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Patent hold-out and licensing frictions: Evidence from litigation of standard essential patents[☆]



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ABSTRACT

The theory of patent “hold-out” posits that frictions in the market for licensing standard-essential patents (SEPs) provide incentives for prospective licensees to opportunistically delay taking licenses with the goal of avoiding or reducing royalty payments. We construct measures of pre- and in-litigation hold-out from information disclosed in U.S. cases filed 2010–2019. Relying on both SEP and a matched control set of non-SEP disputes, we explore whether frictions in the market for licensing are associated with hold-out. We find some evidence of an association between hold-out and both SEP portfolio size and enforcement uncertainty; however, we find no evidence associating pre- or in-litigation hold-out with the international breadth of SEP rights.

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1. Introduction

For more than two decades, academic and policy debates concerning “standard-essential patents” (SEPs)—i.e., patents covering essential features of ubiquitous technology standards, like WiFi and mobile broadband—have focused on the potential for SEP owners to leverage their patent rights to exclude competitors or otherwise “hold-up” companies that produce or sell standard-compliant products or services and, thereby, extract profits or royalties disproportionate to the pre-standardization value of their technological contributions (see for example, [Shapiro, 2001](#); [Lemley and Shapiro, 2007](#); [DOJ/FTC, 2007](#); [FTC, 2011](#); [Scott Morton and Shapiro, 2016](#)). Heeding these concerns, courts, antitrust regulators, and standard-setting organizations (SSOs) responded by placing limits on SEP enforcement in an attempt to curb SEPs’ potential anticompetitive effects ([Shapiro and Lemley, 2020](#)).

In recent years, however, the wisdom of regulatory reactions to hold-up has been fiercely contested by the advancement of countervailing concerns about the resulting potential for “hold-out” by prospective SEP licensees. According to SEP hold-out theory, current limits on SEP licensors’ ability to enforce their rights encourage prospective SEP licensees to opportunistically delay licensing SEPs in an effort to minimize royalty payments or avoid them entirely. Though principally

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supported to date by theoretical arguments (e.g., Layne-Farrar, 2016; Heiden and Petit, 2017; Llobet and Padilla, 2023) and anecdotal discussions of specific court cases (e.g. Epstein and Noroozi, 2017; Gupta et al., 2019; Barnett and Kappos, 2023; Heiden and Rappaport, 2023), warnings about the deleterious effects of hold-out are at present commonly expressed not just by SEP owners, but also by policymakers and media outlets, much as concerns about hold-up were widely aired just a few years ago.²

We contribute to this active debate by investigating the prevalence of potential hold-out in patent disputes, as well as factors associated with such behavior. Specifically, we collect data related to hold-out from the dockets of U.S. district court cases filed 2010–2019 to enforce a declared SEP or one of a matched sample of non-SEPs (NSEPs). We determine whether and to what extent each accused infringer received pre-suit notice of the patent enforcer's rights and additionally define and construct multiple variables suggestive of opportunistic delay. While both courts and the literature have focused to date on delays or refusals to negotiate *prior* to litigation (which we refer to as “pre-litigation hold-out”), we additionally collect evidence of delay- or cost-related gamesmanship by accused infringers *during* the course of litigation (“in-litigation hold-out”).

Using these data, we analyze whether the motivations for hold-out identified in the literature and asserted in ongoing policy debates³ are associated with observing hold-out in practice. Specifically, we ask whether hold-out is associated with the size and international scope of asserted patent portfolios and families, as well as with metrics of patent quality and standard essentiality. We assess hold-out determinants in two ways. First, we examine variation among our sample of cases filed to enforce or challenge at least one declared SEP. This approach allows us to analyze potential determinants that are specific to the SEP context; however, it does not produce results relative to a baseline comparison. In a second approach, we provide comparative results by incorporating data drawn from a matched control sample of cases that involve NSEPs.

Considered in the aggregate, our results offer some evidence of an association between allegations of dilatory conduct by accused infringers and both the size of SEP enforcers' patent portfolios and measures of enforcement uncertainty. However, we find little evidence of a link between alleged hold-out and the international breadth of a licensor's SEP portfolio. Additionally, our findings exhibit a moderate degree of heterogeneity across our analyses of pre- and in-litigation delay metrics, as well as across our approaches that do and do not incorporate NSEP data. Accordingly, our results chiefly indicate a need for additional theoretical analysis of hold-out, both with respect to hold-out's causes and with respect to how prospective licensees' incentives change once litigation is initiated.⁴

From a policy perspective, our findings are broadly consistent with efforts to facilitate portfolio licensing in the SEP context, as well as efforts aimed to increase the quality and better assess the essentiality of patents declared to SSOs. Otherwise, our approach suggests restraint in the face of calls (often forcefully made in recent years) to take sweeping action at the legislative, judicial, and SSO level to counteract perceived hold-out. While our analysis does reveal the occurrence of conduct that may qualify as hold-out under at least some existing legal frameworks, we caution that an improved understanding of the mechanisms driving licensor and licensee behavior (both before and during litigation) may be a predicate to the formulation of effective policy reforms.

2. Hold-out

In the context of SEP licensing, the term “hold-out” commonly refers to a prospective SEP licensee's efforts to avoid, delay, or lower the cost of licensing valid patents that cover a standardized technology. While the concept of hold-out has to date been analyzed to a relatively modest extent in the economics literature (Epstein and Spulber, 2012; Kieff and Layne-Farrar, 2013; Froeb and Shor, August 2015; Simcoe and Shampine, 2018; Llobet and Padilla, 2023), its importance in contemporary legal and policy debates is undeniable. Already the subject of dozens of law journal publications and policy-oriented white papers (see, e.g. Geradin, 2010; Layne-Farrar, 2016; Heiden and Petit, 2017; Epstein and Noroozi, 2017; Bharadwaj, 2018; Gupta et al., 2019; Auer and Stout, 2020; Engler and Renaud, 2022; Osenga, 2022; Teece and Dasgupta, 2022; Barnett and Kappos, 2023; Heiden and Rappaport, 2023), warnings about the allegedly widespread nature and negative consequences of hold-out have in recent years commonly been expressed by courts,⁵ policymakers,⁶ and media outlets⁷ across the globe.

According to these sources and many others like them, companies accused of infringing SEPs have incentives to avoid entering into licenses because SEP owners' ability to effectively enforce their SEPs is hindered by practical, legal, and contractual constraints that are specific to the governing SEP licensing framework. A key component of this argument is the

² In Section 2 below, we provide a summary of hold-out theory and document the vast amount of legal and policy writing produced on the topic in recent years.

³ See most recently the intense debate surrounding the European Commission's April 2023 proposal for the regulation of SEPs.

⁴ To allow for the replication of these results and support related research, we make our dataset and computer code (along with supporting documentation and Online Appendix) available at <https://doi.org/10.5281/zenodo.8031182>.

⁵ We provide a summary of relevant case law in Online Appendix A.

⁶ Pezzano (2023) provides a summary of statements from U.S. officials on the topic of hold-out. Intergovernmental organizations and national patent and competition law authorities outside the U.S. have raised concerns about hold-out as well. See, for example, a European Commission Communication on the topic of SEP licensing, a report on SEPs prepared by WTO staff, and SEP licensing guidelines issued by the Japan Patent Office.

⁷ See, e.g., IAM “The focus in Europe Moves from Patent Hold-up to Hold-out” (Jan. 24, 2020); Law360 “New US Policy On SEP Remedies Restores Critical Balance” (March 19, 2020); IAM “Those Who Adopt a Hold-out Strategy in SEP FRAND Licensing Should Face the Prospect of a Market Red Card” (Dec. 19, 2020); Newsweek “Patent ‘Holdouts’ Are Sapping U.S. Innovation” (Oct. 18, 2021).

effect of widespread contractual requirements that SEPs be licensed on “fair, reasonable, and nondiscriminatory” (FRAND) terms (Froeb et al., 2012). Because standards are developed through cooperation among competitors, patent rights that restrict access to standards have long been viewed as a potential means for exclusionary conduct. To keep antitrust regulators at bay, SSOs typically require that all participants in the standard-development process make a contractual commitment to (i) publicly identify (or “declare”) any patent rights they hold that cover some aspect of the standard and (ii) license those patent rights on FRAND terms, such that competitors not participating in the standard-setting process (and subsequent market entrants) have an open invitation to use or sell standard-compliant products in exchange for a “reasonable” and “non-discriminatory” (i.e., non-exclusionary) licensing fee. While there is widespread disagreement on the precise contours of a FRAND commitment, there is general agreement that potential SEP licensees may hold SEP licensors to their (or their predecessors’) prior FRAND commitments and that FRAND commitments restrict (to varying extents by jurisdiction) SEP licensors’ ability to obtain injunctive relief prohibiting infringement.

3. Hold-out incentives

The literature and related commentary offer three principal arguments why producers and users of standardized-technologies have incentives to opportunistically refuse to license FRAND-encumbered SEPs (Layne-Farrar, 2016; Heiden and Petit, 2017; Lobet and Padilla, 2023). Because the literature focuses primarily on conduct occurring prior to litigation, we first discuss each argument as it applies to the pre-suit conduct of potential licensees. We then consider to what extent these arguments are also applicable in the course of litigation.

3.1. Portfolio enforcement frictions

The first argument why prospective licensees have incentives to hold-out follows from the observation that SEPs tend to be held in large portfolios owned by firms that participated in the standard-development process. In theory, an SEP licensee must license all (valid and infringed) patents in each portfolio to lawfully use or sell standard-compliant technology, and if SEP licensors fail to receive royalties on all such patents, incentives to innovate and develop technology standards will fall (potentially to sub-optimal levels). In practice, however, it is uncommon to enforce a large portfolio of patents in court against a prospective licensee that refuses to take a portfolio license. In order to keep patent litigation manageable, patentees typically restrict the number of patents that they assert in any given case and courts commonly force patentees to narrow their claims further as litigation progresses. As a result, cases rarely proceed to trial on more than a handful of patents. According to the literature, this reality means that a FRAND-encumbered SEP licensor confronted with a recalcitrant prospective licensee faces the prospect of attempting piecemeal litigation with little prospect for interim injunctive relief (Sidak, 2018). If so, the cost and uncertainty of serial litigation may induce an SEP licensor to collect royalties on just a subset of its SEPs or reduce the aggregate royalty requested for a portfolio license. Theory thus predicts that a prospective licensee has incentive to holdout against an SEP licensor with a relatively large portfolio in hopes of forcing the licensor to incur the costs of successive litigation or reduce its royalty demand accordingly.

At the same time, there is also reason to doubt the validity of this hypothesis. For one, SEP licensors can (and commonly do) argue in court that a subset of patents selected for enforcement represent the overwhelming majority of their portfolio’s value.⁸ Relatedly, evidence supports the common contention that SEP portfolios are frequently padded with patents of questionable value and essentiality (Lemley and Simcoe, 2019; Righi and Simcoe, 2020). Moreover, while courts commonly do restrict the number of patents that may be enforced in a single *patent infringement* suit, SEP licensing disputes are commonly litigated as contract and/or antitrust cases, in which courts can (and increasingly do) declare FRAND rates for SEP licensors’ entire portfolios.⁹

3.2. Multinational enforcement frictions

A second reason why prospective licensees may engage in hold-out derives from the global reach of both standardized technologies and efforts to protect them with patent rights. Because SEP licensors frequently hold patents issued by many countries around the world and producers and users of standardized technology frequently operate in many national markets, lawful use of a standard commonly requires a *global* portfolio license. At the same time, individual patents are national rights that must be enforced at the national level and generally entitle their owners to compensation only for infringement occurring within a nation’s borders. According to hold-out theory, the mismatch between the international scope of

⁸ In *Ericsson, Inc. v. D-Link Corp.*, for example, Ericsson’s argument that the six U.S. patents asserted in the case accounted for “at least 50 percent of the total value of the Ericsson 802.11 Portfolio” was approved by the court as “a realistic and thorough attempt to apportion revenue to only the asserted patents.” No. 6:10-cv-473 (E.D. Tex. May 20, 2013).

⁹ See *TCL Comm. Tech. Holdings Ltd. v. Telefonaktiebolaget LM Ericsson*, No. 8:14-cv-341, 2018 WL 4,488,286 (C.D. Cal. Sept. 14, 2018) (determining FRAND rates for Ericsson’s portfolios of 2G, 3G, and 4G cellular SEPs), *vacated by* 943 F.3d 1360 (Fed. Cir. 2019); *Microsoft Corp. v. Motorola, Inc.*, No. 10-cv-1823, 2013 WL 2,111,217 (W.D. Wash. Apr. 25, 2013) (determining FRAND rates for Motorola’s portfolios of Wi-Fi and H.264 video compression SEPs). For rulings by courts in other countries, see *Unwired Planet Intl. Ltd. v. Huawei Tech. (UK) Co.*, [2020] UKSC 37 (Aug. 26, 2020) (holding that UK courts have jurisdiction to determine global, portfolio-wide FRAND rates); *Guangdong OPPO Mobile Telecomm. Co. v. Sharp Corp.* (Supreme People’s Court Aug. 19, 2021) (holding that Chinese courts have the same ability).

SEP portfolios and the national scope of patent enforcement creates frictions that inhibit SEP licensing. If an international SEP portfolio must be litigated in pieces in each jurisdiction where a license is required, prospective licensees can refuse to negotiate a global license and instead insist on country-specific license agreements, each of which provides a separate opportunity for the licensee to hold out and risk litigation. Moreover, in a scenario with sequential litigation across jurisdictions that value SEPs at pre-litigation market rates, [Lobet and Padilla \(2023\)](#) show that a licensee may benefit from information spillovers that licensees can use to their advantage. Whether due to costs, uncertainty, or asymmetric externalities, hold-out theory predicts that the international nature of SEP negotiations depresses licensing fees paid and excessively incentivizes litigation.

On the other hand, additional considerations raise the possibility that this prediction is based on an incomplete—or at least outdated—view of SEP licensing. In recent years, courts in multiple countries have set global FRAND rates in SEP licensing disputes and, today, it is common for SEP litigation to focus intensely not on the question of whether a court can set a global FRAND rate, but rather on the question of *which nation's* courts should set the global FRAND rate ([Geradin and Katsifis, 2021](#)).

3.3. Probabilistic enforcement frictions

A third potential basis for hold-out is the probabilistic nature of patent validity and infringement/standard essentiality. According to the literature, courts commonly interpret an SEP enforcer's FRAND commitment as limiting compensation to the royalty rate that the enforcer's SEPs could have commanded in the licensing market before litigation—when patent validity and infringement/essentiality were (much more) uncertain. In such a scenario, the gains from litigating infringement and validity in SEP cases are asymmetrically divided between the litigants. A potential licensee stands to gain more from litigation in expectation because proving invalidity or non-essentiality/non-infringement will reduce or eliminate the royalty rate it owes, while the SEP licensor by comparison must prevail on both issues simply to recover damages approximating the royalty (discounted to reflect uncertainty) that it could have commanded in the market before succeeding in court. Accordingly, a potential SEP licensee has incentive to delay and risk litigation when confronted with probabilistic FRAND-encumbered patents because litigation in that context may help, and likely won't hurt, its economic position.

However, there are reasons to doubt that this theoretical argument is as clear cut as the literature suggests. While it is true that evidence of comparable royalties is frequently considered in SEP litigation, it is hardly the only methodology employed by courts, and some alternative methodologies have been criticized as overcompensatory.¹⁰ In addition, it is commonly argued that comparable licenses introduced in court proceedings are, in fact, not comparable at all and, instead, are strategically selected or structured to inflate the royalty owed.¹¹ More generally, accused SEP infringers face a complex set of incentives when deciding whether to litigate a case to judgment. For example, it has long been recognized that individual firms have sub-optimal incentives to challenge patent validity or defend common issues concerning infringement because doing so generates uncompensated positive externalities for other market participants, including direct competitors ([Farrell and Merges, 2004](#)). Prospective SEP licensees must additionally consider the possibility that litigation will lead to an award of punitive damages or attorney fees in the licensor's favor.¹²

3.4. In-litigation hold-out conduct

While the existing literature focuses almost exclusively on prospective SEP licensees' incentives in pre-litigation negotiations (i.e., licensees' incentive to enter into a license or instead to delay and risk litigation), there could also exist incentives for prospective licensees to engage in hold-out once litigation has been initiated (i.e., to delay and risk a final judgment rather than settle the lawsuit). According to [Heiden and Petit \(2017\)](#), hold-out “can also arise before courts, when infringing defendants resort to ‘diversionary tactics’ in litigation.” That is, following the logic set forth above, SEP licensees that benefit from increasing SEP licensors' expected costs of enforcement by threatening sequential, uncertain litigation may also benefit from increasing SEP licensors' actual costs of enforcement in the course of any litigation that ensues. At the same time, we caution that when a dispute evolves into full blown litigation, additional factors come into play that could affect licensor and licensee behavior and, therefore, also any association between the different mechanisms and hold-out discussed above. At the very least, behavior in litigation may be impacted by the introduction of asymmetric litigation costs and the opportunity to challenge patent validity ([Meurer, 1989](#)).

¹⁰ For a summary of SEP valuation methodologies employed by courts, see e.g., [Contreras et al. \(2019\)](#).

¹¹ See for example *Microsoft Corp. v. Motorola, Inc.*, No. 10-cv-1823, 2013 WL 2111217, at *67 (W.D. Wash. Apr. 25, 2013) (rejecting a prior license specifying a sizeable 2.25% royalty rate because (i) the license actually required the licensee to pay only a “very small [amount], in the thousands” and (ii) the license was entered “on the eve of a hearing... at which Motorola relied on the agreement as evidence of the reasonableness of its royalty demands on Microsoft”); In re *Innovatio IP Ventures, LLC Patent Litigation*, No. 11-cv-9308, 2013 WL 5593609, at *30-35 (N.D. Ill. Oct. 3, 2013) (rejecting all four comparable licenses proposed by the SEP licensor).

¹² See *Core Wireless Licensing S.A.R.L. v. LG Electronics, Inc.*, No. 2:14-cv-912 (E.D. Tex. Nov. 1, 2016) (awarding \$465,000 in punitive damages—an enhancement of 20%—for willful infringement of two SEPs); *Optis Wireless Technology, LLC v. Huawei Device USA, Inc.*, 421 F. Supp. 3d 410 (E.D. Tex. 2019) (granting the SEP licensor's motion for attorneys' fees).

Table 1
Indicators of pre-litigation notice.

| Indicator | Description |
|---------------------------|---|
| Notice any | Was the accused infringer (admittedly or allegedly) aware of the patent before it was sued for infringement? ^a |
| Notice from patentee | Did the accused infringer receive pre-suit notice of the patent directly from the patent enforcer (or its predecessor-in-interest), for example via a letter or e-mail? |
| Multiple notices | Did the accused infringer receive multiple pre-suit communications concerning the patent (i.e., more than a single letter or e-mail) from the patent enforcer? |
| Notice with claim chart | Did the accused infringer receive a claim chart (or some other detailed explanation of the alleged patent infringement) from the patent enforcer prior to litigation? |
| Notice with royalty offer | Did the accused infringer receive a proposed royalty rate/amount from the patent enforcer prior to litigation? |

^a For this measure, alleged notice could have come from any source, including a patent enforcer's assertion that the accused infringer became aware of the patent by monitoring nominally public court filings, U.S. Patent and Trademark Office's office actions, or SSO declarations.

Table 2
Indicators of pre-litigation hold-out by prospective patent licensees.

| Indicator | Description |
|------------------------|--|
| Pre-suit delay any | Did the patent enforcer allege that the infringer engaged in any of the three behaviors defined below? |
| Refusal to negotiate | If the accused infringer received pre-suit notice from the patent enforcer, did the accused infringer allegedly ignore (or otherwise fail to meaningfully respond to) the patent enforcer's pre-suit communication(s)? |
| Unwilling to negotiate | If the accused infringer and patent enforcer entered into (pre-litigation) licensing negotiations, did the accused infringer allegedly fail to participate in the negotiation with reasonable diligence? |
| Pre-suit delay tactics | If the accused infringer and patent enforcer entered into (pre-litigation) licensing negotiations, did the accused infringer allegedly use a tactic to delay or increase the cost of the parties' negotiation? |

4. Measuring hold-out

4.1. Indicators of pre-litigation notice

Before defining hold-out itself, we first consider a predicate issue: whether—and if so how, when, and to what extent—the potential patent licensee was put on notice of the licensor's patent rights prior to the filing of litigation (see Table 1). Logically, a company producing allegedly infringing products or services cannot hold-out unless it has some reason to believe that it might owe a royalty. Our first measure, *notice any*, considers whether a prospective patent licensee received notice, in some form or fashion, of its potential infringement. In keeping with the legal framework established in existing case law (and as explained below in greater detail), we consider additional measures of the source and content of the notice alleged. While an alleged patent infringer might theoretically be considered to have constructive notice of any nominally public patent application, SSO declaration, or case filing, conceptions of hold-out in the literature and case law typically envision a potential licensee that has been placed on actual notice of alleged infringement by the patent enforcer or its predecessor-in-interest. We refer to this subcategory of notice as *notice from patentee*.

Consistent with the case law, we additionally consider the content of the patent enforcer's pre-litigation communications, including whether the patent enforcer reached out to the potential licensee more than once, whether the patent enforcer included in those communications a detailed explanation of the alleged infringement (e.g., in the form of a "claim chart" mapping the asserted patent's claims to the accused product or service), and whether the patent enforcer requested a particular royalty rate or amount. We refer to these subcategories of notice as, respectively, *multiple notices*, *notice with claim chart*, and *notice with royalty offer*.

4.2. Indicators of pre-litigation hold-out

Our first set of hold-out indicators is based on conduct that took place prior to litigation (see Table 2). Once a prospective licensee has been placed on notice that it may owe royalties on sales of standard supporting products, it can react in a number of ways that may be indicative of intentional delay. One such reaction is a complete refusal to respond to the patent enforcer's communications or, equivalently, to respond with no more than a flat refusal to consider a license. We refer to both reactions as a *refusal to negotiate*. If a prospective licensee does engage in licensing negotiations, it may nonetheless carry out those negotiations in a manner indicative of an intent to delay the consummation of a licensing agreement. For example, a potential licensee may tend to postpone, prolong, or duplicate stages of the parties' negotiations to an unreasonable extent. We refer to this behavior as being *unwilling to negotiate*. In addition to passive "foot dragging," a prospective licensee may further engage in affirmative conduct that may suggest a desire to delay or increase the cost of licensing negotiations. We refer to these behaviors as *pre-suit delay tactics*. As explained in greater detail in Online Appendix B, we include several behaviors that may sometimes be tactical in nature. One is a prospective licensee's decision not to participate in alternative dispute resolution, i.e., mediation or arbitration. Another is a prospective licensee's refusal to enter into a non-disclosure agreement governing the parties' negotiation.

Table 3
Indicators of in-litigation hold-out by prospective patent licensees.

| Indicator | Description |
|----------------------|---|
| In-litigation delay | Did the patent enforcer allege that the infringer engaged in any of the six behaviors defined below? |
| Dismissal delay | Did the patent enforcer argue that the accused infringer filed motion(s) to dismiss in order to strategically delay (or otherwise increase the cost of) litigation? |
| Transfer delay | Did the patent enforcer argue that the accused infringer filed motion(s) to transfer in order to strategically delay (or otherwise increase the cost of) litigation? |
| Stay delay | Did the patent enforcer argue that the accused infringer filed motion(s) to stay (or continue, etc.) in order to strategically delay (or otherwise increase the cost of) litigation? |
| Discovery delay | Did the patent enforcer argue that the accused infringer strategically delayed (or otherwise acted to increase the cost of litigation) in the course of providing or requesting discovery? |
| PTAB delay | Did the patent enforcer argue that the accused infringer petitioned the U.S. PTO to reconsider the patent's validity (e.g., in inter partes review) in order to strategically delay (or otherwise increase the cost of) litigation? |
| Duplicate litigation | Did the patent enforcer argue that the accused infringer pursued the parties' dispute in multiple fora or venues in order to strategically delay (or otherwise increase the cost of) litigation? |

4.3. Indicators of in-litigation hold-out

Because all patent licensing disputes that we observe resulted in a lawsuit, we additionally consider ways in which prospective patent licensees could engage in hold-out in litigation (see Table 3). For one, a prospective patent licensee may engage in pre-trial motions practice in a manner that indicates an intent to delay or raise the cost of litigation. For example, an accused patent infringer may delay a case at the outset by filing a series of weak or trivial motions to dismiss the patent enforcer's complaint.¹³ We capture this conduct in a measure that we call *dismissal delay*. Similarly, an accused infringer may slow the early stages of a patent case by filing a motion to transfer the suit to another court when such a motion was highly unlikely to be granted.¹⁴ We refer to this measure as *transfer delay*.

The discovery stage of litigation provides further opportunities for strategic behavior. By delaying or unreasonably opposing production of documents and discovery responses, an accused infringer can delay the development of a patentee's infringement case, increase costs by requiring the litigation of motions to compel, and ultimately necessitate an extension of discovery and other case deadlines. In addition to neglecting its own obligations to produce discoverable information, an accused infringer may aggressively demand unnecessary or excessive discovery from the patent enforcer in an attempt to slow a case's progression and increase litigation costs. We include discovery gamesmanship in our framework with the measure *discovery delay*.

In addition, throughout litigation's various stages, an accused infringer may directly attempt to pause or prolong litigation by asking the court to stay the case, extend a deadline, or continue the previously selected date for an important event such as the claim construction hearing or trial. We include strategic misuse of motions to stay or continue in our framework with the measure *stay delay*.

Finally, an accused infringer may engage in conduct that falls outside the scope of an individual court case, but nonetheless impacts the parties' dispute. Most notably, patents enforced in litigation are commonly challenged in parallel administrative proceedings before the U.S. Patent and Trademark Office's Patent Trial and Appeal Board (PTAB). We capture alleged abuse of administrative patent challenges by accused infringers or their affiliates in the measure *PTAB delay*. A prospective patent licensee may also increase the complexity of litigation by unnecessarily pursuing overlapping suits in multiple courts. In addition to pursuing an unnecessary declaratory judgment action in another U.S. district court, a prospective patent licensee could initiate duplicative litigation in a U.S. state court or in a foreign jurisdiction. We capture this conduct in a measure that we call *duplicate litigation*.

5. Data

5.1. SEP and NSEP litigation

To construct a database of SEP litigation, we merge the set of SEPs declared to the European Telecommunications Standards Institute (ETSI)¹⁵ with case-level data extracted from the dockets of all patent suits filed at U.S. district courts between 2010 and 2019. We obtain ETSI declarations from the Searle Center Database on Technology Standards and Standard Setting Organizations (Baron and Spulber, 2018; Baron and Pohlmann, 2018)¹⁶ and basic litigation data from the MaxVal Patent Litigation Databank.

¹³ In addition to imposing litigation costs on the patent enforcer, an early motion to dismiss (or series thereof) may allow the accused infringer to delay answering the patent enforcer's complaint. See Fed. R. Civ. Proc. 12(a)(4).

¹⁴ Often motions to transfer are accompanied by motions to stay or limit discovery until the motion is decided.

¹⁵ ETSI supported development of GSM, 4G, and 5G mobile broadband standards (among others) and receives the vast majority of all SEP declarations.

¹⁶ Because the declaration of a single patent or application is generally regarded as a declaration of the patent or application's entire family (ETSI's IPR FAQ, for example, instructs that "[t]he recommended practice is to declare only one member in a patent family... and let the system expand auto-

For comparison purposes, we additionally construct a matched sample of patent litigation involving patents that were not declared essential to a technology standard. We do so following the approach adopted by Lemley and Simcoe (2019, p. 617), according to which each litigated SEP is matched with a litigated NSEP that (i) shares the same technology classification, (ii) claims priority to an application filed in the same year as the SEP's ultimate parent, and (iii) was first asserted in court in the same year as the SEP.

Finally, we conduct an in depth review of all resulting litigation, during which we (i) ensure that included cases represent new, rather than ongoing, licensing disputes,¹⁷ (ii) expand all data from the case-level to the patent-party level, and (iii) collect a wide array of case-, litigant-, and patent-specific variables for use as controls (see Online Appendix D).

5.2. Hold-out

To collect data on the indicators of (and predicates for) hold-out discussed in Section 4, we reviewed each relevant case's docket—including all pleadings filed in the case, all motions filed in the case, and all court rulings on those motions—for allegations, arguments, or admissions that the prospective licensor was aware of each asserted patent prior to litigation and, once put on notice, behaved in a manner potentially indicative of pre-litigation or in-litigation hold-out as defined above. A detailed account of our case coding methodology, including sample cases that demonstrate all variables defined in Tables 1–3, is available in Online Appendix B.

While court filings are an imperfect and indirect means to observe potential hold-out, patent enforcers have a strong incentive to plead facts, if any, establishing the accused infringer's pre-suit knowledge of and disregard for the asserted patent because "willful" infringement may entitle the patent enforcer to treble damages (35 U.S.C. § 284).¹⁸ In addition, claims of indirect patent infringement (which are very common in telecommunications cases) require proof that the accused infringer had knowledge of the asserted patent or was willfully blind as to its existence.¹⁹ Accused infringers that proactively file their own declaratory judgment actions likewise have a strong incentive to plead facts summarizing the parties' pre-suit communications, if any, because declaratory judgment jurisdiction requires demonstration of an existing "real and substantial" dispute between "parties having adverse legal interests."²⁰ Accordingly, if a licensor can make a reasonable claim that pre-litigation hold-out has occurred, this allegation will very likely appear in documents filed very early in the case. As a result, even cases that settle quickly can be rich sources of information regarding pre-litigation notice and hold-out and, thus, selection into reporting pre-litigation hold-out is a negligible concern. In Online Appendix C, we provide a detailed breakdown of several of the more detailed negotiations revealed in case pleadings and explain how we translated the information into our empirical measures of hold-out.

By contrast, evidence of potential in-litigation hold-out emerges over time as cases progress. Nonetheless, when delay or cost-related gamesmanship is suspected in litigation, parties have good reason to report it as well, at least because it can form the basis for sanctions (under, e.g., Federal Rule of Civil Procedure 11) or later support an award of attorneys fees (35 U.S.C. § 285).²¹

5.3. Licensing frictions

To measure SEP licensors' SEP portfolio size, we use the family-based patent count of declared-essential patents held by each licensor at the time of each suit's filing. For patent family size, we use a simple count of the number of applications comprising each asserted patent's family. To measure the international coverage of SEP licensors' SEP portfolios, we count the number of major international markets represented among each SEP enforcer's entire SEP portfolio.²² For patent family breadth, we follow the same approach, but limit our count to the unique international markets represented among members of each asserted patent's family.

Because success in patent litigation is a function of both an asserted patent's validity and its similarity to the allegedly infringing technology, we construct two measures of enforcement uncertainty. First, we construct a measure of patent qual-

matically as new members appear under this patent family."), we use EPO's Patstat database to identify each ETSI-declared SEP family and ensure that all members are included in our data.

¹⁷ Because hold-out theory and relevant case law focus on the incentives of parties engaged in an opening round of licensing negotiations, we exclude from our analysis cases that (i) resulted from an alleged breach of or failure to renew a prior licensing agreement between the parties, or (ii) otherwise followed a prior, resolved suit between the same parties involving the same patent. We also identify all "new" cases resulting from an ongoing case's transfer or severance, as well as all cases that were voluntarily dismissed and subsequently re-filed or merged into another case. When necessary, we consolidate our data so that it follows each patent-party level dispute across two or more case dockets.

¹⁸ See *Halo Elecs., Inc. v. Pulse Elecs., Inc.*, 136 S. Ct. 1923, 1932 (2016).

¹⁹ See *Global-Tech Appliances, Inc. v. SEB S.A.*, 563 U.S. 754 (2011).

²⁰ See *Aetna Life Ins. Co. v. Haworth*, 300 U.S. 227, 240–41 (1937).

²¹ See *Octane Fitness, LLC v. ICON Health & Fitness, Inc.*, 572 U.S. 545 (2014).

²² In other words, if U.S. SEPs A and B are held by a given licensor that asserted SEP A in a given case, we identify all non-U.S. members of SEP A's family and all non-U.S. members of SEP B's family, and then count the number of significant jurisdictions represented. For example, if SEP A's family includes (non-U.S.) members filed in Germany, Japan, and China, and SEP B's family has (non-U.S.) members filed in Germany, Japan, and Korea, our international coverage variable will assume the value of four for this specific licensor-case combination. In order to avoid giving undue weight to relatively small nations/markets in which patent litigation is virtually never pursued, we consolidate our results across some global regions—e.g., we treat Brazil, Mexico, Argentina, and Colombia as one "Latin American" market.

ity, which serves as a proxy for the validity of asserted SEPs and NSEPs. We follow Lanjouw and Schankerman (2004) in treating patent quality as a latent variable and implement an extension of their model proposed by de Rassenfosse and Jaffe (2018) that treats both patent quality and value as latent variables (for a detailed explanation see Online Appendix E). This formulation allows us to separate the effect of validity from the effect of value so that we can focus on the former. Second, we construct a measure of standard essentiality, which serves as a proxy for the likelihood that asserted SEPs are infringed by unlicensed uses of the relevant standard. For this purpose, we use standard essentiality scores provided by Brachtendorf et al. (2023), who employ a semantics-based method to measure the textual similarity between SEPs and the technical standards to which they have been declared essential. Because NSEPs are, by definition, not linked to any specific technology standard, essentiality scores are not available for these patents.

6. Empirical approach

In our empirical analysis, we look for associations between the indicators of licensing frictions set forth in Section 3 and the indicators of hold-out defined in Section 4. We do so, first, by examining variation across SEP disputes. Importantly, limiting our analysis to SEP litigation allows us to incorporate measures of licensing frictions that do not arise in NSEP litigation; i.e., SEP portfolio size, SEP portfolio breadth, and standard essentiality scores. We run an OLS regression using the following linear specification and data drawn exclusively from SEP disputes:

$$\begin{aligned} \text{holdout}_{ijc} = & \beta_0 + \beta_1 \text{PortSize}_{jc} + \beta_2 \text{PortScope}_{jc} + \beta_3 \text{PatQuality}_i + \beta_4 \text{Essentiality}_i \\ & + \gamma X_{ijc} + \epsilon_{ijc} \end{aligned} \quad (1)$$

where holdout_{ijc} denotes our indicators of hold-out for the combination of patent i , party j , and case c ; PortSize_{jc} is the size of the SEP portfolio held by the SEP licensor in party-case combination jc ; PortScope_{jc} represents the international scope of the SEP portfolio held by the SEP licensor in party-case combination jc ; PatQuality_i is our measure of patent i 's quality; Essentiality_i is patent i 's standard essentiality score; X_{ijc} incorporates a long list of controls (detailed in Online Appendix D), including party, case, and patent characteristics, as well as measures of hold-up by the SEP licensor; and ϵ_{ijc} is an error term.

Next, we examine variation across SEP and NSEP disputes. To incorporate NSEP litigation, we modify Equation (1) in several respects. First, we introduce SEP_{ijc} , a dummy variable that is equal to one for all SEP cases and zero for all NSEP cases, and interact this variable with our measures of licensing friction. In addition, we must modify this set of measures. Because NSEPs cannot be compared to a standard, we remove our measure of standard essentiality, Essentiality_i . Similarly, because NSEPs are not members of well-defined, relatively homogeneous portfolios, we substitute family-level for portfolio-level statistics—i.e., we substitute (i) patent family size (FamSize_{jc}) for SEP portfolio size (PortSize_{jc}), and (ii) patent family geographic scope (FamScope_{jc}) for SEP portfolio geographic scope (PortScope_{jc}). In modified form, the specification becomes:

$$\begin{aligned} \text{holdout}_{ijc} = & \beta_0 + \beta_1 \text{SEP}_{ijc} + \beta_2 \text{FamSize}_{jc} + \beta_3 \text{FamScope}_{jc} + \beta_4 \text{PatQuality}_i \\ & + \beta_5 \text{SEP}_{ijc} \times \text{FamSize}_{jc} + \beta_6 \text{SEP}_{ijc} \times \text{FamScope}_{jc} + \beta_7 \text{SEP}_{ijc} \times \text{PatQuality}_i \\ & + \gamma X_{ijc} + \epsilon_{ijc} \end{aligned} \quad (2)$$

While the measures used in specification (1) are, on the whole, more closely aligned with the licensing frictions identified in the literature and other commentary, several are specific to the SEP context and, thus, lack a perfect analog in NSEP cases. At the same time, an analysis based solely on SEP litigation is limited in that it lacks a baseline level of notice and hold-out with which to compare.

Another challenge for our approach is the difficulty inherent in drawing a line between conduct that, on the one hand, constitutes genuine hold-out and conduct that, on the other, is tough-but-legitimate in the context of high-value patent licensing and litigation. While the very existence of litigation is indicative of a failure to reach a private agreement, hold-out theory focuses on recalcitrant conduct that extends beyond the norm. To mitigate any potential concern that our indicators of pre-litigation hold-out too readily capture legitimate conduct, we additionally carry out the specifications set forth above using a subset of litigation in which full-fledged hold-out is especially likely to have been attempted. To define this subset of litigation, we rely on the SEP negotiation framework adopted by the Court of Justice of the European Union (CJEU) in *Huawei v. ZTE* (see Online Appendix A). Tracking the court's multi-step test, we combine our indicators of pre-litigation notice and delay to redefine holdout_{ijc} so that it is only equal to one when (i) *notice from patentee* was provided at least 90 days prior to litigation, (ii) *notice with claim chart* is = 1, and (iii) any of *refusal to negotiate*, *unwilling to negotiate*, or *pre-litigation delay tactic* are = 1. This definition, which we derive from *Huawei v. ZTE* "step 2," allows us to identify patent assertions that follow a non-trivial period of pre-suit notice, during which time the patent licensor explained the basis for its assertion of standard essentiality and the patent licensee (allegedly) opted not to respond or engage in good faith.

A final consideration to note is the fact that our data is limited to licensing disputes that were litigated. As a result, we do not (and as a practical matter cannot) observe situations in which patent infringement allegations were resolved privately or abandoned prior to litigation. It is possible that (unobservable) pre-litigation settlement may bias our sample in favor of disputes that are relatively large and relatively contentious—i.e., valuable enough to justify the high cost of litigation and sufficiently contentious to call for adjudication by a third party—and, if so, theory suggests that hold-out may

Table 4
Pre-litigation notice, hold-out, and in-litigation hold-out.

| | SEP (1) | NSEP (2) | Diff. (3) |
|--|------------|-------------|--------------|
| Pre-litigation notice | | | |
| 1 Any notice | 65.64 | 32.39 | 33.25*** |
| 2 Notice from plaintiff | 43.76 | 24.72 | 19.04*** |
| 3 Multiple notices | 28.23 | 9.71 | 18.51*** |
| 4 Claim chart | 8.26 | 2.89 | 5.36*** |
| 5 Royalty offer | 10.32 | 1.79 | 8.53*** |
| Pre-litigation hold-out behavior by defendant | | | |
| 1 Pre-suit delay any | 17.67 | 3.49 | 14.18*** |
| 2 Refusal | 6.73 | 1.10 | 5.62*** |
| 3 Unwilling | 6.73 | 2.04 | 4.69*** |
| 4 Delay tactics | 4.20 | 0.34 | 3.86*** |
| In-litigation hold-out behavior by defendant | | | |
| 1 In-litigation delay any | 37.79 | 14.66 | 23.13*** |
| 2 Dismissal delay | 8.79 | 1.36 | 7.43*** |
| 3 Transfer delay | 1.22 | 1.70 | -0.48 |
| 4 Stay delay | 5.20 | 2.81 | 2.38*** |
| 5 Discovery delay | 14.30 | 5.45 | 8.85*** |
| 6 PTAB delay | 3.90 | 4.00 | -0.10 |
| 7 Duplicate litigation | 1.53 | 0.76 | 0.76* |
| Total cases | 1307 | 1173 | |

Notes: The table shows the % of patent-party-case combinations where any of the variables listed is = 1; SEP: standard essential patent; NSEP: matched non-standard essential patent; unit of observation at the patent-party-case level; * significant at 10%, ** at 5%, *** at 1%.

be relatively prevalent in such disputes. The existing literature indicates, for example, that case value is positively correlated with portfolio/family size and coverage (Lanjouw and Schankerman, 2001), while patent quality is negatively associated with litigation (Bessen and Meurer, 2006). That said, settlement prior to litigation is likely also directly affected by hold-out, as well as by hold-up and many other factors, which make the effect of selection into litigation not just impossible to measure empirically, but also challenging to predict as a matter of theory.

7. Results

7.1. Descriptive results

Table 4 shows the percentage of cases for which we observe allegations or admissions of pre-litigation notice, pre-litigation hold-out, and in-litigation hold-out. We present averages for disputes involving SEPs and our matched sample of NSEPs.

As expected, we see in the first column of Table 4's top panel that pre-litigation notice of asserted SEPs is commonly alleged or admitted; some form of notice was reported in almost 66% of cases. In about 44% of SEP cases (roughly two-thirds of cases in which notice was reported), it was additionally alleged or admitted that notice of infringement was effected via correspondence from the SEP licensor (or its predecessor). That said, a much smaller subset of cases reveal evidence of a significant attempt by the SEP licensor to negotiate a license prior to litigation. SEP licensors allege that they reached out to the accused infringer more than once in just 28% of cases. Moreover, in just 8% of cases did the SEP licensor allege that it provided the accused infringer with a claim chart or some other explanation of why the relevant patent was essential/infringed, and in only 10% of cases did the SEP licensor report that it communicated a specific royalty offer to the prospective licensee. Nonetheless, a comparison of columns 1 and 2 of the top panel reveals a large and significant difference in the prevalence of pre-litigation notice, with SEP enforcers reporting much more often than NSEP enforcers that they communicated with prospective licensees before filing suit.

Turning next to indicators of pre-litigation hold-out behavior, we see in column 1 of Table 4's middle panel that the SEP licensor alleged in almost 18% of SEP cases that the accused infringer engaged in one of our three categories of pre-suit hold-out. Nearly 7% alleged that the prospective licensee refused to communicate with the licensor, 7% alleged that the prospective licensee engaged in licensing negotiations but did so on a generally "unwilling" basis, and 4% alleged that the prospective licensee engaged in a specific tactic to delay or raise the costs of pre-suit licensing negotiations. Comparing across columns 1 and 2, we see yet again a large and significant difference in the prevalence of alleged pre-litigation hold-out, with SEP enforcers reporting dilatory actions by prospective licensees more often than NSEP enforcers. While this difference plainly stems to some extent from the relative prevalence of notice in SEP and NSEP cases, the difference we observe here remains large even when viewed relative to notice rates.

Table 5
Pre-litigation hold-out behavior by defendant – SEP.

| Hold-out behavior Definition | Pre-suit any | | Refusal | | Unwilling | | Delay tactics | |
|---------------------------------|--------------------|---------------------|-------------------|---------------------|----------------------|---------------------|-------------------|---------------------|
| | All (1) | HZ (2) | All (3) | HZ (4) | All (5) | HZ (6) | All (7) | HZ (8) |
| Log SEP portfolio size | 0.030** (0.012) | 0.008 (0.005) | -0.002 (0.009) | -0.004 (0.003) | 0.034*** (0.007) | 0.012*** (0.004) | -0.001 (0.004) | 0.0002 (0.002) |
| Log # countries SEP | -0.033 (0.030) | -0.025 (0.017) | -0.017 (0.024) | -0.028** (0.013) | -0.003 (0.018) | 0.006 (0.008) | -0.011 (0.010) | -0.003 (0.005) |
| Patent quality | 0.607 (1.125) | -0.495 (0.396) | -0.352 (0.979) | -0.382 (0.250) | 0.768 (0.529) | 0.103 (0.247) | 0.191 (0.308) | -0.217 (0.181) |
| Log patent essentiality score | -0.042 (0.030) | -0.030** (0.014) | 0.016 (0.016) | 0.008 (0.008) | -0.048*** (0.018) | -0.017 (0.010) | -0.010 (0.010) | -0.021** (0.009) |
| Hold-up | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| P/D characteristics | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Case characteristics | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Patent characteristics | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Case filing year | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| R ² | 0.215 | 0.199 | 0.197 | 0.121 | 0.241 | 0.203 | 0.285 | 0.245 |
| Observations | 1,307 | 1,307 | 1,307 | 1,307 | 1,307 | 1,307 | 1,307 | 1,307 |

Notes: Unit of observation at the patent-party-case level (2010–2019); OLS coefficients shown; *HZ*: Huawei v. ZTE hold-out definition where dependent variable equal to one if notice in form of claim chart provided, notice provided at least 90 days prior to filing suit, and either of the following pre-litigation hold-out variables is = 1 *Refusal*, *Unwilling*, or *Delay tactics*. *Hold-up*: Untimely declaration, Overdeclaration, Exhaustion, Discriminatory license, Threats to sue customers, No disclosure, EMVR vs. SSPPU, Prior licenses not comparable; *P/D characteristics*: D is both P and D, P is both P and D, P is NPE, P size, D size, P upstream of D, P and D competitors, D technology user, Technology in component; *Case characteristics*: Declaratory action, Case transferred; *Patent characteristics*: Patent value, patent reassigned. Robust standard errors clustered at the patent-level are shown in parentheses; * significant at 10%, ** at 5%, *** at 1%;

Moving to the bottom panel of Table 4, we find evidence of at least one form of in-litigation delay in almost 38% of SEP cases. While this rate is about twice as large as the rate of alleged pre-litigation hold-out, we caution that the two sets of variables are not directly comparable. For one, it is generally much more difficult to draw a line between common adversarial behavior and outright hold-out during litigation. For another, the litigation process often drags on for years, which potentially provides more opportunities for parties to allege opportunistic or abusive conduct. Among SEP cases, we see that discovery is the largest source of delay-related allegations with 14% of SEP cases involving at least one allegation that the accused infringer unreasonably delayed providing discoverable information or unreasonably pushed to obtain information that was not-discoverable. In addition, we observe a significant minority of cases in which an SEP licensor alleged that the accused infringer moved to dismiss the SEP licensor's claims as a stalling tactic. By contrast, we find relatively few allegations that parties faced with SEP assertion sought to slow the process by pursuing litigation in—or attempting to transfer litigation to—an alternative venue. Comparing across columns 1 and 2 in the bottom panel, we now see more mixed results. While we observe some measures of in-litigation delay significantly more often in SEP cases, alleged NSEP infringers are roughly equally as likely to be accused of transfer or PTAB delay. As one might expect, these results suggest that incentives to hold-out may be more complex once litigation is filed.

7.2. Regression results

7.2.1. Indicators of pre-litigation hold-out

Table 5 presents the results obtained when we estimate Equation (1) using our measures of pre-litigation hold-out. Columns 1, 3, 5, and 7 present results for each measure when we include all allegations of corresponding behavior, while columns 2, 4, 6, and 8 present results when we restrict our definition of hold-out consistent with the *Huawei v. ZTE* framework.²³ Across all specifications, we control for a sizeable set of variables capturing litigant, case, and patent characteristics, as well as additional controls for measures of potential hold-up by the patent owner.

In column 1 we find a positive and statistically significant association between the size of an SEP licensor's SEP portfolio and our summary measure of pre-litigation hold-out. The magnitude of the corresponding coefficient implies that an increase of one standard deviation in SEP portfolio size is associated with a 5.6% increase in the probability of observing some form of pre-litigation hold-out. This is a sizeable effect given a 17.7% mean probability of observing pre-litigation hold-out. An examination of columns 3, 5, and 7 of Table 5 further reveals that this result is driven by an association between SEP portfolio size and our *unwilling* measure, which captures allegations that accused infringers participated in pre-suit negotiations with SEP licensors, but did so in a generally dilatory manner.

In columns 1, 3, 5, and 7 of Table 5, we find no significant association between any measure of pre-litigation hold-out and the geographic scope of a licensors' SEP portfolios. Nor do we find any evidence linking pre-litigation hold-out and patent

²³ Corresponding descriptive statistics are provided in the Online Appendix in Tables A.2 and A.4.

Table 6
Pre-litigation hold-out behavior by defendant – SEP vs. NSEP.

| Hold-out behavior Definition | Pre-suit any | | Refusal | | Unwilling | | Delay tactics | |
|---------------------------------|---------------------|---------------------|--------------------|--------------------|---------------------|---------------------|--------------------|---------------------|
| | All (1) | HZ (2) | All (3) | HZ (4) | All (5) | HZ (6) | All (7) | HZ (8) |
| SEP | 0.239*** (0.080) | 0.062** (0.029) | 0.121** (0.055) | 0.029* (0.015) | 0.097** (0.045) | 0.002 (0.020) | 0.020 (0.025) | 0.030** (0.014) |
| Log family size | 0.114*** (0.042) | 0.026 (0.016) | 0.019 (0.015) | -0.005 (0.005) | 0.073*** (0.027) | 0.023 (0.014) | 0.021* (0.011) | 0.009** (0.004) |
| Log # countries | -0.070** (0.031) | -0.027** (0.012) | -0.016 (0.012) | -0.0009 (0.003) | -0.048** (0.021) | -0.023** (0.011) | -0.005 (0.009) | -0.003 (0.003) |
| Patent quality | 0.293** (0.146) | 0.067 (0.058) | -0.064 (0.091) | -0.024 (0.025) | 0.251** (0.120) | 0.046 (0.042) | 0.106** (0.052) | 0.045** (0.020) |
| Log family size × SEP | -0.088* (0.048) | -0.028 (0.020) | -0.009 (0.024) | 0.011 (0.009) | -0.071** (0.030) | -0.020 (0.015) | -0.008 (0.016) | -0.020** (0.008) |
| Log # countries × SEP | 0.056 (0.044) | 0.024 (0.024) | -0.014 (0.025) | -0.030* (0.017) | 0.076*** (0.026) | 0.038*** (0.013) | -0.005 (0.014) | 0.016*** (0.006) |
| Patent quality × SEP | -0.485 (1.011) | -0.163 (0.293) | -0.026 (0.808) | -0.081 (0.151) | -0.396 (0.548) | 0.105 (0.207) | -0.063 (0.243) | -0.187 (0.146) |
| Hold-up | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| P/D characteristics | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Case characteristics | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Patent characteristics | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Case filing year | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| R ² | 0.154 | 0.092 | 0.125 | 0.082 | 0.115 | 0.080 | 0.183 | 0.156 |
| Observations | 2,480 | 2,480 | 2,480 | 2,480 | 2,480 | 2,480 | 2,480 | 2,480 |

Notes: Unit of observation at the patent-party-case level (2010–2019); OLS coefficients shown; HZ: Huawei v. ZTE hold-out definition where dependent variable equal to one if notice in form of claim chart provided, notice provided at least 90 days prior to filing suit, and either of the following pre-litigation hold-out variables is = 1 *Refusal*, *Unwilling*, or *Delay tactics*. *Hold-up*: Exhaustion, Threats to sue customers, No disclosure, EMVR vs. SSPPU, Prior licenses not comparable; *P/D characteristics*: D is both P and D, P is both P and D, P is NPE, P size, D size, P upstream of D, P and D competitors, D technology user, Technology in component; *Case characteristics*: Declaratory action, Case transferred; *Patent characteristics*: Patent value, patent reassigned. Robust standard errors clustered at the patent-level are shown in parentheses; * significant at 10%, ** at 5%, *** at 1%;

quality. At best, we find in column 5, a significant negative association between standard essentiality scores and our pre-litigation hold-out measure, *unwilling*. The magnitude of the relevant coefficient implies that an increase of one standard deviation in the logarithm of an SEP's standard essentiality score is associated with a 2.4% decrease in the probability of observing an allegation of dilatory conduct in pre-litigation negotiations.

Turning next to columns 2, 4, 6, and 8 of Table 5, we see that our results remain largely unchanged when we use a narrower definition of hold-out consistent with the *Huawei v. ZTE* framework—i.e., a definition that requires, in addition to an allegation of delay by the accused infringer, a longer period and more thorough degree of pre-suit notice by the SEP enforcer.²⁴ The positive association between SEP portfolio size and *unwilling* observed in column 5 remains in column 6; however, the effect is weaker and no longer sufficient to drive a significant result for the summary measure, *pre-suit any*. Nonetheless, the link between portfolio size and allegations of *unwilling* negotiation behavior remains considerable, with an effect size (2.2% for each standard deviation increase in portfolio size) roughly equivalent to the mean probability of observing *unwilling* negotiation behavior when the notice requirements of *Huawei v. ZTE* are also met. We also now see some evidence supporting a negative association between standard essentiality and *pre-suit any* as well as *delay tactics*. At the same time, however, we again find no statistically significant association between patent quality and any measure of hold-out. In addition, contrary to the literature's expectations, we now also find some evidence of a significant *negative* association between the geographic scope of SEP portfolios and the hold-out measure *refusal*.

As an additional robustness test, we re-run Equation (1) once more with our summary measure of pre-litigation notice, *notice any*, included. This modification allows us to account for the fact that allegations of hold-out seem facially suspect when leveled against parties that have not yet been made aware of the asserted SEP. Table A.6 in the Online Appendix shows that these results are very similar to those reported in Table 5. As expected given the mechanistic link between notice and hold-out, we also see that the coefficient on *notice any* is very large, positive, and highly statistically significant.

In Table 6, we present the results obtained when we estimate Equation (2) using our measures of pre-litigation hold-out. Equation (2) compares the occurrence of these measures in SEP and NSEP cases. As before, columns 1, 3, 5, and 7 of Table 6 present results obtained for each measure when we include all allegations of corresponding behavior, while columns 2, 4, 6, and 8 present results obtained when we restrict our definition of hold-out to conform with *Huawei v. ZTE*.

²⁴ Imposing this restriction reduces the share of cases with at least one pre-litigation hold-out measure satisfied from 17.7% to 4.9% of cases (see Table A.5 in the Online Appendix).

Table 7
In-litigation hold-out behavior by defendant – SEP.

| Hold-out behavior | Delay any (1) | PTAB (2) | Dismiss (3) | Transfer (4) | Stay (5) | Dup lit (6) | Discov (7) |
|-------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|--------------------|--------------------|
| Log SEP portfolio size | 0.034*** (0.010) | -0.001 (0.004) | 0.021*** (0.007) | -0.002 (0.002) | 0.008 (0.005) | -0.0006 (0.002) | 0.021** (0.009) |
| Log # countries SEP | -0.063* (0.032) | -0.032** (0.012) | -0.015 (0.024) | -0.004 (0.006) | -0.028 (0.017) | -0.003 (0.007) | 0.020 (0.022) |
| Patent quality | -1.076 (0.892) | 0.203 (0.295) | 0.229 (0.559) | -0.145 (0.176) | -0.923** (0.450) | -0.249 (0.171) | -0.727 (0.503) |
| Log patent essentiality score | 0.073 (0.063) | 0.023 (0.019) | 0.006 (0.037) | 0.027*** (0.007) | -0.041 (0.030) | -0.0002 (0.006) | -0.046 (0.038) |
| Hold-up | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| P/D characteristics | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Case characteristics | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Patent characteristics | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Case filing year | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| R ² | 0.377 | 0.108 | 0.574 | 0.253 | 0.198 | 0.321 | 0.370 |
| Observations | 1,307 | 1,307 | 1,307 | 1,307 | 1,307 | 1,307 | 1,307 |

Notes: Unit of observation at the patent-party-case level (2010–2019); OLS coefficients shown; *Hold-up*: Untimely declaration, Overdeclaration, Exhaustion, Discriminatory license, Threats to sue customers, No disclosure, EMVR vs. SSPPU, Prior licenses not comparable, Injunction requested; *P/D characteristics*: D is both P and D, P is both P and D, P is NPE, P size, D size, P upstream of D, P and D competitors, D technology user, Technology in component; *Case characteristics*: D answer count, MTD, MSJ, Declaratory action, Case transferred; *Patent characteristics*: Patent value, patent reassigned. Robust standard errors clustered at the patent-level are shown in parentheses; * significant at 10%, ** at 5%, *** at 1%.

Focusing first on columns 1, 3, 5, and 7 of Table 6, we see that the coefficients on our SEP dummy variable are large, positive, and significant for our pre-litigation summary measure *pre-suit any* and two of our three pre-litigation hold-out measures, *refusal* and *unwilling*. The coefficient on the SEP dummy for *pre-suit any* indicates that pre-litigation hold-out behavior was alleged almost 24% more often in SEP cases than in NSEP cases. Nonetheless, when we interact the SEP dummy with indicators of licensing friction, we find only one significant result that comports with the literature's expectations: a significant positive association between allegations of *unwilling* behavior in pre-litigation negotiations and the geographic scope of the patent rights asserted interacted with the SEP dummy (in column 5 of Table 6). Otherwise, the interaction of the SEP dummy with our measure of patent quality failed to produce any significant results, and the modestly significant results produced by the interaction of the SEP dummy and patent family size suggest (contrary to the literature) a *negative* association with hold-out.

As shown in columns 2, 4, 6, and 8 of Table 6, these results change relatively little when we repeat the analysis using a more restrictive definition of pre-litigation hold-out. Results for the SEP dummy remain positive and significant for our summary measure of pre-litigation hold-out (in column 2), as well as for two of our three pre-litigation hold-out measures (in columns 4 and 8). We also continue to see a positive association between the geographic scope of the licensor's patent rights and *unwilling* conduct by the accused infringer, and yet also a generally negative association between patent family size and our pre-litigation hold-out measures.

Given the large difference in the rate of pre-suit notice in SEP and NSEP cases reported in Table 4, we also assess once again how our results change when we control for notice. Table A.7 in the Online Appendix presents the results obtained when we re-run Equation (2) with our summary measure of pre-litigation notice, *notice any*, included. In this set of results, the coefficient on the SEP dummy is substantially smaller and no longer statistically significant. This suggests that the observed gap in the prevalence of hold-out in SEP and NSEP cases is largely explained by the observed gap in the prevalence of pre-litigation notice.

7.2.2. Indicators of in-litigation hold-out

Shifting now from an examination of pre-litigation to in-litigation hold-out, Table 7 reports the results obtained when we estimate Equation (1) for the seven indicators of litigation delay defined in Table 3 (for descriptive statistics see Table A.3 in the Online Appendix). Because these measures reflect behaviors observed in the context of litigation, we include a number of additional covariates that control for various characteristics of those lawsuits, including whether each case was transferred, litigated to a substantive decision, or included a request for injunctive relief.

Here, we find a significant positive relationship between SEP portfolio size and our summary measure *in-litigation delay any*, and we see that this association is driven by allegations of delay in the context of attempts to dismiss litigation and discovery disputes. Our results additionally suggest a negative association between in-litigation hold-out behavior and the geographic scope of SEP portfolios, with this result driven by a negative association between portfolio breadth and allegations of delay in the context of parallel administrative validity challenges. Only two other associations produce significant results. We find a negative association between patent quality and alleged delay in the context of motions to stay, and we find a positive association between patent essentiality and delay in the context of attempts to transfer litigation to another court.

Table 8
In-litigation hold-out behavior by defendant – SEP vs. NSEP.

| Hold-out behavior | Delay any (1) | PTAB (2) | Dismiss (3) | Transfer (4) | Stay (5) | Dup lit (6) | Discov (7) |
|------------------------|---------------------|--------------------|--------------------|---------------------|-------------------|---------------------|--------------------|
| SEP | 0.242** (0.104) | 0.010 (0.031) | 0.089 (0.081) | -0.047** (0.018) | 0.057* (0.033) | -0.038** (0.017) | 0.083 (0.064) |
| Log family size | 0.119** (0.051) | 0.027 (0.016) | -0.018 (0.025) | -0.016* (0.009) | -0.011 (0.013) | -0.010* (0.006) | 0.080* (0.046) |
| Log # countries | -0.094** (0.041) | -0.014 (0.015) | 0.012 (0.018) | 0.017* (0.010) | -0.005 (0.012) | 0.0005 (0.006) | -0.066* (0.036) |
| Patent quality | 0.312* (0.186) | 0.071 (0.069) | -0.083 (0.118) | 0.061 (0.052) | 0.121 (0.073) | -0.013 (0.026) | 0.269 (0.164) |
| Log family size × SEP | -0.092 (0.060) | 0.007 (0.021) | -0.045 (0.036) | 0.023** (0.010) | -0.007 (0.019) | 0.030*** (0.009) | -0.067 (0.046) |
| Log # countries × SEP | 0.075 (0.056) | -0.043* (0.024) | 0.061** (0.025) | -0.019 (0.012) | -0.007 (0.021) | -0.018* (0.010) | 0.072* (0.039) |
| Patent quality × SEP | -1.855* (0.958) | 0.205 (0.261) | -0.309 (0.656) | -0.521** (0.234) | -0.614 (0.385) | -0.229 (0.175) | -0.875 (0.613) |
| Hold-up | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| P/D characteristics | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Case characteristics | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Patent characteristics | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Case filing year | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| R ² | 0.273 | 0.080 | 0.293 | 0.074 | 0.099 | 0.181 | 0.232 |
| Observations | 2,480 | 2,480 | 2,480 | 2,480 | 2,480 | 2,480 | 2,480 |

Notes: Unit of observation at the patent-party-case level (2010–2019); OLS coefficients shown; *Hold-up:* Exhaustion, Threats to sue customers, No disclosure, EMVR vs. SSPPU, Prior licenses not comparable, Injunction requested; *P/D characteristics:* D is both P and D, P is both P and D, P is NPE, P size, D size, P upstream of D, P and D competitors, D technology user, Technology in component; *Case characteristics:* D answer count, MTD, MSJ, Declaratory action, Case transferred; *Patent characteristics:* Patent value, patent reassigned. Robust standard errors clustered at the patent-level are shown in parentheses; * significant at 10%, ** at 5%, *** at 1%;

Table A.8 in the Online Appendix repeats the analysis above while controlling for the existence of alleged pre-litigation hold-out. Incorporating our summary measure of pre-litigation hold-out, *pre-suit delay any*, results in relatively little change, and our findings remain similarly mixed.

Next, we incorporate data from NSEP disputes by estimating Equation (2) using our measures of in-litigation hold-out. The results we obtain, presented in Table 8 below, are again quite comparable to those reported above. Our most noteworthy finding here is the relative lack of significance among results related to our SEP dummy variable. In Table 6, which presents corresponding results for our pre-litigation measures of hold-out, we found significant, positive results for three out of four measures. Here, in contrast, the SEP dummy variable is only positive and significant in columns 1 and 5, which present results for our summary measure *in-litigation delay any* and *stay delay*. Further, we observe a significant negative relationship between the SEP dummy and two of our measures of in-litigation hold-out behavior, *transfer* and *duplicative litigation*. Accordingly, conditional on all the other variables included in these regressions, our analysis provides little evidence that in-litigation hold-out is relatively more common in SEP disputes. While the descriptive statistics reported in Table 4 indicated a large gap in the incidence of in-litigation hold-out—and, indeed, an even larger gap than the one observed for pre-litigation hold-out—the results presented here suggest that this gap is largely accounted for by a number of covariates, especially those that capture other case characteristics. When we interact the SEP dummy with our measures of licensing frictions, we find that patent family size is positively associated with *transfer delay* and *duplicate litigation*. Similarly, we find that the geographic scope of asserted patent rights is positively associated with *dismissal delay* and *discovery delay*, but negatively associated with *PTAB delay* and *duplicate litigation*. We also observe a negative association between patent quality and two measures of in-litigation hold-out: *transfer delay* and our summary measure *in-litigation delay any*.

As a final robustness exercise, we once again re-run these specifications while controlling for the existence of alleged pre-litigation hold-out. Table A.9 in the Online Appendix presents results obtained when we add our summary measure of pre-litigation hold-out, *pre-suit delay any*, to Equation (2). The results in this table are very similar to those presented in Table 8. We again find some evidence of a positive association between patent family size interacted with the SEP dummy and hold-out in the form of duplicative litigation and delay due to motions to transfer. We also still find a negative association between the interaction term involving patent quality and several hold-out measures.

8. Discussion

On the whole, our findings present a mixed picture of the association between hold-out and the licensing frictions that are commonly said to motivate it. While our results include some evidence of a link between dilatory conduct by accused infringers and both the size of SEP enforcers' SEP portfolios and their likelihood of proving infringement in court, we fail to find any compelling evidence of a positive association between hold-out and the geographic scope of asserted patent rights.

Further, while we find that hold-out is alleged more often in SEP than NSEP litigation, our results suggest that this difference is largely explained by a much higher rate of pre-suit notice and negotiation in SEP disputes. In addition, our results exhibit a noteworthy degree of variation across our analyses of pre- and in-litigation delay metrics, as well as across our analyses that do and do not compare behavior in SEP disputes with that observed in a matched sample of NSEP litigation.

Accordingly, our study is perhaps most indicative of a need for further theoretical and exploratory data analysis. The fact that our results neither squarely support nor squarely contradict existing commentary on hold-out's root causes may indicate that other mechanisms yet to be considered can better explain the negotiation dynamics that we document. Similarly, the heterogeneous nature of our results across analyses of pre- and in-litigation hold-out metrics cautions against an assumption that theory derived in the context of pre-litigation negotiations can readily be applied to conduct in the course of litigation. In this regard, the literature would benefit from additional research addressing the specific complexities of interactions among litigants engaged in discovery, motions practice, and trial. Finally, our analysis surfaces a number of challenges that complicate the rigorous examination of hold-out. As our empirical approach makes clear, SEPs and NSEPs are in several important respects not directly comparable. Additionally, there is at present no agreement in the literature on where and how to draw a line between genuine hold-out behavior and conduct that is instead tough-but-legitimate in the inherently adversarial context of high-value business negotiations and litigation.

Considered from a policy perspective, our empirical findings generally support initiatives that would facilitate portfolio licensing in the SEP context, as well as calls to improve the quality and better assess the essentiality of patents declared to SSOs. Otherwise, our results largely suggest restraint in the face of calls (often forcefully made in recent years) for sweeping action at the legislative, judicial, and SSO level to counteract perceived hold-out. While we do find some evidence of conduct that qualifies as hold-out under existing legal frameworks, we caution that an improved understanding of the mechanisms driving licensor and licensee behavior (both before and during litigation) may be a predicate to the formulation of effective, balanced reform measures.

Data availability

The paper contains a link to the data and replication code.

Supplementary material

Supplementary material associated with this article can be found, in the online version, at [10.1016/j.ijindorg.2023.102978](https://doi.org/10.1016/j.ijindorg.2023.102978)

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