The Impact of Patent Wars on Firm Strategy: Evidence from the Global Smartphone Industry

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Strategy scholars have documented in various empirical settings that firms seek and leverage stronger institutions to mitigate hazards and gain competitive advantage. In this paper, we argue that such "institution-seeking" behavior may not be confined to the pursuit of strong institutions: firms may also seek weak institutions to mitigate hazards. Using panel data from the global smartphone industry and recent patent wars among key industry rivals, we examine how smartphone vendors that are not directly involved in patent litigation strategically respond to increased litigation risks in this industry. We find that as patent wars intensify, smartphone vendors not involved in any litigation focus more of their business in markets with weaker intellectual property (IP) protection because of institutional arbitrage opportunities. This strategic response is more pronounced for vendors whose stocks of patents are small and whose home markets have weak-IP systems. Our study is the first to examine the relationship between heterogeneity in national patent systems and firms' global strategies. It provides a more balanced view of firms' institution-seeking behavior by documenting how they make strategic use of weaker institutions.

Keywords: patent wars; patent litigation; intellectual property (IP) enforcement; patent thicket; smartphone; platform-based markets; platform competition

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Introduction

Strategy scholars have documented in various empirical settings that firms seek stronger institutions[1] to mitigate hazards and gain competitive advantage. Among these settings are the location choices of foreign production facilities by semiconductor firms (Henisz and Macher 2004), cross-border investment patterns of U.S. venture capital firms (Guler and Guillén 2010), and equity listings on the U.S. stock exchange by Mexican firms, which subsequently confer reputational advantages (Siegel 2005). Studies have also shown that multinational corporations try to mitigate the hazards of weak institutions by sourcing innovations that are of greater value internally than to potential competitors from R&D units located in countries with weak institutions (Zhao 2006) or by employing foreign supervision for subsidiaries located in countries with weak institutions (Zhou 2015). In this paper, however, we argue that *weak* institutions may also help firms mitigate hazards and that firms' "institution-seeking" behavior may therefore not be confined to the pursuit of strong institutions.

We demonstrate how firms seek weak institutions to mitigate hazards in the context of the global smartphone industry. To that end, we investigate how industry rivals' aggressive patent enforcement activities affect firm strategy across different institutional environments for firms

that are not themselves directly involved in patent litigation. In that regard, our conceptual approach is similar to that of McGahan and Silverman (2006) and Oxley et al. (2009), using industry rivals' patent litigation activities as events that are exogenous to a focal nonlitigated firm. We argue that, because of uncertainty, when commercializing products that involve a thicket of patents (Shapiro 2001),[2] firms that are not directly involved in litigation could be affected by escalating patent wars[3] among various patent holders and infringers. Firms may perceive that an increase in patent litigation risk could deter them from expanding their businesses in countries with a strong institutional environment (i.e., countries with strong intellectual property (IP) protection) in which patent enforcement strategies are more effective. As a result, in a global competition with heterogeneous institutional environments, multinational corporations take advantage of institutional arbitrage opportunities (Zhao 2006) to mitigate the overall hazards they face when patent wars intensify, rebalancing their efforts across different countries to carry on more of their business in countries with weak institutions (i.e., countries with weak-IP protection).

Understanding how heterogeneous institutional environments in different countries influence firms' global strategies is important for our understanding of firm behavior. However, because institutional environments,

such as national-IP protection regimes, are often quite stable over time, it is an empirical challenge to study how they affect firm behavior. Our empirical setting offers a rare opportunity to overcome this challenge. Using panel data from the global smartphone industry and recent patent litigation battles among key industry rivals, we provide empirical evidence on how smartphone vendors not involved in litigation strategically respond to changing hazards that are caused by firms' aggressive patent enforcement strategies in strong-IP countries. As patent wars intensify, we find that smartphone vendors that are not directly involved in patent litigation gradually focus more of their business in markets with weak-IP protection and that this strategic response is more pronounced for vendors whose stocks of patents are small and whose home markets have weak-IP systems. We also find that this strategic response is consistent with shifts in vendors' product launch strategies and is mostly driven by market expansion within markets in which the vendor is already present rather than by market entry or exit. Together, these changes play a role in shaping the competitive landscape of the global smartphone market. Thus, our findings provide a more balanced view of firms' institution-seeking behavior and offer a stepping stone for developing a better theory of how firms make strategic use of various institutional settings.

This paper also contributes to the patent enforcement strategy literature (e.g., Agarwal et al. 2009; Somaya 2003, 2012; Somaya and McDaniel 2012), which focuses on how firms leverage their patents for competitive advantage. Specifically, we focus on the strategic behaviors of firms that are not involved in any patent litigation, thereby contributing to the recent literature on how *potential* patent enforcement might affect industry participants' behavior (Agarwal et al. 2009, Clarkson and Toh 2010). Somaya (2012) notes that a firm's patent enforcement strategy is not implemented in a vacuum, but it must take local institutional environments into account, especially the effectiveness of IP systems, which is an important topic that has yet to be considered in the literature. Our study is the first to address this important gap and examine the relationship between the effectiveness of local IP systems and firms' product market strategies in an international context.

In the next section, we draw on the strategy, economics, and law literatures on patent enforcement (Agarwal et al. 2009, Lanjouw and Lerner 2000, Shaver 2012, Somaya 2003, Somaya and McDaniel 2012) to develop our hypotheses. We then discuss our empirical context before presenting our data, methods, and empirical results. We conclude by discussing the implications of this study.

Hypothesis Development
Patents and patent enforcement strategies have become essential components of firms' contemporary competitive strategies (Agarwal et al. 2009, Somaya 2012, Wen

et al. 2013). Recent studies have shown that litigants' strategic responses may include countersuing, settling, exiting the market, inventing their way around patented technologies, and strengthening their own patent portfolios (e.g., Bessen and Meurer 2006, Hall and Ziedonis 2001, Lanjouw and Lerner 2000, Lanjouw and Schankerman 2003, Somaya 2003). These studies have begun to enhance our understanding of the effects of patent enforcement strategies on the strategic behaviors of direct rivals.

Less attention, however, has been paid to how patent litigation activities affect market participants that are not themselves directly involved in patent litigation. As these often represent the majority of the firms in an industry, understanding their strategic responses is important for understanding the broader competitive dynamics and market evolution. Moreover, because of the increasing level of global competition for many products today and the significant heterogeneity of institutional environments across different countries, it has become increasingly important to gain a better understanding of how firms react to patent enforcement strategies and of their consequences on a global scale (Somaya 2012).

The Outbreak of Patent Wars
Because of the confluence of (a) technological convergence across industries and (b) strategic patenting, many industries are increasingly experiencing patent thickets—dense webs of overlapping patent rights (Shapiro 2001, Ziedonis 2004)—which cause hold-up problems (Hall 2004; von Graevenitz et al. 2011, 2013). In such industries, it is nearly impossible to identify all relevant patent holders or even to confidently conclude whether or not there is any potential infringement. Thus, firms in these industries rely on cooperative mechanisms, such as patent pooling (Bittlingmayer 1988, Joshi and Nerkar 2011, Merges 1996), cross-licensing (Grindley and Teece 1997), standard-setting organizations (SSOs),[4] and even tacit patent litigation "truces" between firms (Von Hippel 1988), to obtain access to one another's patents.

Cooperative mechanisms are not always sustainable, though. For example, some portion of the patent thicket may be crucial in establishing an industry-wide technology standard or in establishing a dominant platform in a nascent industry (Simcoe et al. 2009). In these cases, because the expected payoff from driving out competitors and becoming the dominant technology standard is greater than that of maintaining a cooperative mechanism (Somaya 2003), there is often an escalation of patent lawsuits among key industry players.[5] Industries built around platforms or standards, such as the smartphone industry, often evolve rapidly and become dominated by one or a few major players (e.g., Shapiro and Varian 1999, Zhu and Iansiti 2012). With the strategic stakes so high (Somaya 2003), cooperative mechanisms are likely to break down during the early stages of these industries (Lanjouw and

Schankerman 2001) and patent holders are more likely to aggressively assert their patents.[6]

However, patent enforcement is a costly competitive weapon. Direct legal and trial costs alone can run in the millions of dollars, and indirect costs can include managerial time and other resource-intensive drains on capital and human resources (Agarwal et al. 2009, Landes and Posner 2003). Moreover, in industries with patent thickets, the patent holder faces uncertainty about the validity and effective coverage of its own patent. Therefore, the expected payoff of patent litigation must be sufficiently high to outweigh the high cost and uncertainty (Lemley and Shapiro 2005, Shane and Somaya 2007). This implies that, among potential infringers, only major competitors with significant sales would be worthwhile targets of patent enforcement litigation (Lanjouw and Schankerman 2001).[7] This patent enforcement strategy also implies that it would be difficult and risky for small players to grow their businesses in such market environments.

Patent rights are territorial rights, and not all countries have the same level of risk when cooperative mechanisms break down during patent wars. Each country has its own patent system and disputes are adjudicated by its own court. A litigator needs to have a reasonable expectation that the enforcement of their patent rights will be honored in an effective, predictable, and consistent manner. Thus, patent holders are likely to use countries with strong institutions (i.e., countries with strong-IP systems) in their patent enforcement strategies. Even with globalization and efforts to standardize IP protection internationally, such as TRIPS[8] (Trade-Related aspects of Intellectual Property Rights), national patent systems still operate largely independently and differ significantly across countries (Kyle and McGahan 2012, Park 2008, Somaya 2000). Accordingly, markets with strong-IP systems have become natural battlegrounds for patent enforcement strategies. In addition, many strong-IP countries have specialized patent court systems with highly specialized judges. These countries are also likely to offer primary enforcement mechanisms, such as preliminary injunctions, as quick and effective means of deterring imitators (Lanjouw and Lerner 2001), which can be more effective in many rapidly changing technology industries. All told, patent enforcement strategy has become an effective competitive weapon against industry rivals in markets with strong-IP systems.

Firms' Strategic Responses to Global Patent Wars
Because firms tend to use patent litigation as a competitive weapon in strong rather than in weak-IP markets, all else being equal, there is a disproportionate increase in perceived risk associated with strong-IP markets when patent wars break out. However, heterogeneity in the efficacy of patent systems across markets in itself may not be sufficient to create this disproportionate risk unless firms begin to use patent enforcement strategies extensively above and beyond "business as usual." Only then will competitors believe that a cooperative mechanism no longer prevails. In other words, the IP systems must be strong and the cooperative mechanisms must fail simultaneously. It follows that, for multinational corporations, strong-IP countries paradoxically become riskier places to do business when patent wars intensify, especially if the product in question involves patent thickets. Because of the uncertainty associated with commercializing products involving patent thickets, even firms that are not involved in any litigation may start to strategically determine the markets in which to focus more of their business.[9]

It is worth noting that litigating firms need not file costly lawsuits in every individual strong-IP market, as there are spillover effects that affect perceived risk when firms begin to use patent enforcement strategies extensively in such markets (Rothaermel et al. 2006). For example, filing lawsuits in the United States or Germany can create disproportionately increased perceived risk for competitors operating in similar strong-IP countries, such as Canada and the Netherlands.[10] Once a firm makes a sunk-cost investment in pursuing a patent enforcement strategy in one strong-IP country, the marginal cost of adding another similar strong-IP country is relatively low. In other words, perceived litigation risk can propagate across countries.[11] When litigating firms acquire a large portfolio of patents that may serve as additional ammunition at a global level during patent wars, the perceived risk of doing business in strong-IP countries that are patent litigation battlegrounds will be directly affected first, and the risk will then gradually spill over to other similar strong-IP countries. Thus, even nonlitigating firms may need to adjust their strategies by carefully managing their exposure to litigation risks not only in battleground countries that presumably directly affect firm decisions but also in other strong-IP countries as patent wars intensify.

Taken together, to avoid the disproportionate increases in costs and risks associated with strong-IP markets during patent wars, we expect firms to strategically focus more of their business in weaker IP markets for risk-management purposes, even if they are not the direct targets of patent litigation.[12] Rather than exiting strong-IP countries and/or entering new weak-IP countries, firms operating in multiple countries can use their product launch strategy to further expand their operations in weak-IP countries in which they are already present for a relatively quick response. For example, firms can release more phones or release new phones faster in weak-IP countries and simultaneously be selective and reduce the number of phone models in strong-IP countries, thus minimizing their exposure to patent litigation risks. They can also allocate more resources toward marketing in weak-IP countries, thereby increasing advertising in both online/offline channels, obtaining more shelf space within existing retailers, and striking deals with more diverse

retail channels. Firms can then manage their global supply chain system and reallocate their manufacturing capacity across country-specific products accordingly. As a result, the relative importance (share) of a focal firm's business in weak-IP markets will increase compared to that in strong-IP markets as patent wars intensify. We therefore hypothesize the following:

HYPOTHESIS 1 (H1). *As patent wars intensify, the share of a firm's business in weak-IP markets will increase even if the firm is not a target of patent litigation.*

Moderating Effects

Intensified patent wars may have heterogeneous effects on firms with different capabilities (Kotha et al. 2001), especially in the international context (Shaver and Flyer 2000). First, when patents are enforced, some alleged infringers settle and agree to pay royalties, whereas others may challenge the validity of the plaintiff's patent, and countersue, or both. Firms that can credibly countersue are likely to own large stocks of patents themselves, and they may offset their litigation risks by cross-licensing patents from their portfolios to their rivals (Lanjouw and Schankerman 2004). A firm that does not have valuable patents to offer in return (i.e., a firm lacking "bargaining chips") may end up being subject to royalty stacking[13] (Lemley and Shapiro 2006) or paying a higher royalty to a rival patent holder to legally license the patented technology because of hold-up or injunction threats (Lemley and Shapiro 2006). More importantly, the construction of modern digital devices involves a complex web of patents—many of which are only vaguely defined. Thus, it is almost impossible for a firm to search all relevant patent holders or gauge confidently whether or not it is infringing some patents, even if it licenses other patented technologies (Shapiro 2001). Hence, in the case of patent wars, firms with large stocks of patents can defend themselves more effectively, either by possessing more bargaining chips or by threatening—or initiating—litigation, and thus have less incentive to avoid high-stakes markets where patent disputes are more likely (Jaffe 2000). Therefore, we expect firms with small patent stocks to be more susceptible to intensified patent wars. We therefore hypothesize the following:

HYPOTHESIS 2 (H2). *The effect in* H1 *will be more pronounced for firms with small stocks of patents* (*i.e., weak patent portfolios*).

The effects of patent wars may also differ for firms with different institutional backgrounds (McGahan and Victer 2009). This "imprinting" is likely to carry over into their international operations, influencing their capability and willingness to engage in costly litigation (Stinchcombe 1965). As Somaya and McDaniel (2012) note, in the context of patent enforcement, firms from countries with weak-IP systems may develop and carry over

beliefs and strategic orientations toward patents that are poorly aligned with strong patent environments. Because of the different beliefs shaped by institutional differences between firms originating from countries with strong and weak-IP systems (Barkema et al. 1996), such diverse parties may be less likely to settle a patent lawsuit on good terms, thereby increasing the risk that any such litigation will be lengthy (Lanjouw and Lerner 2000, Priest and Klein 1984). Such differences in belief may persist even with the use of outside service providers who are familiar with host-country institutions, because external advice is inherently limited in its influence on firm behavior and learning, especially when those are impeded by deeply entrenched institutional conditioning (Somaya and McDaniel 2012). Furthermore, as countries with weak-IP protection and ineffective enforcement are less frequently patent litigation battlegrounds, firms from such countries will have less patent litigation experience (and fewer benchmark cases to refer to) than will firms from strong-IP environments. This disadvantage due to asymmetry of experience itself increases the risk of litigation (Lanjouw and Schankerman 2004, Lerner 1995). We expect firms from countries with weak-IP systems to be more susceptible to intensified patent wars, and propose the following hypothesis:

HYPOTHESIS 3 (H3). *The effect in* H1 *will be more pronounced for firms whose home countries have weak-IP systems.*

Together, these three hypotheses suggest that patent wars make it more risky for firms with smaller patent portfolios or with weak-IP origins to expand operation in strong-IP countries. Such firms may therefore self-select to focus more of their business in weak-IP countries.

Empirical Context: The Global Smartphone Industry in 2008–2012

> The smartphone industry today is characterized by a thicket of patents and wars based on those patents. Every day brings a new lawsuit or development between Apple, HTC, Microsoft, Motorola Mobility (MMI), Nokia, and Samsung. (Carrier 2012)

We test our predictions in the context of the global smartphone industry. As distinct from a feature phone, a smartphone is a mobile device with advanced functionalities and connectivity that incorporates attributes such as media players, compact digital cameras, video cameras, and GPS navigation and is typically built on a mobile operating system, such as Google's Android, Apple's iOS, Nokia's Symbian, or Microsoft's Windows Phone. Because of technology convergence in a single device, a smartphone involves a myriad of patents for both its hardware and software (Graham and Vishnubhakat 2013).

Although the first smartphone can be traced to early 2001, the smartphone industry did not begin to grow until Apple released its iPhone in mid-2007. The iPhone, which is based on Apple's proprietary operating system (iOS), was one of the first mobile phones to use a multitouch interface. In the same year, Android, a mobile operating system owned by Google, was unveiled, along with the founding of the Open Handset Alliance—a consortium of hardware, software, and telecommunication companies devoted to advancing open standards for mobile devices. The first Android-powered phone (HTC's Dream) was released in October 2008. Our empirical context is the 2008–2012 period and therefore captures the dynamics of the early-stage smartphone industry.

Although major smartphone vendors began enforcing patents against rivals as early as late 2009, the industry has witnessed an unusual explosion of patent litigation cases since 2011, with new patent dispute filings peaking in summer 2011. These actions involve many vendors, most of whom were involved in multiple lawsuits;[14] Apple, for example, has been the plaintiff or defendant in over a 100 patent lawsuits. These actions are often seen as part of a proxy war over platform competition in this industry (Lin and Ye 2009, Simcoe et al. 2009, Wingfield 2012).[15] In fact, Apple's former CEO, Steve Jobs, once said that he was "willing to go to thermonuclear war over Android" because, he claimed, it was a "stolen" product.[16] Accordingly, Apple has been aggressively pursuing patent lawsuits against Android-based vendors such as Samsung, HTC, and Motorola.

In the meantime, major smartphone vendors involved in litigation have sought to expand their patent portfolios rapidly, both to protect themselves and to attack their competitors. For example, Google purchased Motorola Mobility for US$12.5 billion in 2011, primarily to acquire the rights to over 17,000 patents owned by Motorola (Goldman 2012). In the same year, a consortium of companies, including Apple, Ericsson, Microsoft, Research In Motion, and Sony, outbid Google in an auction of over 6,000 Nortel mobile-related telecommunications patents, paying US$4.5 billion (Siegler 2011).

The situation offers an ideal setting in which to examine the interactive effects of escalating patent wars and heterogeneous patent systems on firms' strategies, as most vendors sell smartphones in multiple countries whose patent systems are characterized by varying degrees of effectiveness. Because the smartphone industry is characterized by rapid technological change and short product model life cycles, vendors often need to dynamically decide which countries will serve as their primary markets to make the most efficient use of their resources and to minimize inventory. By gathering data on vendors' operations in multiple countries over time, we can test how patent wars have influenced vendors' strategies across different countries. Furthermore, the unusual surge in patent

Table 1   Major Patent Lawsuit Filings Among Smartphone Vendors Listed in Chronological Order

Year	Month	Plaintiff	Defendant	Country where suit was filed
2009	October	Nokia	Apple	Unites States
2010	March	Apple	HTC	United States
2010	September	Apple	Nokia	United States
2010	September	Apple	Nokia	Germany
2010	October	Microsoft	Motorola	United States
2010	October	Motorola	Apple	United States
2010	December	Nokia	Apple	Netherlands
2010	December	Sony Ericsson	LG electronics	United States
2011	April	Apple	Samsung	United States
2011	April	Samsung	Apple	South Korea
2011	April	Samsung	Apple	Japan
2011	April	Samsung	Apple	Germany
2011	June	Samsung	Apple	United States
2011	June	Samsung	Apple	Italy
2011	July	Microsoft	Samsung	United States
2011	July	HTC	Apple	United Kingdom
2011	August	Apple	Samsung	Australia
2011	August	Apple	Samsung	Netherlands
2011	September	Samsung	Apple	France
2012	May	Microsoft	Motorola	Germany
2012	November	Sony Ericsson	Samsung	United States

Notes. Duplicate pairs in the same country, such as countersuits or other related suits, are not listed. Nonpracticing entities (e.g., patent trolls) are not included in this table.

enforcements (illustrated in Table 1), as well as the prominent worldwide legal battles between Apple and Samsung that began in 2011, have attracted a great deal of attention from both industry participants and the media, which may affect the perception of managers in this industry. We take advantage of this trend to examine how firms changed their strategies as the patent wars intensified.

Methods

Data
We construct our data set of smartphone vendors using data from Gartner. The data set includes quarterly data for the entire population of smartphone vendors from the first quarter (1Q) of 2008 to the fourth quarter (4Q) of 2012, a period that covers both the early stage of the global smartphone market and the intensified patent wars among vendors. Our panel data detail vendors' smartphone unit sales in Asia/Pacific, Eastern Europe, Middle East and Africa, Latin America, North America, and Western Europe regions, as well as in selected countries within those regions (covering a total of 20 countries and regions, as shown in Table 2) for each quarter during that period. There are $N = 77$ vendors in our data set. Table 2 lists smartphone sales to end users in different countries in 4Q2012, the last period in our data set, showing that the two most important markets are China and the United States, which together account for more than 45% of global smartphone sales.

Table 2   Unit Sales of Smartphones to End Users in 4Q2012

Country	Sales to end users (No. of units)	Market share (%)	Weak IP
China	56,641,200	27.3	Yes
United States	39,690,700	19.1	No
United Kingdom	9,484,500	4.6	No
Japan	8,733,800	4.2	No
Germany	6,331,500	3.0	No
Brazil	6,277,000	3.0	Yes
South Korea	5,307,700	2.6	No
France	5,178,700	2.5	No
India	4,606,100	2.2	Yes
Russia	4,562,500	2.2	Yes
Mexico	3,705,400	1.8	Yes
Italy	3,202,400	1.5	Yes
Spain	3,145,400	1.5	No
Canada	3,027,900	1.5	No
South Africa	1,191,100	0.6	No
Rest of Asia/Pacific	17,783,800	8.6	Yes
Rest of Middle East and Africa	9,973,000	4.8	Yes
Rest of Western Europe	7,380,800	3.6	No
Rest of Latin America	6,777,500	3.3	Yes
Rest of Eastern Europe	4,661,300	2.2	Yes
Total	207,662,300	100	

Table 3 provides sales information for the top 10 vendors in the same final quarter of our sample period. These vendors come from South Korea, the United States, Finland, Taiwan, Canada, Japan, and China, confirming that competition in this industry is indeed global. Samsung and Apple are the two most significant global vendors, jointly accounting for more than 50% of total smartphone sales in that quarter. The other vendors had significantly smaller sales.

For additional analyses, we obtain product-level data from *GfK* and *GSMArena.com*. *GfK* (http://www.gfk.com), based in Germany, is one of the world's leading market research companies: for products in each country, *GfK* provides data such as vendor name, product name, product ID number, product's earliest marketing date (month and year), and its nonsubsidized price for

Table 3   Unit Sales of Smartphones to End Users in 4Q2012 for Top 10 Vendors

Vendor	Sales to end users (No. of units)	Market share (%)	Origin
Samsung	64,496,300	31.1	South Korea
Apple	43,457,400	20.9	United States
Huawei Technologies	8,666,400	4.2	China
ZTE	8,310,200	4.0	China
LG Electronics	8,038,800	3.9	South Korea
Lenovo	7,904,200	3.8	China
Research in Motion	7,333,000	3.5	Canada
Nokia	7,094,300	3.4	Finland
Sony Mobile Communications	7,069,400	3.4	Japan
HTC	6,688,600	3.2	Taiwan

each quarter. *GSMArena.com* provides information for consumers—including vendor name, product name, product release date, and other technical product features—to help them choose a mobile device (Alcacer and Oxley 2014). We use a web crawler to scrape data from this source and then crosscheck our *GfK* data and fill in missing data to form a more complete product-level data set.

Dependent Variable

CountryShare$_{ijt}$. To examine how important a county is to a vendor's business, we track s_{ijt}, which measures how many smartphone units vendor i sells in a given country or region j in each quarter t. We then divide this number by the total number of units the vendor sells in that quarter across all countries and regions. Thus, our dependent variable, *CountryShare$_{ijt}$*, indicates the percentage of vendor i's total sales during quarter t that is attributable to country j and is given by

$$CountryShare_{ijt} = \frac{S_{ijt}}{\sum_k S_{ikt}} \times 100.$$

Compared with mere sales measures, this measure has the advantages of reflecting the strategic importance of a country to a vendor in a given period and is independent of the vendor's overall sales growth (e.g., Tanriverdi and Lee 2008). We multiply this measure by 100 to facilitate the presentation of the results.

Independent Variables

PatentWarIntensity$_t$. Ideally, to measure the intensity of patent wars in the global smartphone industry, we would track international patent lawsuits for all vendors in every country, patent purchases and acquisitions of each vendor, and the severity of damages awarded to each vendor, and then develop a weighting scheme that reflects the importance of each event in vendors' strategic calculations. However, some of this information, such as international litigation data, damages, and settlements, is not readily available and the weighting scheme could be arbitrary. Moreover, it is unlikely that all vendors not involved in any litigation would themselves possess all this knowledge unless it is publicized.

Therefore, we use *LexisNexis* to construct a measure of patent war intensity in the smartphone industry based on media articles. We count the number of media articles on smartphone patent lawsuits and related developments (such as patent acquisition, M&A, and amount of damages awarded) covered in all major world publications (such as the *New York Times*, *Wall Street Journal*, *Korea Times*, and *Australian*) on the grounds that as patent wars escalate, the level of media coverage of smartphone patent disputes (and related events) increases, thus improving vendor knowledge about these conflicts.[17] This measure is also supported by a recent study by Tan (2015), which notes how media coverage plays a significant role in

patent enforcement strategy in the semiconductor industry. For each quarter, we count the number of articles containing the keywords "smartphone," "patents," and "litigation" and their uses in other combinations on the grounds that these articles include information about which vendor sued which vendor in each country, major licensing and damages announcements, and major patent acquisition announcements during the sample period, all of which are events related to firms using patents as shields and weapons in combat with their rivals. This measure naturally captures the importance of each event by the frequency of its appearance in media articles. Minor events, that should not affect vendors' strategies much, will not be covered much, which frees us from the need to develop an arbitrary weighting scheme.[18] Figure 1 depicts our measure of patent war intensity graphically and highlights notable events. In contrast to the relatively peaceful era before 2011 (i.e., a "business as usual" period), we see a noticeable escalation of patent warfare-related events during the latter part of our study period, which is likely to affect vendors' strategies.[19]

IP_index$_{jt}$. This variable, which measures the strength of the IP system in a given country,[20] is based on the Intellectual Property Rights Index (IPRI), which has been published annually since 2008 by the Property Rights Alliance. This index combines Ginarte and Park (1997),[21] which has been extensively used in the literature (Oxley 1999, Somaya and McDaniel 2012, Zhao 2006), with an opinion-based measure of IP protections (the World Economic Forum's *Global Competitiveness Index*) in which experts in each country are asked to rate their nation's IP protection, scoring it from "weak and not enforced" to "strong and enforced," so that an increase in the *IP_index$_{jt}$* reflects increased IP protection. According to

H1, we expect the interaction term *PatentWarIntensity$_t$* × *IP_index$_{jt}$* to have a negative and statistically significant effect on our dependent variable. We consider countries with IP indices above (below) the median of all countries in our sample as strong- (weak-)IP countries.[22] During our sample period, many vendors operated in both strong- and weak-IP countries; for example, in the fourth quarter of 2012, there were 25 such vendors.

Figure 2 shows the trend in smartphone sales in strong- and weak-IP countries by vendors not involved in litigation during our sample period. The trends were almost identical in both settings until the early part of 2011, after which there was a clear gap between sales shares in strong- and weak-IP countries. This divergence becomes apparent after the explosion of patent wars in 2Q2011 shown in Figure 1, providing preliminary supporting evidence for our theoretical argument.

PatentStock$_i$. This is a vendor-specific measure of patent counts. Consistent with prior studies (e.g., Ahuja 2000, Narin et al. 1987, Song and Shin 2008), we use the United States Patent and Trademark Office (USPTO) patent database to count the number of smartphone-related patents obtained by each vendor. These include patents filed under international patent classification code H04 (electric communication techniques), which covers the majority of smartphone-related patents.[23] Following the approach used in prior studies (Ahuja 2000, Stuart and Podolny 1996), we use the USPTO patent database for all firms—including those headquartered outside the United States—to maintain consistency, reliability, and comparability because patenting systems across nations differ in their applications of standards, their systems for granting patents, and value of the protection granted (Basberg 1987, Griliches 1990). The United States is one

Figure 1   Patent War Intensity as Measured by the Frequency of Media Coverage of Smartphone Patent Litigation
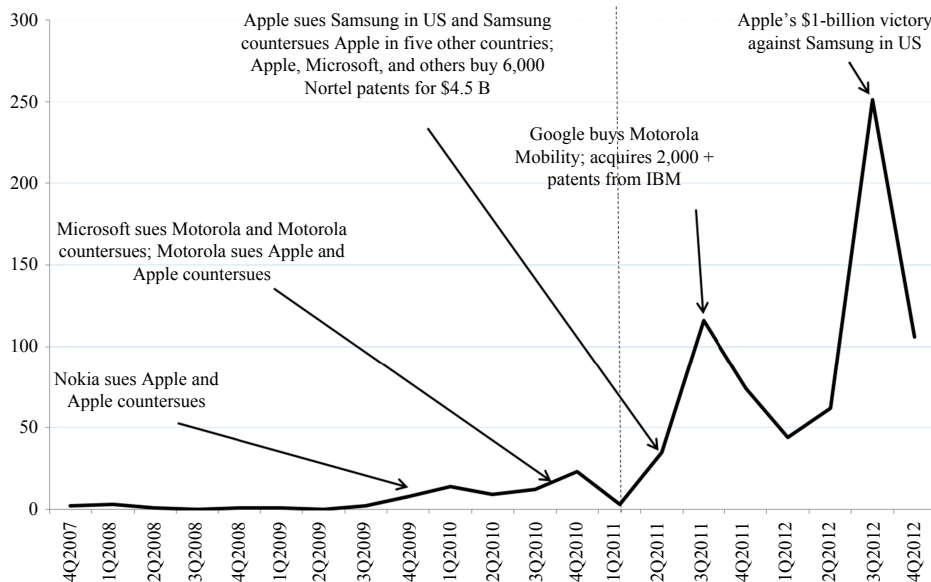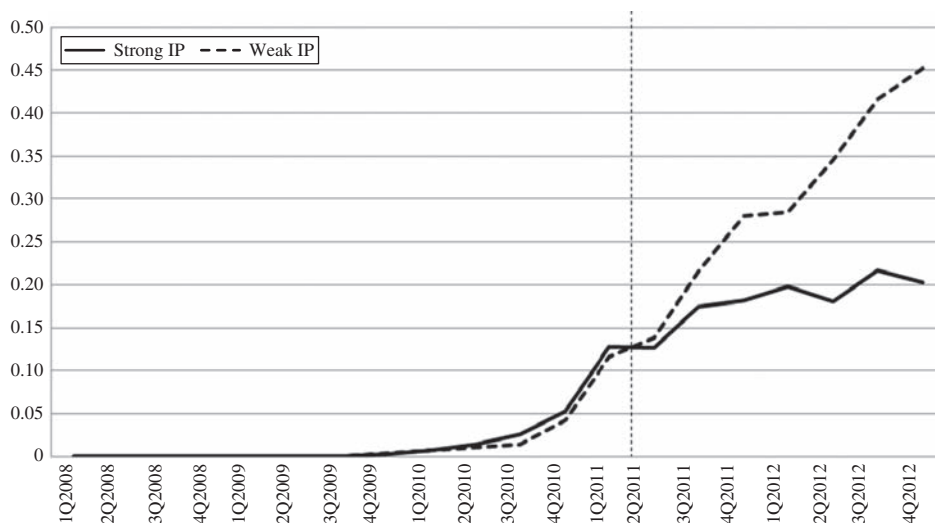
Figure 2 Share of Smartphone Sales in Strong- and Weak-IP Countries by Vendors Not Involved in Litigation

of the largest smartphone markets, and firms commercializing their inventions are most likely to file a patent in the United States if anywhere at all.

We count the number of patents for each vendor at the end of 2008. We do this for two reasons. Given that our sample period ends in 2012 and that a typical patent application takes about two to four years to be granted, the number of patents granted before our sample period reflects the strength of a vendor's patent dispute-related bargaining position free of any right-censoring concerns. More importantly, after the patent wars began, vendors may have taken up strategic patenting behavior in response. Our measure is thus free from such endogeneity concern.[24] We then take the logarithm of one plus the total patent counts to account for skewness. Consistent with H2, we expect the interaction term *PatentWarIntensity$_t$* × *IP_index$_{jt}$* × *PatentStock$_i$* to be positive and statistically significant.

WeakOrigin$_i$. This is a vendor-specific dummy variable that equals 1 if a vendor comes from a country with weak-IP protection and 0 otherwise. We take a vendor's country of origin to be its headquarters' country (Zhang et al. 2010) and if *IP_index$_{jt}$* for that country is below the median *IP_index$_{jt}$* for all our sample countries across our study period, we set *WeakOrigin$_i$* = 1, and 0 otherwise. Consistent with H3, we expect the interaction term *PatentWarIntensity$_t$* × *IP_index$_{jt}$* × *WeakOrigin$_i$* to be negative and statistically significant.

Control Variables
Vendors' business across countries may be affected by many other factors, such as varying demand and supply conditions in the product market, rising income levels in emerging markets, market saturation, and of course the desire to mitigate litigation risks.

First, we construct measures to control for demand-side drivers. One might expect vendors to focus more

of their business in emerging markets (which may be correlated with weak-IP countries), where income or population is rising. To control for such variation, we use variation in country shares of total world GDP (*CountryGDPshare$_{jt}$*),[25] which are taken from the International Monetary Fund (IMF) *World Economic Outlook* database that includes data on both *GDP per capita$_{jt}$* and country-level *population$_{jt}$*. This measure changes over time and shows that emerging markets, such as China and India, experience rapid economic growth during our sample period. Vendors may also change their strategies because of different levels of interest in smartphones or the availability of smartphone-related infrastructure across different countries (Sarkar et al. 1999). To control for such variation, we construct a measure of smartphone-specific market share by computing a country's share of world smartphone sales in a given quarter (*SmartphoneCountryShare$_{jt}$*).

Next, we construct measures to control for supply-side drivers. Competitive dynamics can change dramatically during an industry's nascent stage. Because one would expect vendors to decide on their business foci based on market competition or mimetic behavior in each country (Haveman 1993, Xia et al. 2008), we count the number of vendors competing in each country in each quarter and take the logarithm to account for skewness (*NumberOfCompetitors$_{jt}$*), and also compute a country-level Herfindahl index (*MarketConcentration$_{jt}$*) to account for country-specific market concentration (Xia et al. 2008). It is possible that vendors attach strategic importance to markets in which Apple and Samsung, the two vendors that are clearly in a different league, are present because these leading firms are building the market for smartphones early in the industry life cycle. It is also possible that some vendors avoid, or are squeezed out of, countries in which Apple and Samsung are more popular. Thus, to control for an "Apple–Samsung effect,"

we construct a control ($TotalShareAppleSamsung_{jt}$) for the combined market share of Apple and Samsung for each country and use it to tease out such effects. It is also possible that market saturation in strong-IP countries makes vendors focus more of their business in weak-IP countries, so we include each vendor's sales growth in the previous quarter in each country as an additional control ($VendorCountrySalesGrowth_{ijt}$).

We lag our demand-side measures and supply-side measures by one quarter to ensure that market characteristics precede the focal firm's action.[26] Table 4 presents the summary statistics and pairwise correlation of our variables.

Results

Table 5 reports the main results of our ordinary least squares (OLS) panel regressions.[27] All of our regression models include vendor fixed effects to control for unobserved time-invariant firm heterogeneity, country fixed effects to control for time-invariant country characteristics, such as different distribution channels, contractual issues, or regulations, and quarter fixed effects to control for intertemporal trends and macroenvironmental shocks. The quarter fixed effects therefore absorb the main effects of $PatentWarIntensity_t$. The unit of analysis for testing our hypotheses is the vendor-country-quarter, where the dependent variable is $CountryShare_{ijt}$, and heteroskedasticity-adjusted standard errors are clustered at the vendor level unless otherwise noted.

All of our empirical analyses focus on vendors that are not themselves directly involved in litigation. There

are $N = 67$ vendors that are neither a plaintiff nor a defendant in any smartphone patent lawsuit during the study period.[28] In Table 5, after controlling for a number of factors, the interaction term $PatentWarIntensity_t \times IP\_index_{jt}$ in Model (1) is negative and statistically significant as expected, suggesting that smartphone vendors focus more of their business in weak-IP countries as patent wars intensify and thus supporting H1.[29] Model (1) shows that the marginal effect of a one-standard-deviation increase in the $PatentWarIntensity_t$—computed at the mean value of all other variables—leads to a reduction in the dependent variable of 1.7 percentage points: given that the mean value of the dependent variable is 5.12, this implies a 33% reduction in the significance of a given country to the focal vendor's overall sales. Given that most litigants are large players in the smartphone industry (such as Apple, Samsung, and Motorola), this result shows how small firms strategically respond when large firms fight among themselves, creating hazards in the product market.

Model (2) examines the moderating effect of vendors' stocks of patents. As we hypothesized, the interaction term, $PatentWarIntensity_t \times IP\_index_{jt} \times PatentStock_i$, in Model (2) is positive and statistically significant, suggesting that vendors with large patent stocks (i.e., strong patent portfolios) are less affected by escalating patent wars, whereas those with small stocks of patents (i.e., weak patent portfolios) are more affected, and tend to focus more of their business in weak-IP countries when patent wars intensify. This result supports H2.

Table 4 Summary Statistics and Pairwise Correlations for Variables in the Regression Analyses

	Mean	S.D.	Min	Max	(1)	(2)	(3)
(1) *CountryShare*	5.12	19.01	0	100	1		
(2) *PatentWarIntensity*	61.60	72.97	0	251	0.00	1	
(3) *IP_index*	6.45	1.48	4	8.50	0.04	0.03	1
(4) *PatentStock*	444.08	1,242.09	0	7,365	0.00	−0.11	−0.01
(5) *WeakOrigin*	0.58	0.49	0	1	0.00	0.29	0.02
(6) *CountryGDPshare* (%)	5.06	4.39	0.7	20.94	0.29	−0.02	0.01
(7) *SmartphoneCountryShare*	0.05	0.06	0	0.27	0.33	−0.02	0.13
(8) *NumberOfCompetitors*	2.28	0.85	0	3.64	0.16	0.34	0.05
(9) *MarketConcentration*	0.31	0.16	0	1	−0.10	−0.29	−0.31
(10) *TotalShareAppleSamsung*	0.33	0.21	0	1	−0.04	0.54	0.29
(11) *VendorCountrySalesGrowth*	0.20	7.46	−1	689.50	0.08	0.00	0.01

	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) *CountryShare*							
(2) *PatentWarIntensity*							
(3) *IP_index*							
(4) *PatentStock*	1						
(5) *WeakOrigin*	−0.34	1					
(6) *CountryGDPshare* (%)	0.01	−0.01	1				
(7) *SmartphoneCountryShare*	0.01	−0.01	0.85	1			
(8) *NumberOfCompetitors*	−0.13	0.20	0.31	0.42	1		
(9) *MarketConcentration*	0.09	−0.18	−0.03	−0.11	−0.42	1	
(10) *TotalShareAppleSamsung*	−0.11	0.26	−0.04	−0.03	0.26	−0.38	1
(11) *VendorCountrySalesGrowth*	0.03	−0.01	0.04	0.05	0.03	−0.02	0.01

Table 5   Main Results

DV = *CountryShare*	Model (1)	Model (2)	Model (3)	Model (4)
Independent variables				
$PatentWarIntensity \times IP\_index \times PatentStock$		0.003**		0.001*
		(0.001)		(0.001)
$PatentWarIntensity \times IP\_index \times WeakOrigin$			−0.013***	−0.008**
			(0.004)	(0.004)
$PatentWarIntensity \times IP\_index$	−0.004**	−0.005	0.013***	−0.007
	(0.002)	(0.003)	(0.004)	(0.004)
$PatentWarIntensity \times PatentStock$		−0.017**		−0.009*
		(0.006)		(0.005)
$PatentStock \times IP\_index$		0.322*		0.044
		(0.164)		(0.130)
$PatentWarIntensity \times WeakOrigin$			0.089***	0.056**
			(0.027)	(0.025)
$WeakOrigin \times IP\_index$			−4.121***	−4.037***
			(0.775)	(0.823)
Controls				
IP_index	−0.806	−2.372	−1.737	−1.335
	(1.578)	(2.231)	(1.545)	(1.784)
CountryGDPshare	6.472**	6.516**	5.996*	5.999*
	(3.148)	(3.051)	(3.066)	(3.047)
SmartphoneCountryShare	50.633*	49.407*	51.709*	51.624*
	(27.349)	(26.864)	(26.822)	(26.776)
NumberOfCompetitors	0.684*	0.673*	0.742*	0.678
	(0.393)	(0.388)	(0.406)	(0.416)
MarketConcentration	−3.956	−3.343	−1.867	−2.217
	(3.739)	(3.771)	(3.715)	(3.665)
TotalShareAppleSamsung	2.026	1.934	2.730*	2.052
	(1.439)	(1.467)	(1.507)	(1.530)
VendorCountrySalesGrowth	0.167**	0.160***	0.156***	0.155***
	(0.056)	(0.054)	(0.051)	(0.050)
Country fixed effects	Yes	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes	Yes
Vendor fixed effects	Yes	Yes	Yes	Yes
Observations	9,331	9,331	9,331	9,331
Number of vendors	67	67	67	67
R-squared	0.183	0.183	0.204	0.205

Notes. The dependent variable is each vendor's sales in a given country-quarter divided by the vendor's total sales in that quarter, and OLS regression models are used for estimation. All vendors used in the regression models are not involved in any patent litigation during the sample period. The main effect of *PatentWarIntensity* is absorbed by quarter fixed effects, so it is dropped from the regression models. Heteroskedasticity-adjusted standard errors clustered at the vendor level are in parentheses.

*Significant at 10%; **significant at 5%; ***significant at 1%.

Model (3) examines the moderating effect of the vendor's country of origin. As we hypothesized, the interaction term, $PatentWarIntensity_t \times IP\_index_{jt} \times WeakOrigin_i$, in Model (3) is negative and statistically significant, suggesting that vendors from countries with weak-IP systems are more likely to focus more of their business in weak-IP markets when patent wars intensify. This result supports H3. We also notice that $PatentWarIntensity \times IP\_index$ is positive and significant, suggesting that firms from countries with strong-IP systems could have even expanded their businesses in strong-IP markets, possibly because of their strong legal capability and extensive litigation experience.

Finally, we include both sets of moderating effects in Model (4). The results continue to support H2 and H3. Based on the coefficients of three-way interactions, we find that holding all other variables at their mean value, a one-standard-deviation increase in *PatentStock* increases the dependent variable by 1.5 percentage points, which is approximately a 29% increase, and switching from strong to weak-IP origins decreases the dependent variable by 3.3 percentage points, which is approximately a 64% decrease. The interaction variable $PatentWarIntensity \times IP\_index$ is no longer significant in Model (4). Much of the average effect captured by $PatentWarIntensity \times IP\_index$ in Model (1) is being captured by the three-way and two-way interactions that

include firm-specific variables (*PatentStock* and *Weak-Origin*) in Models (2)–(4), implying that firm heterogeneity plays an important role in explaining the effect of intensified patent wars on firm behavior.

Robustness Checks and Extensions

The environment is complex. Many other changes may have affected smartphone vendors' strategic responses during this period. We have already controlled for a number of factors in our regressions. For example, we take advantage of the panel-data structure to control for vendor-specific, country-specific, and quarter-specific fixed effects to tease out the factors that do not change over time. We also control for many demand-side drivers and supply-side drivers (e.g., demand for smartphones and competitive rivalry between smartphone vendors in different countries) that may change over time and affect vendors' strategic decisions. However, it is still possible that the empirically observed pattern can be explained by something other than vendors' desires to mitigate litigation risks. We therefore conduct a number of robustness checks to gain more confidence in our results.

Pricing strategy. We consider whether our results are driven by systematic changes in vendors' pricing strategies over time and across countries. Some vendors might use strategies—such as the bottom-of-the-pyramid (BoP) strategy—to systematically launch cheaper smartphones in weak-IP countries (which may be correlated with low-income countries) *and* may have coincidentally employed this strategy during (and after) 2011, thus creating the gap illustrated in Figure 2. Note that if a vendor employed a BoP strategy *constantly* over the sample period, this pricing strategy effect would be absorbed by the vendor fixed effects used in our analysis. Using data from *GfK* and *GSMArena.com*, we compute the average price level of a vendor's smartphone in a given country and quarter to detect changes in pricing strategy over time. We report our result in Model (1) of Table 6 after replacing our dependent variable with the (logged) price level. The interaction $PatentWarIntensity_t \times IP\_index_{jt}$ is no longer statistically significant, suggesting that vendors have not systematically changed their pricing strategies in weak-IP regimes relative to strong-IP countries as patent wars intensify. Thus, although a price gap between strong- and weak-IP countries is observed, heterogeneity in pricing strategy dynamics does not explain the pattern.

Market saturation. It is also possible that the observed pattern is driven by market saturation in strong-IP countries, which may lead vendors to focus more on weak-IP countries. Although we have tried to address this possibility by including each vendor's sales growth in the previous quarter in each country as a control (i.e., *Vendor-CountrySalesGrowth$_{ijt}$*), we conduct a robustness check of our main result using an alternative approach. We measure and rank the growth rate in smartphone sales for each

country in 2012, the last year of our study period. We identify four strong-IP countries with particularly fast-growing smartphone sales (i.e., Canada, Germany, Japan, and South Africa) and combine all the weak-IP countries that had slower growth rates than these fast-growing, strong-IP countries to form a hypothetical global market. We then repeat the analysis. If market saturation is driving our main results, then, by construction, we should not see any change in firm strategy in this hypothetical market. However, as Model (2) in Table 6 shows, we continue to find vendors focusing more of their business in weaker-IP countries as the patent wars intensify, even in our hypothetical market.[30]

Infrastructure deployment. Our next concern is that vendors' strategic responses might be driven by the deployment of telecommunication infrastructures (e.g., 3G/4G technologies) to support smartphone diffusion in weak-IP countries (starting in 2011). We have used a control variable *SmartphoneCountryShare$_{jt}$* to address this concern in our main analysis, but we use an alternative approach to test for robustness. We restrict our sample to countries whose infrastructures already supported smartphones at the beginning of our sample period, which we identified by whether the country registered smartphone sales in 1Q2008. Repeating the analyses produces similar results, as shown in Model (3) of Table 6.

Country-specific competitive intensity. We are concerned that our measure $PatentWarIntensity_t$ may be picking up country-specific competitive effects as well as litigation risks. In our main regressions, we include *NumberOfCompetitors$_{jt}$* and *MarketConcentration$_{jt}$*, in addition to *SmartphoneCountryShare$_{jt}$*, *TotalShareAppleSamsung$_{jt}$*, and *VendorCountrySalesGrowth$_{ijt}$*, to better control for country-specific competitive intensity in the market, and we use vendor-level fixed effects to control for unobserved time-invariant factors, such as vendors' competitive capabilities. To further tease apart the effect of litigation risk from the (product market) competitive effects at the country level, we take an alternative approach. We interact IP_index_{jt} with our country-specific competition measures, such as *NumberOfCompetitors$_{jt}$* $\times IP\_index$ and *MarketConcentration$_{jt}$* $\times IP\_index_{jt}$, and include them in our model. If our main effect ($PatentWarIntensity_t \times IP\_index_{jt}$) is indeed confounded with country-specific competitive effects that are not already captured by our controls, we should find that it becomes attenuated or insignificant. In Model (4) of Table 6, we find that this is not the case. Our main effect remains unchanged in both magnitude and significance compared to the main results in Table 5. These results show that our measure of *PatentWarIntensity$_t$* is primarily picking up litigation risks, as intended.

Litigation battleground countries. We are also concerned that our main variable of interest, *PatentWarIntensity$_t$* $\times IP\_index_{jt}$, is a relatively indirect way to

measure the litigation risk of operating in a focal country because it relies on a global trend that does not allow heterogeneity in litigation risk across strong-IP countries. To address this concern, we use the major smartphone-related litigation that occurs in each strong-IP country to construct a new country-specific variable called *BattlegroundCountry$_{jt}$* (which equals 0 but switches to 1 in country j at quarter t when the first major smartphone litigation listed in Table 1 occurs). The timing of the switch (from 0 to 1) will be different for each strong-IP country depending on the timing of *actual* patent litigation, which allows for different timing of litigation risk and heterogeneity across strong-IP countries. For example, during our sample period, litigation risk should rise in the United States earlier than it does in, say, France. Some strong-IP countries will always be coded as 0. At the time of these major smartphone-related litigation events, there is a noticeable surge in media coverage, as expected (supporting our *PatentWarIntensity$_t$* measure). We then repeat our analysis using a three-way interaction term, *PatentWarIntensity$_t$ × IP_index$_{jt}$ × BattlegroundCountry$_{jt}$*, akin to a difference-in-difference-in-differences model. The idea is to take advantage of the fact that we can identify the nine strong-IP countries (listed in Table 1) in which smartphone-related patents were actually enforced so that we can separate the strong-IP countries with *actual* litigation risk from those with *potential* litigation risk only. Our main results should then come primarily from strong-IP countries that *actually* had litigation. We therefore expect the three-way interaction term to be negative and significant, which is indeed what we find in Model (5) of Table 6.

Market Entry, Expansion, and Exit

The shares of a firm's business across strong- and weak-IP markets can change when it enters a new weak-IP country, exits a strong-IP country, or expands its existing business within weak-IP countries. To explore which strategy drives the observed pattern, we consider market *entry*, *expansion*, and *exit* separately in Table 7. In Model (1), we include only observations for which vendors had no previous smartphone sales in the country. The variable, *VendorCountrySalesGrowth$_{ijt}$*, is therefore dropped. Models (2) and (3) include only observations for which vendors have already entered a country and have positive sales in that country and quarter. Models (1) and (3) use a linear probability model to examine vendors' entry and exit strategies. We find that the interaction variable, *PatentWarIntensity$_t$ × IP_index$_{jt}$*, is only significant in Model (2). The results in Table 7 thus suggest that the strategic response we document is driven by market expansion within countries in which a vendor is already present rather than by market entry or exit (Sarkar and

Table 6   Robustness Checks

	Model (1) DV = log(price)	Model (2) Fast-growing strong-IP + Slow-growing weak-IP countries	Model (3) Infrastructure deployment	Model (4) Country-specific competitive effects	Model (5) Legal battleground countries
Independent variables					
PatentWarIntensity × IP_index *× BattlegroundCountry*					−0.016* (0.009)
PatentWarIntensity × IP_index	0.0003 (0.0004)	−0.0017*** (0.0005)	−0.0009* (0.0004)	−0.004** (0.002)	0.002 (0.002)
NumberOfCompetitors × IP_index				0.112 (0.541)	
MarketConcentration × IP_index				−3.037*** (1.014)	
PatentWarIntensity × BattlegroundCountry					0.112 (0.069)
BattlegroundCountry × IP_index					−3.315* (1.671)
Controls	Included	Included	Included	Included	Included
Country fixed effects	Yes	Yes	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes	Yes	Yes
Vendor fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	1,610	1,722	5,067	9,331	9,331
Number of vendors	52	28	54	67	67
R-squared	0.372	0.201	0.238	0.171	0.173

Notes. In Model (1), the dependent variable is the average price level (in logarithm) of a vendor's smartphone in a given country and quarter. In Models (2)–(5), the dependent variable is each vendor's sales in a given country-quarter divided by the vendor's total sales in that quarter. OLS with vendor fixed effects are used in all models. Heteroskedasticity-adjusted standard errors clustered at the vendor level are in parentheses.

   *Significant at 10%; **significant at 5%; ***significant at 1%.

Table 7   Market Entry, Expansion, and Exit

DV = *CountryShare*	Model (1) Market entry	Model (2) Market expansion	Model (3) Market exit
Independent variables			
PatentWarIntensity × IP_index	-0.004×10^{-4}	-0.016^{***}	0.00011
	(0.120×10^{-4})	(0.006)	(0.00010)
IP_index	-0.001	7.227	0.014
	(0.012)	(7.289)	(0.042)
Controls	Included	Included	Included
Country fixed effects	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes
Vendor fixed effects	Yes	Yes	Yes
Observations	7,203	1,615	1,950
Number of vendors	67	66	67
Pseudo *R*-squared	0.013	0.303	0.159

Notes. The dependent variable is each vendor's sales in a given country-quarter divided by the vendor's total sales in that quarter. We separately investigate market entry, expansion, and entry. In Model (1), we drop *VendorCountrySalesGrowth* because it only includes observations in which vendors had no smartphone sales in the past in a country. Models (2) and (3) only include observations in which vendors have already entered in a country in the past and have positive sales there in that quarter. OLS models are used in all models. Heteroskedasticity-adjusted standard errors clustered at the vendor level in parentheses.

  ***Significant at 1%.

Table 8   Strategic Response Using Product Launch Strategy

	Model (1) Number of new phone models	Model (2) Delay of new-product releases (months)
Independent variables		
PatentWarIntensity × IP_index	-0.0027^{*}	0.0003^{*}
	(0.0016)	(0.0002)
IP_index	-0.8993	0.0203
	(1.0910)	(0.0984)
Controls	Included	Included
Country fixed effects	Yes	Yes
Quarter fixed effects	Yes	Yes
Vendor/Phone fixed effects	Yes	Yes
Observations	1,781	1,529
Number of vendors	31	34
Number of new models		391
Pseudo *R*-squared	0.025	0.769

Notes. In Model (1), the dependent variable is the number of phone models launched in each country in each quarter, and a negative binomial model is used. In Model (2), the dependent variable is the logarithm of the number of months since a model's first release. OLS with vendor fixed effects are used in Model (1) and with phone model fixed effects in Model (2). Heteroskedasticity-adjusted standard errors clustered at the vendor level are in parentheses.

  *Significant at 10%.

Cavusgil 1996); in other words, by vendors rebalancing their portfolios rather than entering new weak-IP markets or exiting strong-IP markets. Our result is consistent with the following logic: If increased litigation risk in strong-IP countries serves as an entry barrier to entrepreneurial companies that were founded after the escalation of the patent wars or to other vendors that did not set up operations in strong-IP countries prior to the outbreak of patent wars, then vendors not involved in litigation that already had made investments (i.e., paid sunk costs) in strong-IP countries may have no incentive to completely exit them despite the increased litigation risk. In addition, entry into new weak-IP markets does not occur either because it requires a "big step" relative to expansion as noted by the international business literature (Pedersen and Shaver 2011). The result could also reflect our study period: the peak of the patent war was in the middle of 2011, and our sample ends in late 2012. The short time window means that firms may not have sufficient time to make big strategic moves such as market entry and exit.

Strategic Response Using Product Launch Strategy
The observed pattern we document could be caused by changes in a number of strategic decisions, such as marketing efforts, product launch strategies, and supply chain management. Although our data do not allow us to explore all these possibilities, we are able to examine changes in vendors' product launch strategies. In particular, we look at the number of new phone models introduced in strong- and weak-IP countries and, for

phone models released in multiple countries, how quickly vendors release those new phone models in different countries.

Number of newly launched products in strong-IP countries. If vendors become cautious in strong-IP countries because of increased litigation risk as patent wars intensify, then we expect them to minimize their exposure to such risk by being selective about products they launch. Hence, vendors might *reduce* the number of product models being launched in strong-IP countries relative to weak-IP countries as patent wars intensify. To examine product launch strategies, we first count the number of new smartphone models each vendor releases in each country and quarter using data from *GfK* and *GSMArena.com* and use this measure as our new dependent variable. We report the results in Model (1) of Table 8 and find that *PatentWarIntensity$_t$* × *IP_index$_{jt}$* is negative and statistically significant, suggesting that smartphone vendors launched fewer product models in strong-IP countries relative to weak-IP countries as patent wars intensified. This is consistent with our theoretical argument.

Faster release of new phone models in weak-IP countries. Challenges in global supply chain management, such as the need to order country-specific SIM cards, and constraints in manufacturing capacity usually preclude a vendor from launching its newest smartphone model in all countries at once. Thus, vendors need to prioritize and spread launch dates across countries. For instance, they could first focus on strong-IP countries with higher margins and then launch in weak-IP countries, often months later. Therefore, if vendors are focusing more of their

business in weak-IP countries as patent wars intensify, we expect them to reallocate manufacturing capacity in order to launch new models more quickly in these countries. To test this, we examine the launch dates for phone models released in multiple countries and measure the delay in release dates as the number of months since the model's first release anywhere. We then use the (logged) release delay as our new dependent variable and repeat the analysis. Instead of vendor-level fixed effects, we control for phone-model fixed effects. Consistent with our theoretical argument, in Model (2) of Table 8, we find that as patent wars intensify, vendors indeed release the phone models more quickly in weak-IP countries than they did before.

In sum, these additional analyses give us greater confidence that vendors' incentives to mitigate litigation risks play a significant role in focusing more of their business in weak-IP countries as patent wars intensify. Moreover, to further ensure that it is patent wars that are causing change in vendors' strategy, we supplement our empirical analyses with interviews with Xiaomi, a Beijing-based smartphone vendor that surpassed Samsung as the top-selling smartphone brand in China in 2014 to become the world's fifth-largest smartphone maker. The company had hired an ex-Google executive to help with their global expansion strategy and has opted to focus on Brazil, Mexico, Russia, Turkey, India, and other South Asian countries (Kan 2014). Our conversations with Xiaomi corroborated the idea that potential patent litigation threats in Western markets were the chief concern in formulating its global expansion strategy.

Consequences of Vendors' Strategic Responses for the Global Smartphone Industry

What were the consequences of vendors' strategic responses? In our context, Android-powered smartphones were at the center of most litigation, and most vendors that were not involved in any litigation were Android-dependent vendors. Thus, we expect vendors that rely on Android-powered smartphone sales to be more prone to the strategic response we document in this study. Consequently, the overall market share of Android-powered smartphones should grow more rapidly in weak-IP countries than in strong-IP countries as patent wars intensify. To test this prediction in a regression framework, we compute two measures. First, at the vendor level, we divide the number of Android-based smartphone units sold by a vendor in a given quarter in a given country by the total number of units that vendor sells in the same quarter across all countries. The measure reflects the impact of Android-powered smartphones to each vendor's business in each country. Second, at the country level, we compute the overall market share of Android-powered phones in each country and each quarter.

Table 9 reports the regression results. In Models (1) and (2) of Table 9, the dependent variables are the vendor-level Android share and the country-level Android market

Table 9 Consequences of Vendors' Strategic Response in the Global Smartphone Industry

	Model (1) Vendor-level Android share	Model (2) Country-level Android market share
Independent variables		
$PatentWarIntensity_t$ $\times$ IP_index_{jt}	−0.0013*** (0.0003)	−0.0015*** (0.0003)
IP_index_{jt}	2.1201 (0.9765)	0.0320 (0.0385)
Controls	Included	Included
Country fixed effects	Yes	Yes
Quarter fixed effects	Yes	Yes
Vendor fixed effects	Yes	—
Observations	9,621	285
Number of vendors	68	—
Pseudo R-squared	0.16	0.93

Notes. In Model (1), the dependent variable is each vendor's sales of Android devices in a given country-quarter divided by its total sales in that quarter. In Model (2), the dependent variable is the market share of Android-powered smartphones in a given country. In both models, the period is 4Q2008–4Q2012. Heteroskedasticity-adjusted standard errors are clustered at the vendor level for Model (1) and at the country level for Model (2).

***Significant at 1%.

share, respectively. We include all observations during or after 4Q2008, the quarter in which the first Android-based phone was released. Models (1) and (2) show that vendors increase their dependence on Android-powered phones in markets with weak-IP protection as patent wars intensify and that the overall market share of Android-powered smartphones grows faster in weak-IP countries than in strong-IP countries.[31] As a result, patent wars, which according to Steve Jobs, were intended to hamper the proliferation of Android phones in the marketplace (Isaacson 2011), may have merely shifted the proliferation of Android phones to weak-IP countries. Consequently, Android has flourished in weak-IP countries due, in no small part, to vendors' strategic responses to patent wars. Mobile applications supported by local language and local information are in turn supplied in abundance, creating a robust ecosystem for Android-powered smartphones in weak-IP countries.[32]

Discussion and Conclusion

Patents and their enforcement have become increasingly important for value appropriation by innovators, much as marketing and pricing strategies have done (Teece 1986). This paper views firm patents as competitive weapons and empirically shows how patent wars affect market participants in the global smartphone market. Specifically, we investigate how competitors respond strategically to patent wars in an industry characterized by patent thickets. We find that, as patent wars intensify, smartphone vendors not involved in any litigation attempt to manage litigation risk by focusing more of their business in

markets with weak-IP protection. This strategic response is more pronounced for vendors with small stocks of patents and whose home markets have weak-IP systems. Together, these changes play a role in shaping the competitive landscape of the global smartphone market. This study provides the first empirical evidence of how heterogeneity in national patent systems affects firm strategies and global competition during patent wars.

This study contributes to a broader literature on institution-based views of strategy, which emphasize how the institutional environments affect firm strategies (Ahuja and Yayavaram 2011, Mahoney et al. 2009, Peng et al. 2009). While prior empirical studies have noted that markets with well-developed institutions offer less business risk, leading to economic growth and prosperity (Acemoglu and Johnson 2005, Acemoglu et al. 2005, North 1990) and firms thus should use such institutions to mitigate hazards (e.g., Guler and Guillén 2010, Henisz and Macher 2004, Siegel 2005), our study suggests that well-developed institutions may offer more business risk during patent wars. We support our argument by empirically demonstrating that firms can also use *weak* institutions to mitigate hazards when the product in question is characterized by patent thickets *and* when market participants revert to aggressive patent enforcement strategies rather than to maintaining cooperative mechanisms. As a result, our empirical findings provide a more balanced view of firms' institution-seeking behaviors and offer a step toward a better theory of how to make strategic use of various institutional settings.

Our study also contributes to an emerging patent enforcement strategy literature (e.g., Agarwal et al. 2009, Clarkson and Toh 2010, Polidoro and Toh 2011, Somaya and McDaniel 2012), which focuses on how firms leverage their patents as business assets to gain a competitive advantage. In industries characterized by patent thickets, firms that are not directly involved in patent litigation may still be significantly affected by increased litigation risk in markets with strong-IP protection because of the uncertainty in identifying all relevant patent holders or in identifying the effective boundaries of all relevant patents. In a single-market context, this would simply deter firms from competing. In many global markets, this implies that firms are willing to rebalance their efforts across various countries to conduct more of their business in weak-IP countries, merely reshaping the competition.

Our study also points to important practical implications. First, our findings suggest that rivals in global industries may not be deterred from competing in high-stakes markets by patent enforcement; they may simply shift their business toward markets with weak-IP systems, where such enforcement is ineffective and where institutional arbitrage opportunities exist (Khanna and Palepu 2005, Zhao 2006). Thus, given the costly process of litigating and the global aspect of competition in many industries today, it may not always be in a

firm's best interest to use patent litigation to deter imitation (Polidoro and Toh 2011). Although currently pending patent lawsuits in the smartphone industry may be years away from a conclusive outcome, a strong Android ecosystem has emerged in many weak-IP countries, partly because of lawsuits filed in strong-IP countries, as our study demonstrates. Hence, managers need to be mindful of the broader consequences of using patent litigation as a deterrence mechanism in one market when competing globally in heterogeneous markets. Second, digital convergence implies that future technological innovations will be increasingly complex and likely to rely on thickets of patents. Our results highlight the importance of holding valuable patents as a defense mechanism: competitors having no patents with which to countersue or bargain are likely to be forced to rebalance their business, even if they are not infringing on patents. Finally, in our setting, competition between rivals can take the form of indirect wars between participants in different ecosystems. Thus, in addition to paying close attention to direct competitors within the same ecosystem (e.g., Samsung versus HTC within the Android ecosystem), participants need to be cognizant of potential threats from different ecosystems (e.g., Nokia in the Windows Phone ecosystem versus Samsung in the Android ecosystem).

This study naturally has some limitations. First, the range of participants in the smartphone industry is not limited to mobile device manufacturers; other business ecosystem participants (such as telecommunication operators and application developers) may also need to respond strategically to patent wars. Because the wars are waged among device makers, we believe that our results illustrate first-order effects. Future research could gather additional data to explore the impact of patent wars on other types of market participants. Second, although we believe the theory we introduce applies to many settings, it hinges on whether the product in question is embedded in a web of patents and whether the strategic stakes in these markets are sufficiently high. The generalization of our theory should therefore be taken with caution. Future studies could explore other industry settings to extend our findings. Third, while it may be optimal for vendors to focus more of their business in weak-IP countries because of increased litigation risks, vendors are likely to face intense competition there. Future research could gather profit data to estimate the extent to which the escalated patent wars have affected their profitability. Fourth, focusing more of firms' business in weak-IP countries may not be the only strategic response to patent wars. In an unreported analysis, we examined whether vendors that are not involved in litigation seek more patents to defend their market positions in strong institutions, but found no evidence of this behavior.[33] Future research can investigate other possible strategic moves. Finally, the worldwide smartphone market is still dynamic. Thus, our empirical observations reflect a transitory state in a particular

moment in the industry life cycle. Future studies could examine the impact of patent enforcement over the full life cycle of an industry.

Endnotes
[1]Institutions are the "rules of the game" in a society or, more formally, humanly devised constraints that structure political, economic, and social interactions. They include formal systems such as constitutions, laws, taxation, insurance, and market regulations and informal norms of behavior such as habits, customs, and ideologies (North 1990). Here, strong institutions refer to the formal systems that provide more effective checks and balances to corporate misbehavior, executive discretion, political actors' arbitrary behavior, or other private and public expropriation hazards (Acemoglu and Johnson 2005, North 1990, Shleifer and Vishny 1997, Williamson 1985). For example, a country with a strong institution may have a judicial system with strong respect for the "rule of law" (Oxley and Yeung 2001), a system for strong intellectual property protection (Lee and Mansfield 1996, Oxley 1999), a strong political institution (Henisz and Zelner 2001), or a corporate governance system with strong shareholder protection (Black 2001, La Porta et al. 2000, Reese Jr and Weisbach 2002). In our empirical context, strong institutions refer specifically to markets with strong intellectual property protection.

[2]A thicket of patent is "a dense web of overlapping intellectual property rights that a company must hack its way through in order to actually commercialize new technology" (Shapiro 2001, p. 120).

[3]For the purposes of our study, patent wars refer to battles among multiple firms to litigate regarding patent rights, or to secure patents for litigation, whether offensively or defensively, and other closely related events (e.g., patent portfolio acquisition). This occurs when industry rivals or other patent holders aggressively assert their patents against infringers.

[4]A standard-setting organization (SSO) requires its members to license any standard-essential patents on fair, reasonable, and nondiscriminatory (FRAND) terms, although what exactly constitutes FRAND is not clear.

[5]While the recent explosion in patent litigation in the global smartphone industry received much public attention, it is not an entirely new phenomenon. More than a 100 years ago, in the early days of the incandescent light bulb, which eventually replaced gas lights, patent warfare was crucial in securing Thomas Edison's control of that market and establishing his invention as the industry standard. During the first year of litigation, Edison's company was involved in nearly 100 patent disputes in multiple countries, including the United States, Great Britain, Germany, and other countries (Bright 1972, Shaver 2012). Earlier, the 1850s had witnessed the famous "sewing machine wars" (Lampe and Moser 2010, Mossoff 2011). In recent years, there have been fights over diapers, air fresheners, and oil drilling equipment, as well as one dispute over heart devices that has lasted more than a decade. However, none of these has received the same attention paid to the smartphone wars (Decker 2012).

[6]The phenomenon seems more consistent with the patent warfare view suggested by Shaver (2012). According to this view, technology firms race to assemble patent portfolios—initially for defensive purposes in the context of a dynamic and competitive field—and eventually convert their shields into weapons, which they wield to influence their competition and gain competitive advantage.

[7]Of course, we can reasonably expect the cost of patent enforcement strategy to decrease over time, as the focal firm accumulates more experience and secures favorable court decisions. For example, a firm can send a more cost-effective cease and desist letter to both large and small rivals based on favorable court decisions from suing other major rivals. Thus, litigation risk can diffuse to other firms.

[8]TRIPS is an international agreement, administered by the World Trade Organization (WTO), that sets minimum standards for many forms of IP regulation, as applied to nationals of other WTO members. It was negotiated at the end of the Uruguay Round of the General Agreement on Tariffs and Trade in 1994.

[9]In intellectual property law, intention is not required for an infringement.

[10]This is because multinational corporations use experienced internal and external legal experts (e.g., large law firms that maintain a presence in multiple countries) to pursue patent enforcement strategies in multiple countries with economic, linguistic, and administrative similarities but with procedural arbitrage opportunities. The pretrial discovery process in Canada is more restrictive than that of the United States, so firms may use the U.S. legal system first to efficiently obtain broader evidence against the opposing party and later add Canada to further pursue a cost-effective patent enforcement strategy in that market. Germany has a well-respected specialized patent court system with highly specialized judges for patent infringement cases wherein cases are ruled on relatively quickly, and it can be easier to obtain an injunction in Germany than in other countries. Thus, many technology firms tend to pursue lawsuits in Germany and in the United States—where it is relatively slow and expensive to file a suit and juries may not have specialized knowledge in the underlying technology in the dispute—simultaneously. Once a favorable decision is obtained from Germany, a favorable outcome is more likely elsewhere, including in the Netherlands, as German court rulings are well respected (but not legally binding). Even simple "cease and

desist" letters may then be more credible and effective in other countries.

[11]To the best of our knowledge, there is no systematic study, theoretical or empirical, on how firms choose and prioritize international jurisdictions in pursuing their global patent enforcement strategies, which is an important topic beyond the scope of this paper. However, experienced legal practitioners generally agree that there are strategic advantages to litigating in multiple countries depending on the facts and circumstances (e.g., Garvin 2015, Hoyng and Eijsvogels 2015), including differences in potential damages awarded, procedural arbitrage opportunities, multimarket competition advantages, and cost and speed of the court system. Empirically, because of the size of potential economic damages awarded, among other reasons, Germany, Japan, the United Kingdom, and the United States are the most common battlegrounds for international lawsuits for many multinational corporations (Hoyng and Eijsvogels 2015).

[12]These firms, however, are not expected to exit strong-IP markets entirely (presumably, these are lucrative high-income markets) as a precautionary measure because they might not be infringing on any patent and it could still be rational to sell newer versions of its products given its sunk investment costs in market-specific infrastructure, such as building relationships with big-box retailers (e.g., Amazon, Best Buy, or Costco), customizing product design for local adaptation, or training local sales personnel. Similarly, new market entry into weak-IP countries might not be immediately feasible because it takes time to make sunk-cost investments in market-specific infrastructure.

[13]Royalty stacking refers to situations in which a single product potentially infringes on many patents and may thus bear multiple royalty burdens. The term "royalty stacking" reflects the fact that, from the perspective of the firm making the product in question, all of the different claims for royalties must be added or "stacked" together to determine the total royalty burden borne by the product if the firm is to sell that product free of patent litigation (Lemley and Shapiro 2006).

[14]Nonpracticing entities or patent assertion entities—the so-called patent trolls—have also played an increasing role in escalating the number of litigation cases (Fischer and Henkel 2012, Reitzig et al. 2010).

[15]For example, Apple's lawsuits against Samsung, Motorola, and HTC, among others, are widely viewed as part of a proxy war between the Apple's iOS and Google's Android platforms.

[16]Steve Jobs famously invoked the metaphor of nuclear war while threatening a competing mobile operating system, a statement that became popular in the media: "I will spend my last dying breath if I need to, and I will spend every penny of Apple's \$40 billion in the bank, to right this wrong. I'm going to destroy Android, because it's a stolen product. I'm willing to go to thermonuclear war on this" (Isaacson 2011, p. 512).

[17]The text search in *LexisNexis* includes both English and non-English news articles.

[18]To ensure that our measure does in fact reflect the intensity of patent wars, we crosscheck our data with data from *Lex Machina* and *Innography*, providers of U.S. litigation data, on smartphone patent lawsuits filed in each quarter. We then weigh each lawsuit by the average smartphone sales of the defendant and the plaintiff to account for the importance of each lawsuit. We find that our measure based on media coverage is significantly correlated with the sales-weighted U.S. patent litigation count in each quarter (correlation $= 0.41$ and p-value $= 0.07$). Using this measure based on U.S. lawsuits produces results that are qualitatively similar to our main results. However, these patent litigation data are available only for the U.S. market and, more importantly, do not include all patent warfare–related events, such as purchases, acquisitions, or damages. Hence, we use international media coverage frequency over time as a proxy measure of patent war intensity in our analysis because our study examines the global smartphone market, and patent warfare–related events outside the United States are significant. Note, however, that the combination of (a) U.S. litigation data obtained from *Lex Machina* and *Innography* and (b) our text analysis from the international media coverage allows us to identify whether a given vendor was involved in any litigation. We are also able to identify which vendor sues which vendor in each country (see Table 1, for example).

[19]Because news coverage may be significantly affected by discrete patent litigation events, whereas the underlying litigation risk may increase gradually over time, we create two alternative measures of patent war intensity as robustness checks: (1) the three-quarter moving average of the frequency and (2) the total frequency of news coverage in the past three quarters. Our results hold when using these measures.

[20]For the multicountry regions in our sample, we use a GDP (PPP)-weighted IP_index_{jt}.

[21]Ginarte and Park (1997) construct an index that reflects the strength of a country's patent laws based on five extensive criteria: coverage, membership in international treaties, restrictions on patent rights, enforcement, and duration of protection. The index was updated until 2005 (Park 2008) and has been used extensively in the patent literature.

[22]This classification was natural, as the IP index was measured on a 10-point scale ranging between 4.0 and 8.5 for all countries during our sample period. All weak-IP countries listed in Table 2 had values of less than 6.0, and all strong-IP countries had values over 7.0, leaving a void in between 6.0 and 7.0. The median and average levels of the IP index for all 20 countries/regions across all sample years were 7.00 and 6.45, respectively.

[23]As a sensitivity check, we also include H01 (basic electric elements), H03 (basic electronic circuitry), G02 (optics), G06 (computing, calculating, counting), and G11 (information storage), and we find virtually no change in our results.

[24]We also count the number of patents for each vendor at the end of each year during our sample period (2008–2012) but find that the vendors' positions rarely change from year to year. In other words, vendors with weak patent portfolios in one year had weak portfolios in other years. For our purposes, it suffices to identify whether a vendor had a strong or weak patent portfolio based on the number of patents owned—which reflects the strength of the vendor's patent dispute-related bargaining position. It makes little difference which end-of-year is used to count patents. Nonetheless, we choose the year 2008 for the reasons mentioned above.

[25]Because some of our variables exist as annual data (e.g., $CountryGDPshare_{jt}$), we convert our annual measures into quarterly measures using linear interpolation, assuming four equal increments in a year.

[26]Because it may be possible that firms change strategies in anticipation of intensified competition rather than in response to it, we repeat our analyses using forward-looking measures of

competition, where we use next quarter's values for *NumberOf-Competitors$_{jt}$*, *MarketConcentration$_{jt}$*, and *TotalShareApple-Samsung$_{jt}$* in our regressions. These results are qualitatively similar to our main results.

[27]Unless noted otherwise, we use OLS panel regressions and include observations over the 1Q2008–4Q2012 period for all 20 countries/regions in all regression analyses. Our results remain qualitatively similar after excluding some outlier countries (e.g., China, India, and the United States). As a robustness check, we use fractional logit models (Papke and Wooldridge 1996, 2008), and the results are fully consistent.

[28]Several smartphone vendors are also targets of patent trolls. Our results do not change qualitatively if we include the three vendors that are not sued by any smartphone vendor, but only by patent trolls.

[29]In contrast, in an unreported analysis, we find no evidence of vendors that *are* directly involved in patent litigation (e.g., Apple or Samsung) changing strategies or rebalancing their portfolios for risk management purposes. Rather, these tech giants initiated multiple lawsuits and undertook multiple countersuits to strengthen or defend their market positions in strong-IP countries, consistent with the prior literature (Lanjouw and Lerner 2000, Lanjouw and Schankerman 2003).

[30]It is possible that firms are concerned with potential growth at the firm level rather than growth (or lack thereof) at the country level. For example, one or two firms (e.g., Apple and Samsung) may capture most of the growth in a given country, and the other firms may be discouraged from trying to grow their businesses there. To account for this, we repeat the robustness check using an alternative method to rank markets/countries. We first compute the growth rate of each nonlitigant firm in a given country and take the average of the growth rates (we focus on nonlitigants, as this is the correct reference group for the vendors we study). We then rank countries according to this measure and repeat our analysis. Our results continue to hold.

[31]Moreover, we find that for vendors not involved in litigation, the more committed they are to Android before the escalation of patent wars, the more they shift their strategy as patent wars intensify.

[32]This made owning an iPhone nearly impossible in countries, such as Argentina (Oleaga 2014).

[33]Using data from the USPTO, we examined the patent filing behavior of vendors that are not directly involved in patent litigation and have sales during our study period in the United States, and we did not find increased patenting behavior among these vendors. We also found that the vast majority of these vendors do not license technologies from major industry players to mitigate litigation risk after patent wars escalate.

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