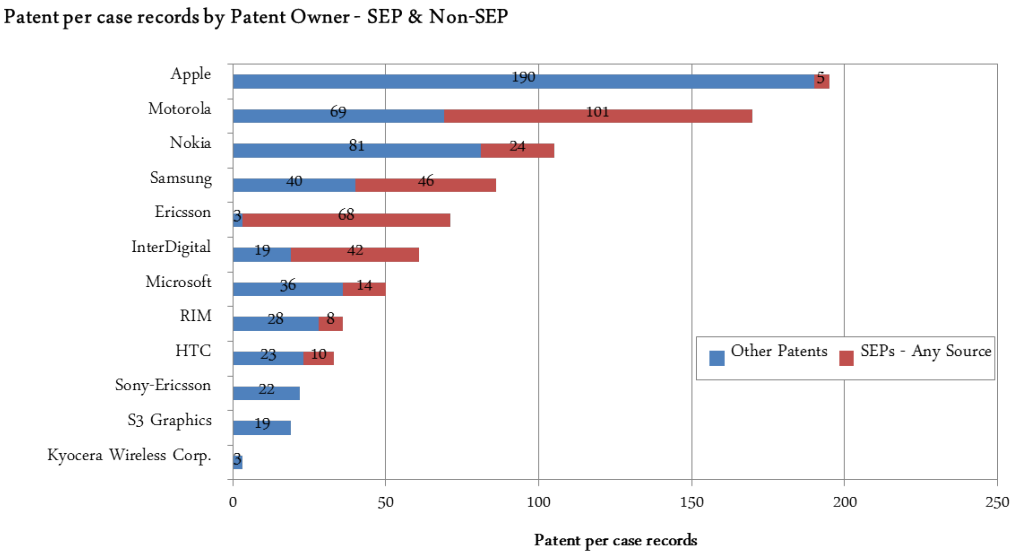

Figure 1: Patents per case-record by patent owner: SEP and non-SEP.

In order to understand further, we move to a case-level analysis. Table 1 summarizes the number of cases that each firm is involved in as a plaintiff and as a defendant. Once again,

[12]Most of the declarations for the patents that may be potentially essential to the standards defined by 3GPP are made to ETSI.

Apple Inc. is involved as a party in more number of cases than any other litigant, explaining 43% of the overall litigation.

Figure 2 depicts the trend for the total number of cases filed over the years, by plotting all the cases along with those that involved one or more patents characterized as SEPs. The number of cases saw a significant increase in the recent years, notably from 2010-2012. Based on the data in Figure 1 and Figure 2, the recent (potentially temporary) rise in smart phone litigation appears to be primarily driven by non-SEPs.

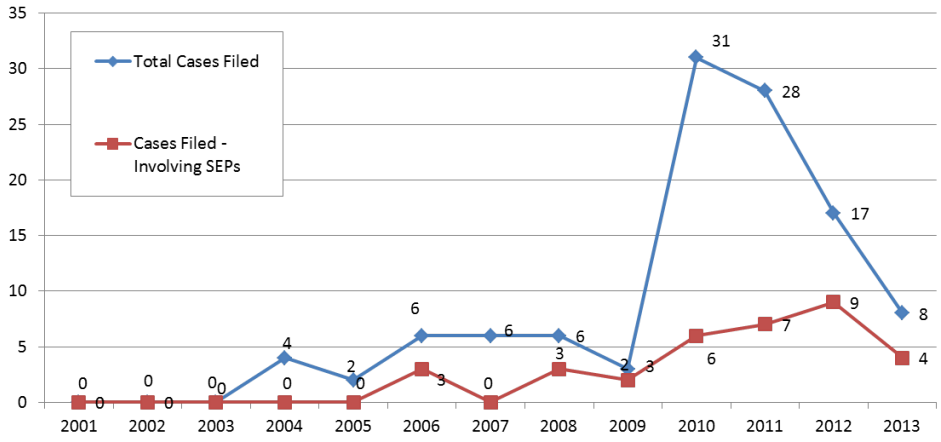

Figure 2: Time trend by cases filed.

3.3 Smart phone litigation and development of standards

We further explore this trend by understanding the relationship with the time-line of the development of the 2G and 3G wireless cellular standards, that cover 87% of the potential SEPs asserted amongst all the cases in the data-set.

Figure 3 explains the time-line of the development of these wireless cellular standards in 3GPP. By the time of the smart phone litigation rapidly increases (2010-2012), the 2G and 3G standards were in a mature stage, and the focus in the standards bodies was on the development of 4G standards. Moreover, 60% of the litigation activity (by the number of cases) is explained by Apple Inc. and HTC Corp., both of which entered the mobile wireless industry as smart phone manufacturers in 2007 and 2008 respectively, at the time the 2G and 3G standards development was in a mature stage.

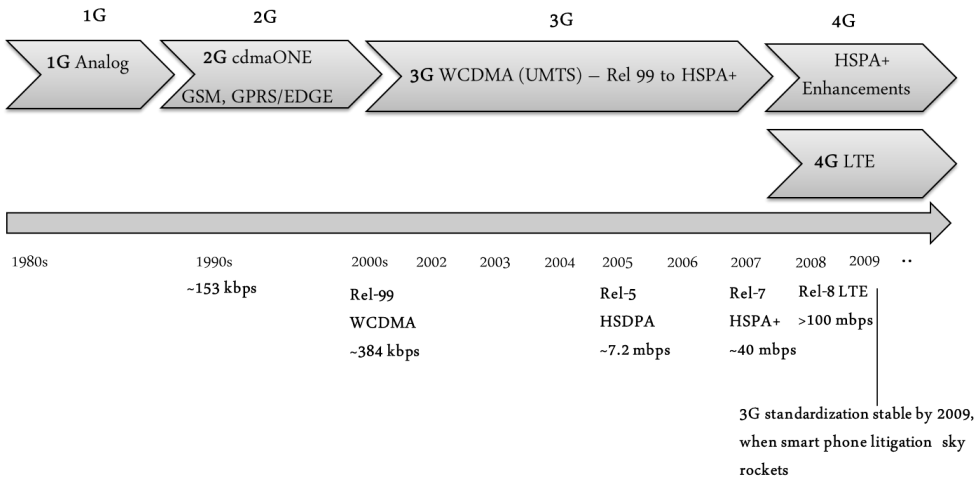

Figure 3: Wireless cellular standards timeline.

Data from 3GPP participation corroborates the late entry of these firms compared to some of their smart phone rivals. For example, the number of change requests (CRs) over the period of 2005-2013[13] - which are formal technical proposals submitted in 3GPP for inclusion in the standard subject to a discussion based on consensus-building or majority ruling - for Apple Inc. and HTC Corp. are 21 and 978 respectively, compared to Motorola Mobility's 5592 and Samsung's 5767. Therefore, it is possible that the recent (potentially temporary) rise in smart phone litigation is not only primarily driven by non-SEPs, but may be driven due to the recent market entry in the mobile wireless industry of some key firms that supply devices.

3.4 Injunctions

The majority of the cases in the data-set had a request for an injunction associated with them. However, injunctions are seldom granted (both pre- and post- eBay) and have been granted for a total of eight cases and a total of sixteen asserted patents in these cases. What is more striking, however, is that no injunctions have been granted for any patent that was plead as or determined to be an SEP. One exception to this finding is an exclusion order that was granted by the ITC for one patent alleged to be an SEP[14] (in Samsung vs. Apple case 337-TA-794), however, the decision was later overturned by the Obama Administration.

This is an important observation because there has been a lively debate over whether injunctions, as legal remedies, should be available for SEP holders to seek, having made a commitment

[13]Unfortunately the CR data is available in a clean format from www.3gpp.org only starting from the year 2005.
[14]The patent in question in the Samsung vs. Apple case 337-TA-794 was never determined to be an SEP or not.

to license their patents on Fair, Reasonable, and Non Discriminatory (FRAND) terms. Of special focus have been patents related to wireless technologies, such as 3G and 4G wireless cellular standards, due to their high proliferation and success in the market. These technology standards enable the smart phones commonly used today by enabling not only high-quality voice but also high-speed data communications, in other words, mobile internet. These data show that the alleged concerns about injunctions for SEPs are unfounded.

4 Regression analysis

A key question is whether SEPs result in more favorable litigation outcomes than non-SEPs of comparable quality. In making a comparison between SEPs and non-SEPs based on injunctions, we see that only non-SEPs were ever granted an injunction in the entire U.S. smart phone litigation data discussed in this paper.

To understand the difference between SEP and non-SEP outcomes in patent litigation, it is necessary to control for various patent related factors that may have an impact on the case outcomes related to these patents, such as the findings of infringement and validity. For example, previous studies have demonstrated that there is a strong correlation between factors related to the economic value of the patents at issue in the case and the level of damage awards. Any measured difference between SEPs and non-SEPs could be misleading if SEPs are systematically over or under-represented among cases with an independent correlation with the case related outcomes being examined.

We address this issue by performing a regression analysis on the case outcomes in the smart phone litigation data, focusing our attention on the differential impact of a patent being an SEP or not. For patent-level case outcomes, our key explanatory variable is an indicator for patents that are SEPs based on case pleadings data, as well as based on any source. Suitable control variables include potential proxies for the economic value, or quality, of patents. However, there are varying results in past studies exploring the determinants of economic value of patents – for example, Lanjouw and Schankerman (2001)[15] found that the number of citations received by a patent (forward citations) and number of claims help towards identifying a more valuable (litigated) patent, while the number of citations included in a patent to older patents (backward citations) do not. Allison, Lemley, Moore and Trunkey (2003)[16] found that claims, forward

[15] Jean O. Lanjouw, and Mark Schankerman, "Characteristics of patent litigation: a window on competition." RAND journal of economics, 129-151 (2001).

[16] Allison, John R., Mark A. Lemley, Kimberly A. Moore, and R. Derek Trunkey, "Valuable patents", Georgia Law Journal (92):435 (2003).

as well as backward citations, as well as how long patents took to be granted help towards determining their potential value. Finally, Gambardella, Harhoff and Verspagen (2008)[17] discuss how the overall impact of all such patent indicators towards identifying patent value is small, when controlling for country and industry specific fixed effects. We err on the side of being inclusive towards the potential patent characteristics that may be predictors of their potential value.

We therefore include the following explanatory variables in our regression:

- Dummy for SEP (by "any source" or "by pleading"): The dummy for SEP is created based on whether the patent was determined to be an SEP based on the case pleadings and/or based on the the combination of the pleadings data and the SSO patent declaration data as discussed in Section 2. The dummy is set to 1 if the patent is determined to be an SEP and 0 otherwise.
- Number of predicted forward citations - A higher number of citations received by a patent – **forward citations** – may indicate the social impact of that patent on future inventions, which can be measured by the number of inventions that build upon this patent. However, a crucial problem with the citations data must be addressed, namely the truncation of the forward citations due to number of years for which the forward citations are observable. For example, a 5-year old patent will receive fewer citations than a 15-year old patent simply by the virtue of the number of years the patent has been available to be cited. The truncation problem is addressed by predicting the total number of citations that will be received by a patent in its lifetime, by estimating the shape of the citation lag distribution from the data, i.e., the number of (forward) citations received in each year after a patent is published. We use the citation lag distribution from Jaffe and Trajtenberg (1996)[18] to predict the forward citations.
- Number of backward citations - In the U.S., patent applicants have a duty of candor by law to disclose any prior art citations to the patentability of an invention. The ultimate responsibility to add relevant citations rests on the patent examiner. If an applicant knowingly fails to disclose relevant prior art, s/he risks being accused of inequitable conduct

[17] Gambardella, Alfonso, Dietmar Harhoff, and Bart Verspagen, "The value of patents", Universita Bocconi, Ludwig-Maximiliens Universitaet, and Eindhoven University, Working Paper. Available at: `http://www.creiweb.org/activities/sc_conferences/23/papers/gambardella.pdf` (2005).

[18] Adam B. Jaffe and Manuel Trajtenberg, "Flows of knowledge from universities and federal laboratories: Modeling the flow of patent citations over time and across institutional and geographic boundaries", Proceedings of the National Academy of Sciences 93.23: 12671-12677 (1996).

defense in court by the potential accused infringer of the patent, thus rendering the patent invalid. It is therefore often assumed in the patent literature that patents with a large number of backward citations may be building upon a large existing invention base and potentially covering a narrower or a more incremental invention.

- Number of patent claims: Each patent comprises a set of claims that represent the legal boundary of the property rights granted to the applicant. In order to determine whether an accused defendant truly infringes a patent, the claims of the patent are compared against the defendant's product. There is a cost associated with filing more claims for the applicant. The minimum U.S. Patent and Trademark Office fee covers twenty claims per patent (three independent and seventeen dependent claims), with an additional fee required per claim. In addition, the drafting and prosecution attorneys – typically hired by the applicant firm – usually charge a substantial per claim fee. Therefore, a higher number of claims may be a result of a principal-agent problem, where patent attorneys file more claims (e.g.: a repetitive set of method, apparatus and system claims for the same concept) for jacking up their fee, or they may represent a higher effort expended towards receiving broader claims for a more valuable invention. It is however, often assumed in the literature that patents with a higher number of claims have a broader legal coverage, thus increasing the likelihood of higher quality claims, leading to a higher likelihood of validity and infringement.
- Geographic coverage: The number of countries in which a patentee sought protection determines the geographic scope of the patent. Intuitively, the metric capturing the geographic scope should reflect a patent's value, as firms will seek protection of the most valuable patents in the largest number of countries. Firms' strategies on where to file patents almost always depend upon the complex function of the expected revenue from a geographical area for its products, enforceability (or strength of the legal system) in a geographical area, budget constraints, and other factors along with the patent's potential quality.
- Length of first claim: It is possible that a longer claim may be broader in its legal scope. However, for a claim to be found infringed, every element of the claim must be found infringed, which often leads to the finding of a longer claim making for a weaker patent in terms of the infringement finding. The first claim is the most important, therefore, we include the its word count of the first claim as its length as an contributor towards a patent's economic value.
- Number of times litigated: The number of times a patent is litigated could represent

another measure of a patent's economic value or relevance, based on the litigation resources and expenses that the owning company is willing to spend on the patent.

- Year of Decision: We also include the time dummy variables based on the year of the decision of the case. This can be used to establish an independent time trend (that is, controlling for the mix of cases) in the data related to the patent level case outcomes.

We examine two patent-level case outcomes: the finding of infringement and (in)validity, as determined by the court. For patent-level outcomes, we focus on the differential impact of a patent being an SEP. Our key explanatory variable is an indicator for patents that are SEPs. We currently focus on one case-level outcome, the case length, i.e., the time from filing to termination of the case. For case-level outcomes, we focus our attention on the differential impact of the presence of any SEP in the case. Our key explanatory variable is an indicator for cases with at least one SEP. We run the regression on all of the observations from our data-set for which we have some information about the case findings. This limits our data-set to the 83 USDC and ITC cases that have been terminated to-date, representing 314 unique patents (asserted 602 times) in these cases. We plan to expand the data-set to more observations in our future work covering smart phone litigation activity for all the firms involved in 3GPP standards.

We first start with the infringement finding. Some of the settled or dismissed cases may not have any infringement findings associated with them. We start by coding the determination of a patent infringement as a 1 and all other outcomes as a 0 (as a proxy for not found infringed). Therefore, we use a logit model to estimate the impact of the key explanatory variables related to the patent characteristics on the likelihood of infringement. As mentioned above, the key explanatory variable of interest in Table 4 is the dummy variable indicating whether a patent is SEP or not. For a robustness check, we define an SEP indicator variable based on whether the patent was determined to be an SEP solely based on the case pleadings (SEP-pleadings-only), or by combining the pleadings information with the SSO declarations (SEP-any-source). As the results show, in either case, a patent's association with a standard does not have any impact is not statistically significantly different from zero. However, predicted forward citations received by a patent do have a statistically significant and a positive effect in determining its likelihood of being found infringed[19].

[19] As additional robustness checks, we use only observed forward citations (instead of predicted citations), and also check for multi-collinearity (specifically correlation between the SEP indicator and any of the patent characteristics).

	β (S.E.)	p-value	β (S.E.)	p-value
SEP Any Source	.161 (.843)	.849		
SEP Pleading			.301 (.838)	.719
Predicted Fwd Cites (log)	.790** (.288)	.006	.752 (.311)	.016
Backward Cites (log)	.011 (.288)	.970	.136 (.321)	.671
No. of Claims (log)	.216 (.493)	.661	.182 (.533)	.733
Geographic Coverage	.107* (.064)	.094	.048 (.065)	.459
1st Claim Length (log)	.665 (.946)	.482	1.247 (1.097)	.256
No. of Times Litigated	.041 (.233)	.861	.081 (.231)	.727
%Design Patent Dummy	4.251	.166	4.945	.150
Year Dummies Included	Yes		Yes	
Constant	1.725 (24793)	.999	-.580 (33116)	.999
No. of Observations	314		314 193	
Pseudo R-Square	.299		.300	
χ^2 (p-value)	30.923 (0.001)		25.100 (.009)	

Table 4: Infringement Table

Second, we address the issue that while some cases made a clear determination about a patent's infringement, others may have settled or led to a voluntary dismissal prior to even an initial finding related to infringement. We use a multinomial logit approach, with coding a patent that was found infringement as a 2, the still favorable outcomes such a settlement and voluntary dismissal to 1, and the finding of the patents clearly found not to be infringed as a 0. (Time dummies are always present.)

	β	p-value	β	p-value
	(S.E.)		(S.E.)	
1 = Not Infringed				
SEP Any Source	1.186	0.21		
	(0.946)			
SEP Pleading			1.162	0.307
			(1.138)	
Predicted Fwd Cites (log)	-1.066***	0.004	-1.306	0.002
	(0.367)		(0.427)	
Backward Cites (log)	0.392	0.267	-0.31	0.639
	(0.352)		(0.66)	
No. of Claims (log)	-0.214	0.705	0.299	0.462
	(0.565)		(0.406)	
Geographic Coverage	-0.057	0.427	-0.027	0.732
	(0.072)		(0.078)	
1st Claim Length (log)	-1.156	0.292	-2.735	0.076
	(1.096)		(1.541)	
Number of Times Litigated	-0.171	0.577	-0.099	0.768
	(0.307)		(0.335)	
2 = Settled/Dismissed/Dropped				
SEP Any Source	0.527	0.556		
	(0.895)			
SEP Pleading			1.695	0.102
			(1.037)	
Predicted Fwd Cites (log)	-1.075***	0.003	-1.042	0.01
	(0.36)		(0.404)	
Backward Cites (log)	0.211	0.534	-0.171	0.785
	(0.34)		(0.626)	
No. of Claims (log)	-0.16	0.772	0.044	0.908
	(0.551)		(0.381)	
Geographic Coverage	-0.092	0.181	-0.026	0.714
	(0.069)		(0.071)	
1st Claim Length (log)	-1.037	0.338	-2.075	0.167
	(1.083)		(1.5)	
No. of Times Litigated	0.146	0.6	0.143	0.615
	(0.278)		(0.284)	
No. of Observations	314		193	
Pseudo R-Square	0.162		0.289	
χ^2 (p-value)	66.827 (0.001)		70.163 (0.002)	

Table 5: Infringement Table

Per the results in Table 5, we still find similar results as in the binomial coding of the infringement outcome: a patent's association with a standard has an impact is not statistically significantly different from zero. However, predicted forward citations continue to have a statistically significant and a positive effect in determining its likelihood of being found infringed. Additionally, the number of times a patent is litigated also displays a positive (and statistically significant) effect towards increasing the likelihood of infringement.

For exploring the finding of invalidity, we run into some issues. In the U.S., patents are presumed valid, resulting in a clear and convincing proof required to prove inequitable conduct. In our data-set, few patents have been clearly found to be invalid (coded as 1), therefore skewing the data towards missing findings or patents found valid (coded as 0). Therefore, the findings in Table 6 that lists the logit findings for this outcome must be taken with caution. The table shows that the number of times a patent is litigated to be negative and significant, i.e., a patent litigated multiple times is less likely to be found invalid. The variable of interest, SEP indicator, still appears not to be statistically significantly different from zero.

Based on these findings, it appears that controlling for the potential quality of a patent, whether a patent is potentially related to standards or not does not seem to have an effect on the likelihood of infringement. Indeed, the litigation outcomes are more likely to be determined based on patent characteristics such as received citations, that have been found to be representative of the patent's quality or economic value in the past literature.

	β (S.E.)	p-value	β (S.E.)	p-value
SEP Any Source	0.481	0.516		
	(0.741)			
SEP Pleading			-1.910	.112
			(1.202)	
Predicted Fwd Cites (log)	-0.265	0.301	-.158	.583
	(.256)		(.289)	
Backward Cites (log)	0.184	0.522	.659	.104
	(.287)		(.405)	
No. of Claims (log)	0.298	0.522	.559	.354
	(.465)		(.603)	
Geographic Coverage	-0.054*	0.377	-.014	.853
	(.061)		(.073)	
1st Claim Length (log)	1.051	0.231	1.490	.174
	(.877)		(1.097)	
No. of Times Litigated	-0.452***	0.003	-.087	.709
	(.152)		(.234)	
Constant	-18.233	0.999	-3.104	.999
	(24733)		(33295)	
No. of Observations	314		193	
Pseudo R-Square	0.2		.329	
χ^2 (p-value)	19.372 (0.05)		22.82 (0.010)	

Table 6: Validity Table

Finally, we explore how fast a terminated case reached its conclusion measured by the number of days from the date of filing to the date of termination - whether it was based on granting an injunction, calculating damages, settlement, etc. The key explanatory variable of interest in Table 7 is the dummy variable indicating whether at least one patent involved in the case is SEP or not. All the other patent characteristics variables are represented as averaged over the patents involved in the case. We also include other relevant case-specific controls such as whether a stay, an appeal, or a Markman hearing was involved in the case, the total number of patents involved in the cases, as well as whether the case was filed pre- or post- the famous eBay decision in 2006. We find that several of these variables do significantly influence how fast the case reaches a conclusion, and most notably, cases involving one or more SEPs reach a faster

conclusion.

	β (S.E.)	p-value	β (S.E.)	p-value
50% or greater SEPs	-85.689	0.206		
	(67.257)			
At least one SEP			-159.757	0.019
			(66.591)	
Stay Involved	266.207	0	283.3	0
	(66.245)		(64.718)	
Total Patents Involved	1.202	0.828	4.806	0.391
	(5.526)		(5.575)	
PostEbay_1_Else_0	-16.447	0.849	-12.415	0.883
	(85.992)		(83.837)	
Predicted Fwd Cites (log)	58.262	0.156	63.95	0.112
	(40.708)		(39.837)	
Backward Cites (log)	-101.112	0.011	-106.58	0.006
	(38.669)		(37.7)	
1st Claim Length (log)	-137.629	0.401	-151.01	0.345
	(163.097)		(158.864)	
No. of Claims (log)	17.05	0.831	52.275	0.511
	(79.647)		(79.145)	
Geographic Coverage	23.513	0.008	26.202	0.002
	(8.701)		(8.342)	
Constant	1294.528	0.257	1298.883	0.241
	(1133.904)		(1099.824)	
No. of Observations	83		83	
R-Square	0.402		0.43	

Table 7: Case Length Table

Patents that are litigated may systematically differ from patents that are not litigated. However, we assume that this difference is likely similar for SEPs versus non-SEPs. For example, the stronger SEPs likely get settled outside of litigation, as do non-SEPs. Litigation, then, should serve the purpose of determining the outcome of a patent based simply on the quality of a patent, independent of whether the patent is related to a standard or not. These findings suggest that the patent litigation system does precisely that on average, i.e., it is indifferent to whether the

patent is related to a standard or not in the infringement finding, and potentially the validity finding. Cases that involve SEPs do have an advantage of coming to a final determination earlier. This may be because of the relative potential ease of determining any infringement finding for a technology that is published in a standard, than it is for non-SEPs, but we have not sought to explain this phenomenon.

5 Concluding remarks

Smart phones have become essential to our way of life and in the process, are creating enormous value not only for consumers, but also for both the manufacturing firms and technology suppliers. The intense commercial competition between smart phone companies is also driving large volumes of complex and often multi-jurisdictional patent litigation. News reporters, public officials, and scholars have sounded alarms over the smart phone patent wars, often suggesting broad, categorical fixes to problems this litigation allegedly reveals. This paper tries to take a step towards understanding these smart phone wars from a data-driven approach, specifically, to address two perceived problems that have attracted immense attention: the role of patents related to standards, and the patent quality.

The first of these is the role of SEPs in smart phone patent litigation. We find that the smart phone patent wars do not appear to be driven by SEPs, and the large majority of the patents asserted in these cases are not related to standards. It has been argued that SEPs have a special position to exploit the downstream manufacturers, causing patent hold-up under the threat of seeking an injunction for patents that by definition cannot be designed around. Apart from the issue that not all SEPs, as the term is typically used, represent patents that are essential to the standards, the recent smart phone litigation cases reveal an interesting result: no injunctions or active exclusion orders were found for SEPs, compared to 16 patents unrelated to standards. This raises the question of whether the threat of injunction for SEPs can possibly be substantial enough to result in the alleged harms. In this paper, we do not explore what a diluted threat of injunction can mean for the bargaining strategies under bilateral licensing negotiations between SEP holders and licensees, and eventually to the incentives to contribute to standards related technologies, but simply explore the first-order issue of unearthing and exploring what the data related to smart phone litigation has to reveal. We also find that most of the SEPs were related to 2G/3G wireless cellular technologies, litigated primarily against smart phone manufacturing firms that were recent participants in the relevant standards bodies. The potentially temporary spike in smart phone litigation was primarily driven by a handful of device manufacturers that were late and highly-successful entrants in the mobile wireless industry. It may be that smart

phone litigation is on a decline, but it is too early to determine a trend.

The second of these issues is that of patent quality. We are interested in understanding whether an association with standards, or patent quality, determines the outcomes of patent litigation. We find that at least the infringement findings are likely determined by patent quality characteristics, such as citations received by patents, and not by whether the patents are related to standards or not. However, cases involving SEPs appear to be more likely to come to a conclusion faster. If patent litigation is ignoring any factors apart from the quality of patents, then litigation is working as it should be, and SEPs are getting no undue advantage based on any preceding presumption of infringement.

We note that this is a first step in studying smart phone litigation. The logical place to start was active smart phone manufacturers, firms most representative of the litigation in the smart phone industry. Policy proposals must be preceded by careful empirical analysis of perceived problems in the industry. In order to get a broader understanding of litigation in the mobile wireless area, we need to expand the study to capture the litigation activity between a broader set of firms. A possible extension is expanding the data-set to all firms in the ICT industry associated with wireless cellular standards by focusing on 3GPP membership and participation data, representing the most ubiquitous wireless cellular standard in the industry that is well attending by makers, users, and sellers of the technology to identify the overall litigation trends related to mobile devices.