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THE ECONOMIC IMPACT OF PATENT HOLDOUT

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ABSTRACT

This Article investigates the economic impact of patent holdout — defined as the strategic decision by firms to infringe rather than license patents based on the risks and rewards of the given patent regime. We develop a theoretical framework for understanding holdout behavior, emphasizing the need to evaluate infringer conduct against industry norms and the patent owner's licensing intentions. The analysis focuses on scenarios where licenses are willingly offered such as universities and other innovation specialists, and owners of patents subject to licensing commitments, such as declared Standard-Essential Patents ("SEPs"). We identify key economic consequences of holdout, including the Indemnification Effect, bargaining asymmetries leading to royalty discounts, and the "Fighting Zone" of litigation and transaction costs. This leads to different business responses among licensors, including litigation, licensing or settling on inadequate terms, and abstaining from licensing, where much of the impact of patent holdout is not easy to observe directly on the firm level. However, empirical analysis of aggregate cellular SEP royalties reveals a significant royalty gap — estimated at seven to twenty-eight billion dollars annually as of 2021.

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I. INTRODUCTION — PATENTS AND THE GOVERNANCE OF MARKETS FOR TECHNOLOGY

The U.S. patent system exists "[t]o promote the Progress of Science . . . by securing for limited Times to . . . Inventors the exclusive Right to their respective . . . Discoveries."[1] The role of the patent system is important not only to incentivize investment in research and development ("R&D") but also to govern the transfer of technology.[2] Thus, in addition to using patents to exclude infringing products from the market to gain competitive advantage for their own innovative products, inventors may license their invention to one or multiple third parties, often in exchange for a fee.[3] In the modern knowledge

1. U.S. Const., art. I, § 8, cl. 8.

2. *See* David J. Teece, *Capturing Value from Knowledge Assets: The New Economy, Markets for Know-how, and Intangible Assets*, 40 CAL. MGMT. REV. 55, 62 (1998).

3. According to an inventor survey published in 2009, 21% of Japanese and 14% of U.S. patents are used for licensing. Sadao Nagaoka & John P. Walsh, *Commercialization and*

economy, the patent system must increasingly support the dynamic transaction of technology to facilitate open innovation and an efficient division of innovative labor in the economy.

In some fields, the use of patents to govern markets for technology is challenging due to the non-rivalrous nature of technology[4] and the probabilistic nature of patents.[5] Potential users may have multiple opportunities to acquire the knowledge and technical know-how created by others' inventions.[6] New products may embody many different inventions, and it can be challenging for a company to determine which patents may be infringed by their products and whether these patents are, in fact, valid.[7] In this context, it is common for companies to begin practicing a technology that is subject to other companies' patent rights before contractual terms for all the required patent licenses are set.[8]

This situation is prone to two different outcomes. On the one hand, patent owners may seek to license (potentially inadvertent) users of their patented inventions on exorbitant terms relative to the value their invention adds to the infringing product.[9] An infringing company may be compelled to accept such exorbitant royalty requests because of the risk of damaging legal consequences, such as an injunction excluding the entire infringing product from the market; the difficulty in reversing earlier technical implementation decisions leading to the use of certain patented inventions; and the unavailability or potentially prohibitive cost of legal avenues to seek a determination of appropriate licensing terms.[10] A strategy by a patent holder opportunistically exploiting the

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Other Uses of Patents in Japan and the U.S.: Major Findings from the RIETI-Georgia Tech Inventor Survey (Rsch. Inst. of Econ., Trade & Indus. (RIETI) Discussion Paper, 2009); *see also* Peter C. Grindley & David J. Teece, *Managing Intellectual Capital: Licensing and Cross-Licensing in Semiconductors and Electronics*, 39 CAL. MGMT. REV. 8, 8 (1997) (providing an initial account of the importance of licensing and cross-licensing in the early electronics and semiconductor industries).

4. *See* DOMINIQUE FORAY, ECONOMICS OF KNOWLEDGE 93 (2004).

5. *See* Mark A. Lemley & Carl Shapiro, *Probabilistic Patents*, 19 J. ECON. PERSPS. 75, 95 (2005).

6. FORAY, *supra* note 4, at 95–96.

7. *See* Fed. Trade Comm'n, *The Evolving IP Marketplace: Aligning Patent Notice and Remedies with Competition* 3–4 (2011).

8. This is the norm in standard essential patent ("SEP") licensing (e.g. cellular standards) whereby the fair, reasonable, and non-discriminatory ("FRAND") commitment made by SEP holders provides assurance for SEP implementers to make and sell products prior to acquiring licenses from all potential licensors. *See, e.g.*, Lionel M. Lavenue, Joseph M. Myles & Robert Evans, *IP Transactions, Professional Perspective — Future of SEP Licensing in the Auto Industry*, BLOOMBERG LAW (2023) (describing the reluctance of OEM automakers to pay cellular SEP licensing for years after the cars had been produced).

9. Numerous authors and courts have noted the potential for inadvertent use of technologies protected by SEPs. *See* Case C-170/13, Huawei Techs. Co. v. ZTE Corp., ECLI:EU:C:2015:477, ¶ 62 (July 16, 2015).

10. *See* Thomas F. Cotter, *Comparative Law and Economics of Standard-Essential Patents and FRAND Royalties*, 22 TEX. INTELL. PROP. L.J. 311, 344 (2014).

lock-in of an infringing product manufacturer to extract excessive royalties is often called holdup.[11]

On the other hand, implementers may knowingly infringe on other companies' patent rights without seeking or even actively delaying the conclusion of a licensing agreement.[12] Such infringers may calculate that because of the cost of patent litigation and the difficulty for patent holders to be granted sufficiently strong remedies, patent owners may not be able to obtain adequate compensation and either abstain from enforcing their patent rights altogether or accept an unreasonably low offer. A strategy by an implementer exploiting the cost and difficulty of enforcing patent rights to knowingly use others' patented technology without consenting to pay a reasonable compensation is often called holdout.[13]

Patent holdup and holdout are related phenomena. Both strategies occur in a context in which patent owners seek to license their patents to potential licensees in exchange for royalty payments after infringing use of the patented technology has already begun and are facilitated by the cost and uncertainty of patent litigation. Under such conditions, prices in the product market may have formed without properly reflecting the value of the patented technology. Therefore, determining the amount of a reasonable compensation for the use of the patents may be inherently challenging.[14] In practice, reasonable royalties are usually determined by referencing industry norms, which reflect the terms of voluntarily concluded comparable licenses.[15]

In the absence of readily available, external, and objective benchmarks for reasonable royalties, the licensing terms to which parties may agree in bilateral licensing negotiations often depend on the availability of remedies for patent infringement. In particular, holdup and holdout behavior are intrinsically related to the availability of remedies in equity that deter the unauthorized use of patent technology through the threat of injunctive relief and enhanced damages. Such remedies can potentially create financial losses for infringing companies that are significantly larger than the value of the unlicensed

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11. *See* Richard J. Gilbert, *Deal or No Deal-Licensing Negotiations in Standard-Setting Organizations*, 77 ANTITRUST L.J. 855, 855 (2010).

12. Kristen Osenga, *Efficient Infringement in the SEP Space*, *in* 5G AND BEYOND: INTELLECTUAL PROPERTY AND COMPETITION POLICY IN THE INTERNET OF THINGS 112, 111–28 (Jonathan M. Barnett & Sean M. O'Connor eds., 2023).

13. *See* Richard A. Epstein & Kayvan B. Noroozi, *Why Incentives for "Patent Holdout" Threaten to Dismantle FRAND, and Why It Matters*, 32 BERKELEY TECH. L.J. 1381, 1384 (2017).

14. It should be noted that the costs of many other inputs can vary over time, so this is not a novel challenge for implementing firms to address.

15. See, for example, the court's prioritization of comparable licenses as the first two patent damages factors in *Georgia-Pacific Corp. v. U.S. Plywood Corp.*, 318 F.Supp. 1116, 1120 (S.D.N.Y. 1970).

use of the patented technology.[16] In situations where such remedies are readily available, infringers may seek to settle their disputes with owners of infringed patents even at the cost of signing licenses on exorbitant terms, thus potentially rewarding and encouraging holdup strategies.[17] On the contrary, situations in which such remedies are never or only exceptionally available to patent owners seeking to license their patents to implementers, potential licensees may have little reason to fear patent litigation, and holdout may often be profitable for implementers.[18]

While the licensing of patents to other companies for the generation of royalty revenue is not limited to any particular technological field or industry, the information and communication technology ("ICT") sector has come to epitomize a certain model of patent licensing, in which patent owners seek to license their patents to potentially large numbers of companies that are already (allegedly) using their patented inventions, and where some product manufacturers face infringement allegations by larger numbers of owners of different, complementary patents.[19] Some of these patents are essential to technology standards, meaning that any of the potentially thousands of users of such standards may be using the patented technology, and some such standards are subject to thousands of potentially complementary patents declared to be potentially standard-essential.[20]

Starting in the late 1990s and early 2000s, a strand of literature on anticommons and patent thickets hypothesized that the growing number of patents in the biotech and ICT industries was blocking and disincentivizing innovation.[21] Companies that primarily or exclusively develop and patent their inventions for the purpose of licensing these patents to others, so-called "non-practicing entities" ("NPEs"), became a focus of this criticism, in particular, those actors that acquired and

16. For example, when the cost of lost sales from an enjoined product are very high, a potential infringer could be incentivized to settle rather than risk an injunction. *See* Mark A. Lemley & Carl Shapiro, *Patent Holdup and Royalty Stacking*, 85 TEX. L. REV. 1991, 1992–93 (2006).

17. *Id.*

18. *See* Bowman Heiden & Matthew Rappaport, *How Weak Are Strong Patents: Patent Holdout and Small(er) Technology Firms*, 38 BERKELEY TECH. L.J. 349, 364–65 (2023).

19. *See* Jonathan M. Barnett, *From Patent Thickets to Patent Networks: The Legal Infrastructure of the Digital Economy*, 55 JURIMETRICS 1, 2–3 (2014) (exemplifying how the MPEG-2 patent pool facilitated thousands of licenses of complementary SEPs in the ICT sector).

20. Owners of such Standard-Essential Patents ("SEPs") usually commit to license such SEPs to standards implementers on reasonable and non-discriminatory terms — SEPs are thus a category of patents that are primarily used for licensing, rather than excluding competitors.

21. *See* Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 SCIENCE 698, 699 (1998); Carl Shapiro, *Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard Setting*, 1 INNOVATION POL'Y & ECON. 119, 120 (2000).

asserted patents from others, known as "patent assertion entities" ("PAEs").[22]

Over the past two decades, the U.S. patent system has undergone a series of judicial rulings and legislative reforms that made it significantly more difficult for patent owners to enforce their patents.[23] This evolution disproportionately affected patent owners who are seeking to license their patents to other companies, such as most NPEs.[24] In addition, owners of standard-essential patents ("SEPs") are also particularly impacted.[25] Recently, an increasing number of voices suggest that the weakening of remedies of patent infringement has led to holdout behavior.[26]

In essence, there are thus two competing patent theories of market failure — one on the technology market (i.e., freeriding/patent holdout) and one on the product market (i.e., anticommons/patent holdup). While some claim that opportunities to exploit the patent system for patent holdup continue to present the most pressing concern and that patent remedies should be further curtailed (in particular in the context of SEPs),[27] others argue that the pendulum has swung too far, and holdout by implementers is currently a more serious problem.[28] Empirical evidence of the position of the pendulum on the patent holdout/up spectrum is an important input to the governance process so as to both understand the current economic reality and the future economic impact of potential changes in governance policy.[29]

Nevertheless, empirical evidence on the occurrence of holdup and holdout is scant.[30] On one hand, some studies point to indicators of

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22. *See* James Bessen & Michael J. Meurer, *The Direct Costs from NPE Disputes*, 99 CORNELL L. REV. 387, 388 (2013).

23. Heiden & Rappaport, *supra* note 18, at 354–55 tbl.1.1.

24. *See* Kirti Gupta & Jay P. Kesan, *Studying the Impact of eBay on Injunctive Relief in Patent Cases* 35 (Univ. of Ill. College of Law Legal Stud., Research Paper No. 17-03, 1, 36, 2016) (finding that patent holding companies are 82.2% less likely to obtain a permanent injunction post-*eBay*). *See generally* Kristina Acri, *Injunctive Relief in Patent Cases: The Impact of eBay*, 38 HARV. J. L. AND TECH. 735 (2025).

25. *See* Bowman Heiden & Nicolas Petit, *Patent "Trespass" and the Royalty Gap: Exploring the Nature and Impact of Patent Holdout*, 34 SANTA CLARA HIGH TECH. L.J. 179, 219 (2017); *see also* Gerard Llobet & Jorge Padilla, *A Theory of Socially Inefficient Patent Holdout*, 32 J. ECON. & MGMT. STRATEGY 424, 425 (2023).

26. Heiden & Petit, *supra* note 18, at 232; *see also* Epstein & Noroozi, *supra* note 13, at 1429.

27. *See* Carl Shapiro & Mark A. Lemley, *The Role of Antitrust in Preventing Patent Holdup*, 168 U. PA. L. REV. 2019, 2023–24 (2020).

28. *See* Kalyan Dasgupta & David Teece, *Protecting Innovation in the Mobil Wireless Ecosystem: Understanding and Addressing 'Hold-Out*,*'* 38 BERKELEY TECH. L.J. 313, 333–36 (2023).

29. *See* Heiden & Petit, *supra* note 25, at 227–28 (providing a descriptive framework of the patent holdout/up spectrum).

30. *See* Alexander Galetovic, Stephen Haber & Ross Levine, *An Empirical Examination of Patent Holdup*, 11 J. COMPETITION L. & ECON. 549, 551 (2015); Heiden & Petit, *supra* note 25, at 207.

thriving innovation in patent-intensive industries to suggest that holdup is not a serious concern.[31] This evidence for the overall health of these industries may also be interpreted to indicate that (at least so far) holdout has not systematically deterred innovation incentives. In the same vein, Baron et al. (2023) observe that empirical evidence on SEP licensing conditions does not suggest that there are systemic problems.[32] On the other hand, some studies purport to more directly observe holdup or holdout.[33] These studies essentially measure holdup and holdout by counting how often parties in licensing disputes complain about the other side using holdup or holdout strategies.[34] As we will argue in this paper, the relative nature of holdup and holdout makes this empirical strategy inadequate for the purpose of measuring the overall significance of holdup or holdout problems.

This study will attempt to examine the empirical relevance of holdout concerns. In the remainder of the paper, we will discuss (2) the theoretical foundations of patent holdout, (3) a typology of patent owner's responses to patent holdout, (4) a typology of patent holdout outcomes, (5) evidence of the economic impact of patent holdout in aggregate cellular SEP royalties, and (6) a conclusion.

II. THEORETICAL FOUNDATIONS OF PATENT HOLDOUT

The primary focus of the literature on patent holdout theory is within the context of standards and SEPs, providing a countervailing argument to patent holdup theory, particularly in the context of weakened patent remedies.[35] However, the general principles can be applied to any patent enforcement situation involving opportunistic behavior.[36] Drawing a parallel from Lemley and Shapiro's definition of patent holdup — where weak patents within a system of strong injunctive relief can hypothetically enhance the bargaining power of

31. Galetovic et al., *supra* note 30, at 549.

32. *See* JUSTUS BARON, PERE ARQUE-CASTELLS, AMANDINE LEONARD, TIM POHLMANN & ERIC SERGHERAERT, EUR. COMM'N, EMPIRICAL ASSESSMENT OF POTENTIAL CHALLENGES IN SEP LICENSING 185 (2023).

33. *See* Brian J. Love & Christian Helmers, *Patent Hold-Out and Licensing Frictions: Evidence from Litigation of Standard Essential Patents*, 89 INT'L J. INDUS. ORG. 1, 13–14 (2023).

34. *Id.* at 6.

35. Love and Helmers, e.g., observe that patent owners asserting SEPs in court are significantly more likely than companies asserting other patents to allege that the infringer engages in a variety of holdout behaviors (including both hold-out prior to and holdout after the beginning of litigation), *id.* at 9. The prevalence of (alleged) holdout in SEP licensing negotiations may be attributed to the success of technology standards, where SEP licensing may amount to very large annual licensing revenues, and the incomplete contractual nature of FRAND IPR policies that underpin these standards.

36. Lemley & Shapiro, *supra* note 16, at 2008–09 (primarily arguing the case of patent holdup in the context of PAEs, which the authors refer to as "patent trolls").

patent holders (i.e., patent holdup)[37] — it can be posited that strong patents within a system of weak injunctive relief could enhance the bargaining power of potential infringers (i.e., patent holdout). This situation would allow an infringing firm to negotiate royalties significantly below the true economic value contributed by the patent holder. Consequently, if we are to question the strength of weak patents, we must also consider the vulnerability of strong patents.[38]

Below are put forward a number of key theoretical propositions to better define the nature of patent holdout.

A. Patent Holdout Is a Transactional Phenomenon

It is linked to the dynamic, not static, use of patents (i.e., the licensing or sale of patented technology instead of the blocking of its use by others). Holdout is distinguished from other forms of patent infringement by the fact that the infringer can reasonably expect to be offered a license — a company engaging in holdout seeks to use patented technology that is offered for license without paying the necessary licensing fees; holdout is thus distinct from an infringement on patented technology that the patent owner seeks to reserve for exclusive use.[39]

B. Patent Holdout Is a Rational Behavior

It is a purposeful and rational strategy dependent on the legal and business norms of the patent system in a country.

(1) ***Patent holdout implies willful infringement***

> A company knowingly and purposefully uses a technology protected by a patent to which it is not fully licensed. Willful infringement implies either that a company begins unlicensed use of a technology in spite of knowing about the existence of a patent (or should have reasonably expected the technology to be protected by a patent and failed to conduct due diligence) or continues unlicensed use when becoming

37. *Id.* at 2008.

38. *Compare* Joseph Farrell & Carl Shapiro, *How Strong Are Weak Patents?*, 98 AM. ECON. REV. 1347, 1347 (2008), *with* Bowman Heiden & Matthew Rappaport, *How Weak Are Strong Patents: Patent Holdout and Small(er) Technology Firms*, 38 BERKELEY TECH. L.J. 349, 356–57 (2023).

39. This is to say that if there is no expectation of a license, then patent holdout (or holdup) are not applicable, as the purpose of the infringement is for the infringer to access a patented technology that the owner had no intention of sharing, not to lower the cost of a license below the rates offered by the patent owner.

aware of the existence of a patent.[40] Patent holdout implies that this conduct is rationally motivated, that is, the infringer engages in or continues unlicensed use based on an expectation that this conduct is profitable (rather than out of spite, vengefulness, or any other irrational motivation).[41]

(2) ***Patent holdout implies a willing licensor***

The infringer would have the possibility to put an end to the infringing use by entering into a potentially available license but engages in conduct that delays or averts the conclusion of such a license.

(3) ***Patent holdout is established by the infringer's unwillingness to license on reasonable terms***

Holdout does not require absolute unwillingness to license by the infringer — the infringer may be willing to license, but only on certain terms that the licensor is not offering (conditional willingness to license). An infringer's unwillingness to enter into a license on certain available terms alone does not constitute holdout. Two elements combine to characterize conditional willingness to license as holdout: first, the infringer seeks to obtain a licensing offer on unreasonably favorable terms; and second, the infringer uses unreasonable means to pursue such terms. The two elements are cumulative. Almost any means employed by an infringer refusing a reasonable licensing offer to obtain more favorable, objectively unreasonable terms would constitute holdout. Conversely, there may be holdout independent of the reasonableness of the different offers if the implementer employs objectively unreasonable means to pursue more favorable terms.

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40. *See* Christopher B. Seaman, *Willful Patent Infringement and Enhanced Damages After* In Re Seagate*: An Empirical Study*, 97 IOWA L. REV. 417, 421–23 (2012) (describing the intent-based nature and consequences of willful patent infringement).

41. *See* Anne Layne-Farrar, *Why Patent Holdout Is Not Just a Fancy Name for Plain Old Patent Infringement*, COMPETITION POL'Y INT'L: N. AM. COLUMN, (Feb. 7, 2016), https://www.pymnts.com/cpi-posts/why-patent-holdout-is-not-just-a-fancy-name-for-plain-old-patent-infringement/ [https://perma.cc/FK9W-KT8P].

C. Patent Holdout Requires an Industry Context for Reasonableness

Disagreements about the empirical existence of holdout (or the extent of holdout) thus often revolve around disagreements on the applicable standards of reasonableness.[42]

(1) ***Patent holdout requires a frame of reference***

Thus, it is generally impossible to define holdout behavior without reference to either a reasonable royalty level for a license or standards of reasonable conduct in licensing negotiations. It is possible to define and identify some holdout behavior if only one of these (a reasonable royalty level or standards of reasonable conduct in licensing negotiations) is defined and observable.[43]

(2) ***Patent holdout is related to norms of reasonableness***

Both the level of a reasonable royalty and the standards of reasonable conduct in licensing negotiations are defined in a social (industry-specific) context.[44] Normal behavior in the industry is an important indicator of reasonableness. Holdout is a deviation from reasonableness. There are also objective indications of reasonableness where systematic holdout is possible, but usually, holdout is a conduct that stands out unfavorably by comparison to other, similarly situated users.[45]

There is usually not one objective reasonable rate level, but there are royalty levels such that further depressing royalties

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42. "Reasonable" is a core tenet of the FRAND (fair, reasonable, and non-discriminatory) commitment within the intellectual property rights ("IPR") policies of many standard development organizations ("SDOs")."Reasonable" is also defined within 35 U.S.C. § 284 regarding patent damages, stating, "Upon finding for the claimant the court shall award the claimant damages adequate to compensate for the infringement, but in no event less than a reasonable royalty for the use made of the invention by the infringer, together with interest and costs as fixed by the court." Thus, "reasonableness" is the key benchmark that defines whether the actual royalty paid is either too high (holdup) or too low (holdout). For the historic difficulties in determining reasonable royalties in U.S. jurisprudence, see Michael Risch, (*Un)Reasonable Royalties*, 98 B.U. L. REV. 187, 189–91 (2018).

43. *See* J. Gregory Sidak, *The Meaning of FRAND, Part II: Injunctions*, 11 J. COMPETITION L. & ECON. 213–14 (2015) (describing the contractual duties of an SEP holder "to offer a license on FRAND terms" which defines conceptually the frame of reference).

44. *See* Michael A. Carrier, *Why Is FRAND Hard?*, UTAH L. REV. 931, 951 (2023) (describing the use of similarly situated users by courts when accessing FRAND royalty rates).

45. *See* Jorge L. Contreras, *A Framework for Evaluating Willingness of FRAND Licensees* 3 (Univ. of Utah Coll. of L. Rsch. Paper No. 442, 2021) (stating that a number of objective factors, informed by relevant commercial practice, should affect the characterization of an implementer as being willing or unwilling to enter into a FRAND licensing agreement).

would unambiguously reduce social welfare.[46] If royalty levels are such that the protected inventions could not be profitably invented if all implementers paid such rates (i.e., implementers exploit the fact that R&D investments are sunk to undercompensate inventors for even the cost of developing the invention), rates are objectively unreasonable (unsustainable and thus socially intolerable, regardless of current norms of behavior).

Provided that rates are sufficient to compensate the innovator for the cost of invention and sufficiently low to allow the implementer to profitably implement the invention, the level of the royalty determines the division of surplus between the inventor and implementer. The reasonable division of this surplus is generally defined by industry norms — within this range, there are only industry-specific social norms of reasonable rates.

(3) ***Reasonableness is linked to objectively justifiable means of conduct***

Reasonable means to pursue more favorable terms that may have objective elements. Parties of a negotiation may employ many different strategies to obtain leverage (i.e., increase the other side's willingness to accept an offer on desired terms). Different means can be ranked by the extent to which they are objectively justified.

(a) Objectively justified means are specifically related to an objective source of genuine uncertainty over the reasonable terms of a license, and the means are *efficient* in addressing this uncertainty (e.g., the reasonableness of a royalty level may hinge on the rates of directly comparable licenses, seeking disclosure of the terms of these licenses under a non-disclosure agreement ("NDA") is specifically related to and efficient in resolving this uncertainty. The value of a license to a large portfolio may be related to the number of valid and essential patents in the portfolio. Challenging individual, non-representative patents from the portfolio is related but not efficient in reducing the scope of uncertainty over a reasonable value of the license.

46. Heiden & Petit, *supra* note 25, at 227.

(b) Objectively justified means are *discriminating* — they are more effective when used to make a licensor accept a reasonable rate than when used to force a licensor to accept unreasonably low rates.

(c) Objectively unjustified means include those that create leverage by producing costs for the other party that are unrelated to an objective source of genuine uncertainty over the value of the license. Requesting detailed claim charts for large numbers of patents, requesting disclosure of large numbers of not directly relevant licenses, requesting disclosure of commercial information without a NDA, etc., are conducts that have the potential to create costs to the other side and thus increase the willingness of the other side to make concessions for reasons unrelated to the value of the license under dispute.

(d) Objectively unjustified means also include those that are primarily or exclusively intended to generate a delay. Many means pursued during licensing negotiations and disputes have the potential to make an objectively valuable contribution to the resolution of a disagreement while also causing delays and/or costs to the other side. Whether such means are considered reasonable is not defined by absolute and objective standards but social norms. Implementers can, for example, be expected to respond to a notice of infringement within a certain period of time, which is largely based on what is common practice in the industry.[47]

III. PATENT OWNERS' RESPONSES TO HOLDOUT

Holdout is a *strategic* behavior — it seeks to produce an advantage for implementers by eliciting a certain response from patent owners. Implementers may engage in holdout to dissuade patent owners from asserting their patents against them or to force patent owners to license their patents on unreasonably favorable terms. In order to understand

47. Case law developing the standard for an "unwilling licensee" defined in the *Huawei* decision has taken place in Europe through several recent decisions. *See, e.g.*, Sisvel v. Haier, Bundesgerichtshof [BGH] [Federal Court of Justice] May 5, 2020 (Ger.); Hof's-Gravenhage 7 mei 2019, No. 200.221.250/01 (Koninklijke Philips N.V./ Asustek Computers Inc.) (Neth.).

holdout, its impacts, and the possibility of its measurement, it is thus important to analyze the different types of responses of patent owners to holdout. Below is a description of possible behavioral responses to patent holdout.

A. Types of Business Responses

(1) ***Litigate***

One possible response from patent holders experiencing holdout behavior is to initiate litigation to receive just compensation.[48] Litigation may also arise even between two parties seeking to negotiate in good faith. Nevertheless, holdout behavior increases the likelihood of litigation and may also result in litigation becoming more complex (e.g., parallel litigations in multiple venues related to the same dispute) and lengthy.

(2) ***License or settle on inadequate terms***

Cognizant of the cost of litigation, patent holders may accept to license their patents on terms that are unreasonably favorable to the implementer. If a license is reasonably worth two million dollars (i.e., an informed third party would determine licensing terms whose net present value to the patent owner amounts to two million dollars), but a patent owner would need to incur 1 million dollars on litigation-related expenses to license its patents on such terms, the patent owner may accept to license the patent for a price that is above 1 million, but below the reasonable value of two million dollars. Similarly, patent holders that have initiated litigation may be forced financially to settle for an amount lower than the true value of their patented technology before the final resolution of their case.

(3) ***Abstain from licensing***

A patent holder may be unable to license its patents on reasonable terms to companies infringing their patents. Licensing is generally subject to certain costs, e.g., those related to identifying current users of the patented technology, involvement of legal and other experts in the formulation of a licensing offer, conduct of negotiations, attorney fees for the drafting of a license, and (after a license

48. *See, e.g.*, Jack Nicas & Daisuke Wakabayashi, *Sonos, Squeezed by the Tech Giants, Sues Google*, N.Y. TIMES (Jan. 7, 2020), https://www.nytimes.com/2020/01/07/technology/sonos-sues-google.html [https://perma.cc/NEX8-VJZY].

> is concluded) reporting and auditing.[49] In many cases, including in those in which it would be possible to license a patented technology to a willing licensee, it may not be profitable for patent owners to seek to license implementers engaging in holdout.[50]
>
> In addition to licensing costs, patent holders may prefer tolerating unlicensed use of their patented technology by some implementers to concluding a license on inadequate terms in order not to compromise the consistency of their licensing program.
>
> The high transaction costs associated with litigation can thus serve as an indemnification for prolonged infringement.

B. Strategic Interdependence

Implementers' decision to engage in holdout and patent holders' responses to such holdout behavior, are strategically interdependent as shown in Figure 1 below. A patent holder must first decide whether to approach a certain implementer for licensing. If the patent holder chooses to seek to license a certain implementer, the implementer then decides whether to engage in good faith licensing negotiations or holdout tactics. If the implementer opts for holdout, the patent holder then chooses between fighting for adequate compensation or conceding (e.g., by settling on unfavorable licensing terms or simply giving up on licensing that implementer).

Like any strategic game, this game is decided by backward induction:[51] the implementer forms an expectation of whether the patent holder would fight or concede when faced with holdout behavior. This expectation determines whether the implementer engages in good-faith negotiations or holdout. The patent holder's expectation of whether a licensee will engage in good faith negotiations contributes to determining whether the patent holder chooses to approach such an implementer for licensing in the first place.

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49. BARON ET AL., *supra* note 32, at 134–40.

50. For example, in the case of "resource indemnification" as discussed *infra* in Section IV.A.

[51] Game theory analyzes how decision makers evaluate the consequences of their actions, taking into account other actors' responses. A rational decision maker assumes that other parties will also act rationally, i.e., use their best responses to the initial decision maker's actions. The initial decision maker can thus rank his choices, knowing how other parties' responses to each choice would affect the ultimate outcome. This reasoning is called backward injunction because it first analyzes the last choices to be made and then proceeds backwards to determine the initial decision. GIACOMO BONANNO, GAME THEORY 80–82 (2d ed. 2018).

Consider again the case of a potential license whose value is small compared to licensing transaction costs. The net licensing revenue of the patent holder (licensing fees minus transaction costs borne by the licensor) is thus bound to be small compared to the cost of legal actions against an infringing implementer. When faced with holdout behavior, such patent holders have little incentive to "fight." Implementers thus choose between engaging in relatively costly good-faith negotiations (cost of licensing plus transaction costs borne by the licensee) or holdout with little risk of ensuing litigation. The most likely outcome for a patent holder approaching such a small implementer for a low-value license is, thus, holdout, resulting in major concessions by the patent holder. As even a reasonable compensation for such a license would be small compared to the cost of licensing, such a heavily discounted licensing fee may often not justify the cost of transactions. Rationally, patent holders would thus often abstain from seeking to license such implementers in the first place.

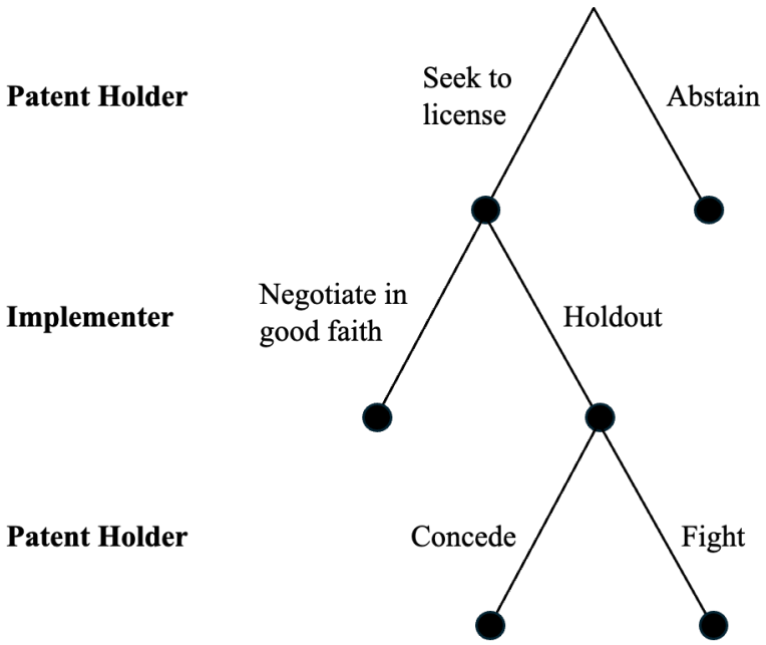

Figure 1: Decision Tree of Potential Licensing Behaviors and Responses

C. Business Response by Context

How patent holders experiencing holdout behavior choose to respond depends on a variety of circumstances, including the potential

economic value of the license,[52] the number of similarly situated implementers requiring a license,[53] and the patent holder's bargaining position with respect to the infringing implementer.[54] The expected response from the patent holder contributes to determining an implementer's incentives to engage in holdout (e.g., an implementer facing a patent holder with strong incentives to engage in litigation is less likely to holdout). Below is a description of certain factors that are likely to contribute to determining patent holders' response.

(1) ***Threshold size***

The value of a license depends on the value of the patented portfolio and the value of the sales covered by the license. Some licenses have very large value. Nevertheless, the transaction value of many other licenses is small, either because the portfolio is small, the potential licensee only makes limited sales of products using the technology, or both. Nevertheless, patent licensing is subject to certain fixed costs.[55] The royalty revenue that patent holders can achieve by licensing implementers making limited use of their patented technology is often small compared to licensing costs. Anticipating that patent holders have limited incentives to spend significant resources on litigation, implementers have strong incentives to holdout in situations where the value of the license is small.

(2) ***Many-to-many licensing***

The incentives of implementers to engage in holdout and the type of response by patent holders may also depend on other potential licensing relationships that each of these companies may need to take into consideration. A patent holder seeking to license a single implementer may be willing to make concessions and offer unreasonably favorable licensing terms to an implementer engaging in holdout in order to avoid protracted disputes. A patent holder seeking to license a large number of similarly situated implementers may be less inclined to make such concessions in order not to compromise the consistency of its licensing program. Such patent holders may thus be more likely to either abstain from licensing such implementers or vigorously pursue adequate compensation. Patent holders seeking to license large

52. *See infra* Section IV.A (describing the "revenue indemnification" effect).

53. *See* Gilbert, *supra* note 11, at 875–76 (introducing the economic meaning of "similarly situated" licensees in the context of FRAND negotiations).

54. Heiden & Rappaport, *supra* note 18, at 365–66.

55. BARON ET AL., *supra* note 32, at 116–18.

numbers of implementers may also have incentives to initiate litigation against smaller infringers engaging in holdout where the cost of litigation exceeds the expected revenue from that particular license if such actions against individual implementers maintain a sufficiently credible threat of enforcement to incentivize larger numbers of implementers to engage in licensing negotiations; or where an agreement with terms that are favorable to the patent owner can be used as a comparable license in subsequent negotiations.

Similarly, implementers may be incentivized to engage in holdout depending on the number of similarly situated patent holders from whom they may also need a license. An implementer may have stronger incentives to engage in holdout, including by employing costly means and risking litigation, if doing so discourages other patent holders from asserting their patents against them or makes these other patent holders more inclined to offer favorable terms.[56] Implementers that need further licenses from other patent holders may also be particularly incentivized to pursue favorable terms in order to establish a benchmark that can be used as a comparable license in future negotiations.

(3) ***Bargaining power***

In addition to the potential value of a license under dispute and the external effect of a specific licensing negotiation on other deals with third parties, licensors' and licensees' conduct in negotiations is determined by their relative bargaining powers.[57] Many factors may affect licensors' and licensees' relative bargaining power, including the availability of financial resources to sustain litigation[58] and the value of assets, potential revenues, and social and organizational capital that may be at risk in case of an adverse litigation outcome.[59] In other words, a company that has little to lose but has significant means to pursue litigation

56. Heiden & Rappaport, *supra* note 18, at 414–15 (describing this phenomenon as "adverse signaling").

57. *See generally* Gregory J. Sidak, *The Meaning of FRAND, Part I: Royalties*, J. COMPETITION L. & ECON. 935 (2013).

58. *See* Gaurav Kankanhalli & Alan Kwan, *Bargaining Power in the Market for Intellectual Property: Evidence from Licensing Contract Terms*, 21 J. EMPIRICAL LEGAL STUD. 109, 112 (2024) (indicating "that financially constrained licensors receive lower royalty rates, and financially constrained licensees pay higher rates, consistent with diminished relative bargaining power").

59. Jorge Lemus & Emil Temnyalov, *Patent Privateering, Litigation, and R&D Incentives*, 48 RAND J. Econ. 1004, 1004 (2017) (finding that "PAEs can negotiate higher licensing fees than producing firms because they cannot be countersued for infringement").

can produce a much more credible threat of litigation than a company that is resource-constrained and/or may suffer significant damages from adverse litigation outcomes.

IV. TYPES OF PATENT HOLDOUT OUTCOMES

A. The Indemnification Effect — The Missing SEP Market Segments

Transaction costs may make licensing unviable in general (even licensing willing licensees); but holdout may significantly extend the non-licensing zone. Heiden and Petit (2017) provide an estimated cost of negotiating SEP licenses of 300,000 dollars in the United States, based on a small survey of licensors.[60] For very small licenses, the total net present value of the license may not even justify the general cost of licensing.[61]

Holdout behavior may significantly extend the number of contexts in which patent licensing is unviable. The costs of patent licensing significantly increase if there is a need for litigation. IP practitioners surveyed by the American Intellectual Property Law Association ("AIPLA") estimate that the median cost of patent litigation in cases with less than 1 million dollars at risk is 28,000 dollars for initial case management and 600,000 dollars inclusive of pre- and post-trial and appeal when applicable.[62]

These figures illustrate the difficulty of licensing smaller implementers. Rational implementers anticipate that patent holders have limited incentives to engage in costly litigation, and it is therefore rational for these implementers to drag their feet in negotiations or to offer to enter into a license only on heavily discounted terms. Given the small value of the license to start with, the potential (discounted) royalty revenue to be gained (net of licensing costs inflated by delaying tactics) may not be enough for patent holders to justify the expense of licensing in the first place. Therefore, many of these small potential licenses never materialize, and some implementers may go fully unlicensed, as will be described below.

The size of the "marginal" licensee (i.e., the smallest potential licensee that it is profitable for a patent holder to seek to license) depends, among other things, on the size of the licensor's portfolio, as well as its bargaining strength. For a very large patent holder, a small vendor may still represent a revenue potential that is sufficient to justify the cost of patent licensing.

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60. Heiden & Petit, *supra* note 25, at 238 tbl.8.

61. This would be the case when the transaction costs of implementing a license are greater than the revenue from the license.

62. AMERICAN INTELLECTUAL PROPERTY LAW ASSOCIATION, REPORT OF THE ECONOMIC SURVEY 61 (2023).

Qualcomm, for example, currently lists on its website the names of more than 400 current patent licensees.[63] Other patent licensors that — similarly to Qualcomm — focus on licensing cellular communication technology include Nokia, Ericsson, and InterDigital.[64] Nokia states on its website that it currently has more than 250 licensees;[65] and Ericsson states that it has signed more than 100 license agreements.[66] A UK court found that "InterDigital have conducted their licensing program for a number of years, amassing a total of about 72 licenses."[67] The ranking of these four licensors in terms of number of licensees coincides with the ranking in royalty revenues: In 2023, Qualcomm collected approximately 5.8 billion dollars in royalty revenue,[68] compared to 1.2 billion dollars for Nokia,[69] 1.1 billion dollars for Ericsson,[70] and 550 million dollars for InterDigital.[71] The implication is simple: the larger the licensor, the larger the number of licensees it can manage.

Of course, there are more than just these four SEP licensors. Several hundred companies have declared to own patents that are potentially essential to 4G or 5G cellular communication technology standards.[72] While not all of these companies may actually have SEPs that could be licensed, many do. Avanci, for example, operates a licensing platform for licensing patents that are essential for 5G to the automotive industry, and this program currently has sixty-nine licensors.[73] Each of these sixty-nine licensors may also attempt to sign bilateral SEP licenses with manufacturers of mobile

63. *Licensees Search*, QUALCOMM, https://www.qualcomm.com/licensing?#licensee-search [https://perma.cc/TWW6-XDQQ].

64. Based on publicly available information, these are four of the five largest current licensors of SEPs by revenue. *See* Alexander Galetovic, Stephen Haber & Lew Zaretzki, *An Estimate of the Average Cumulative Royalty Yield in the World Mobile Phone Industry: Theory, Measurement and Results*, 42 TELECOMM. POL'Y 263 app. at 275 tbl.A1 (2018).

65. *Patent Licensing*, NOKIA, https://www.nokia.com/licensing/patents/ [https://perma.cc/4EWW-U45D].

66. *Company Facts*, ERICSSON, https://www.ericsson.com/en/about-us/company-facts [https://perma.cc/9EYE-JDP3].

67. InterDigital's website lists the names of only 21 current bilateral licensees, in addition to other companies licensed through platforms. *Our Licensing Program*, INTERDIGITAL, https://www.interdigital.com/licensing [https://perma.cc/5U2K-K9VG].

68. Qualcomm reported 5,792 million dollars in revenue from licensing for fiscal year 2023 in its Annual 10-K report. Qualcomm Inc., Annual Report (Form 10-K) 41 (Nov. 1, 2023).

69. Nokia reported 1,085 million Euros (1,176 million dollars) in revenues from licensees in its Annual Report for 2023. NOKIA, NOKIA IN 2023 77 (2023).

70. Ericsson reported 11.1 billion SEK in IPR licensing revenues in its Annual Report for 2023. ERICSSON, ANNUAL REPORT 17 (2023).

71. InterDigital which derives most of its revenues from patent licensing, reported 550 million dollars total revenue for 2023 in its Annual Report. InterDigital, Inc., Annual Report (Form 10-K) 3 (2023).

72. The ETSI IPR Online Database currently hosts declarations of potential SEPs submitted by 401 companies. *ETSI IPR Online Database*, EUR. TELECOMM. STANDARDS INST., https://ipr.etsi.org/ [https://perma.cc/Z2XR-ETT7].

73. *Avanci 5G Vehicle*, AVANCI, https://www.avanci.com/vehicle/5gvehicle/ [https://perma.cc/XV8P-AZMB].

telecommunications devices such as smartphones and tablets. Very large manufacturers of such devices are likely to be licensed to a significant number of such licensors. Apple, for example, states on its website that it "has entered into license agreements with dozens of SEP licensors"[74] and has produced nineteen licenses with SEP licensors as potential comparable licenses in its dispute with Optis.[75] Optis, during the same dispute, pleaded that it had entered into nineteen licenses covering all, or a subset of, Optis' portfolio since 2015.[76] Other licensors that are smaller than Optis are likely to have concluded even lower numbers of licenses, in many cases limited to one or two of the largest manufacturers.[77]

Overall, it is thus clear that there are vast swaths of SEP licensing segments that are missing. On one side, there are at least several hundred companies that use cellular communication technology and would potentially need a license from every company that owns patents that are essential to 4G or 5G cellular communication standards.[78] More than 400 companies have taken a SEP license from at least one licensor (Qualcomm).[79] On the other side, there are dozens (and possibly hundreds) of companies that own patents that are plausibly essential to 4G or 5G. For instance, over sixty-five companies are part of Avanci's 5G licensing platform, indicating that an independent evaluator appointed by Avanci has considered at least one of their patents to be essential to 5G.[80] If each of these potential licensors had a license with each potential licensee, this would result in several 10,000 SEP licenses for just cellular communication SEPs,[81] but it is clear that the vast majority of these *potential* SEP licenses do not exist.

We summarize this situation in the following Figure 2. Many SEP owners are simply too small to build a credible threat of SEP enforcement; these companies are unlikely to produce any significant royalty revenue from bilateral SEP licensing. We call this resource indemnification. On the other hand, many implementers are so small

74. *A Statement on FRAND Licensing of SEPs*, APPLE, https://www.apple.com/legal/intellectual-property/frand/ [https://perma.cc/U7SQ-AMMF].

75. Optis v. Apple [2023] EWHC 1095 (Ch) [238].

76. *Id.* at [232].

77. After acquiring a substantial SEP portfolio from Ericsson in early 2013 and prior to its litigation with Huawei, Unwired Planet only signed two licenses: one with Lenovo and another with Samsung. Unwired Planet v. Huawei Technologies [2017] EWHC 711 (Pat).

78. The International Data Corporation (IDC) tracks over 450 mobile phone vendors in its Worldwide Quarterly Mobile Phone Tracker. *Worldwide Quarterly Mobile Phone Tracker*, IDC, https://www.idc.com/getdoc.jsp?containerId=IDC_P8397 [https://perma.cc/6JHH-MV7V]. In addition to mobile phones, there are many other products and industries in which cellular communication technology is being used.

79. *Licensees Search*, QUALCOMM, https://www.qualcomm.com/licensing#licensee-search [https://perma.cc/TWW6-XDQQ].

80. *See* AVANCI, *supra* note 73.

81. For example, if each of the sixty-nine licensors in the Avanci program had 400 licensees, this would represent 27,600 different SEP licenses.

that it is not profitable for any SEP licensor to attempt to license these companies. We call this revenue indemnification. SEP licensing (including licensing negotiations and a possibility of litigation) only actually occurs when the value of the potential SEP license is sufficiently significant.

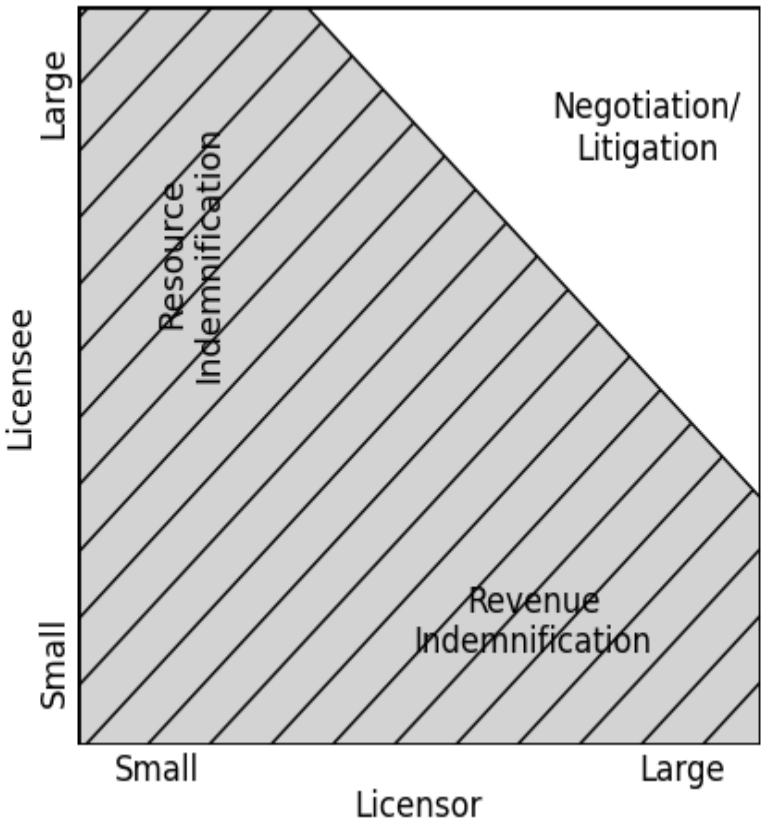

Figure 2: Illustration of Indemnification Effect in Cellular SEP Licensing

While it is plausible that the vast majority of potential SEP licenses never materialize, most of the largest and most valuable of these potential SEP licenses do materialize. The market share of "microvendors" provides an approximation of the potential licensing revenue that is lost to indemnification.[82] Figure 3 below shows the growth in the size of the microvendor market for handsets, growing to

82. Microvendors represent the many actors in the "long-tail" of the market. In this study, microvendors were defined as mobile phone implementers with a market share below 5%.

approximately 186 million units or 13 percent of the global market in 2015 with most of their sales in developing or emerging economies.

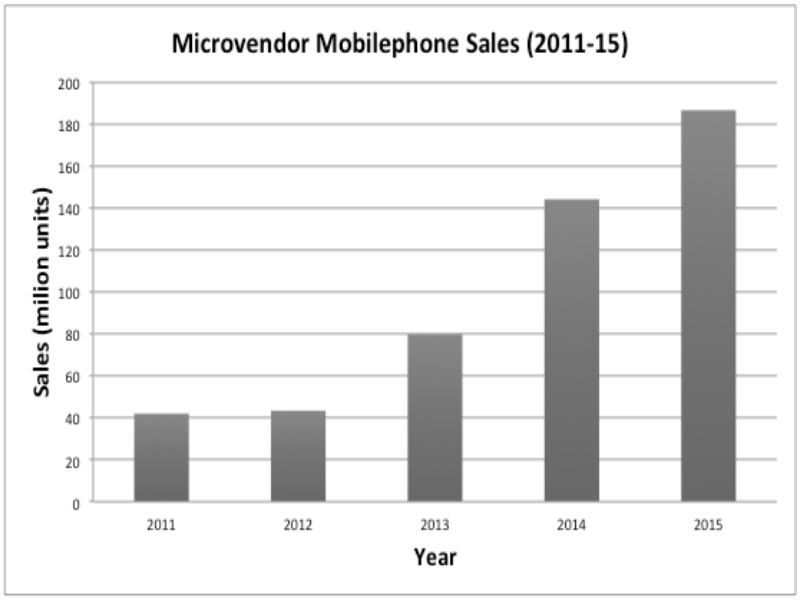

Figure 3: Microvendor Mobile Phone Sales (2011–15)[83]

Figure 4 below provides a graphical illustration of the global handset market in 2015 with the visible long tail of microvendors.

83. Heiden & Petit, *supra* note 25, at 236 fig.3.

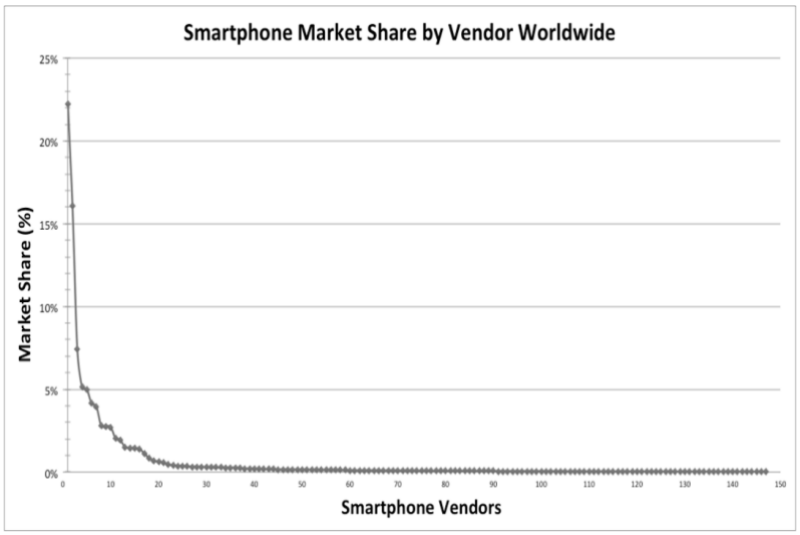

Figure 4: Microvendor Mobile Phone Sales (2011–15)[84]

Using the price for a budget smartphone in emerging markets (fifty-five dollars),[85] the expected aggregate royalty rate from Table 2 (six to ten percent), and the units sold by microvendors in 2015 (186 million), the estimated lost royalties are calculated between 614 to 1023 million dollars for one year. This estimate is likely conservative as the range of indemnification likely extends beyond the microvendors.

B. Discounted Licensing Due to Bargaining Power Asymmetry

For more valuable licenses, indemnification effects diminish as the reasonable value of the license grows larger relative to the cost of filing a lawsuit and the transaction cost of licensing. As the value of the potential license increases, the SEP holder's threat of litigation becomes increasingly credible so that "flying under the radar" becomes unviable.

Nevertheless, the mere threat of initiating legal proceedings is often insufficient to incentivize large implementers to engage in good-faith negotiations, as implementers may be willing to incur significant costs in litigation (including parallel litigations in multiple

84. *Id.* at 237 fig.4.

85. The lowest priced smartphone from Lava in 2015, the Lava Iris 350 (3499 rupees), was used as the estimated price. *Top 8 Budget Smart Phones*, LAVA (Jan. 30, 2015), https://www.lavamobiles.com/blog/top-8-budget-smartphones/ [https://perma.cc/A8VF-E6NA].

jurisdictions) to obtain more favorable terms.[86] Patent licensors wishing to forcefully pursue a patent license on their expected terms against a large licensee must thus be prepared to incur very significant costs on litigation, potentially reaching hundreds of millions of dollars for a single license.[87]

Most licensors do not have the means to engage in this kind of litigation. In order to license a large implementer prepared to actively resist licensing using all available means, patent holders must make more significant concessions. In InterDigital's dispute with Lenovo, experts testifying for InterDigital explained that InterDigital gave significant discounts to larger licensees; and that "if [InterDigital] did not give such discounts, then those [large] companies would very well force [InterDigital] to litigate to try to get any royalties, and that that would involve large amounts of cost and time."[88] The experts further explained that while "[a]ll companies are capable of some degree of hold out but[. . .]larger companies had very significant leverage in negotiations because of their enhanced capacity to hold out from taking a license."[89] The value of the different discounts granted by InterDigital to its largest licensees is very significant. Samsung, for example, qualified for a volume discount of eighty percent.[90]

While not all licensors may grant similar discounts, InterDigital is certainly not unique. Significant volume discounts are also observable in the publicly available licensing fee tables of certain pool licensing

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86. Baron et al. identified twenty-three SEP licensing disputes involving parallel litigation in two to seven different jurisdictions. BARON ET AL., *supra* note 32, at 88–90. One example of such a complex SEP licensing dispute was the conflict between Nokia and Daimler. When the dispute ended with Daimler finally accepting to take a license from Nokia (and later, in December 2021, from the Avanci patent pool), there were ten active lawsuits pending in different courts, in addition to a complaint before the European Commission. Mathieu Klos, *Nokia and Daimler Settle All Global Litigation in Connected Cars Dispute*, JUVE PATENT (June 1, 2021), https://www.juve-patent.com/cases/nokia-and-daimler-settle-all-global-litigation-in-connected-cars-dispute/ [https://perma.cc/XB2C-YULJ]; *see also* Eingestellt von Florian Mueller, *Daimler Takes Avanci Patent License — All Major German Car Makers Now Avanci-Licensed, but Volkswagen Only Up to 3G*, FOSS PATENTS (Dec. 22, 2021), http://www.fosspatents.com/2021/12/daimler-takes-avanci-patent-license-all.html [https://perma.cc/QKG9-M4E4].

87. *See, e.g.*, Qualcomm Inc., Annual Report (Form 10-K) 41 (Nov. 4, 2020) (reporting "$167 million in lower litigation costs, primarily resulting from the settlement of our prior dispute with Apple and its contract manufacturers in April 2019"); Qualcomm Inc., Annual Report (Form 10-K) 44 (Nov. 6, 2019) (reporting "$235 million in lower litigation costs, primarily resulting from the settlement of our prior dispute with Apple and its contract manufacturers and the end of the District Court trial in the lawsuit filed against us by the FTC."). This means that Qualcomm's spending on litigation in 2018 was 402 million dollars higher in 2018 than it was in 2020, primarily due to its litigation with Apple. Summing up the excess litigation spending of the years 2018 and 2019 (compared to the level of 2020), Qualcomm has spent more than 569 million dollars on extraordinary legal costs in these two years, primarily related to its disputes with Apple.

88. [2023] EWHC 539 (Pat) [476].

89. *Id.*

90. *Id.* at [136].

programs.[91] Via LA's licensing program for advanced audio coding, for example, applies a 0.98 dollar per unit fee for the first 500,000 units.[92] The per unit fee gradually decreases in the number of units; for units 75,000,001 and more, the fee reaches 0.10 dollar (a 89.7% volume discount).[93]

Therefore, the *royalty gap* — the difference between the reasonable value of a license (expected royalty, R_E) and the royalties that patent holders are actually able to recoup (actual royalty, R_A) — first decreases and then increases in the value of the license, as shown in Figure 5 below.[94]

There are thus two different holdout zones, characterized by very different incentives:

(1) A zone of small implementers "flying under the radar," facing limited risk of actual patent enforcement. This is modeled in Figure 5 below by the offset (I) in the x-axis representing what could be called an *indemnification effect*.

(2) A zone of large implementers with large stakes employing considerable means to achieve more favorable licensing conditions. This is modeled in Figure 5 below by the increasing convexity of the actual royalties curve (RA).

As a result, the share of potential royalty revenue that is actually collected increases in product revenue exposure due to reduced indemnification effects up to a certain threshold point (T) and then decreases again due to implementers' increased bargaining power advantage.

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91. Examples of pool licensing programs offering volume discounts include Sisvel's licensing program for VP9 and Via LA's program for advanced audio coding. *See, e.g.*, *VP9 License Terms*, SISVEL, https://www.sisvel.com/licensing-programmes/audio-and-video-coding-decoding/video-coding-platform/#tab-licence-terms [https://perma.cc/V85R-R794]; *License Fees*, VIA LICENSING ALLIANCE, https://www.via-la.com/licensing-2/aac/license-fees/ [https://perma.cc/3GJW-8L2R].

92. VIA LICENSING ALLIANCE, *supra* note 91.

93. *Id.*

94. The shape and slope of this line could change depending on industry norms regarding royalty rates, discounts, caps, etc.

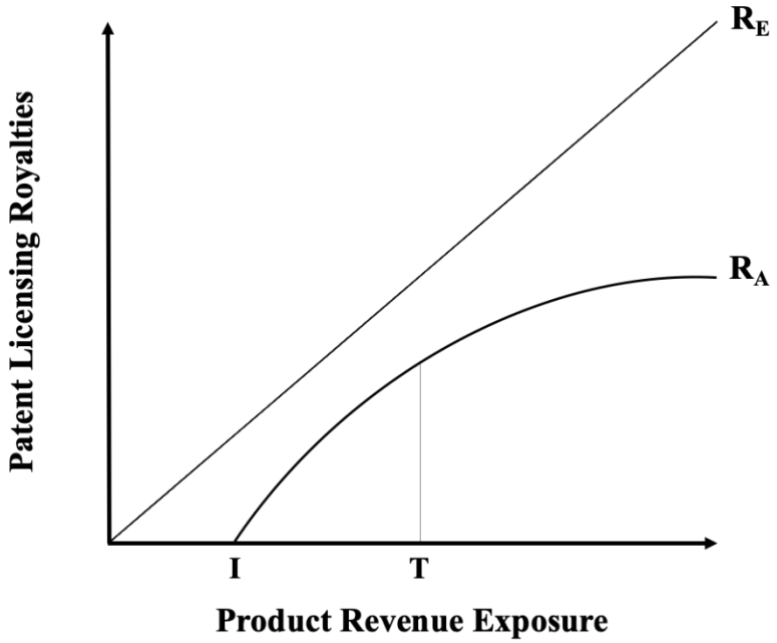

Figure 5: Graphical Representation of the Types of Financial Impact from Systematic Patent Holdout

C. The Fighting Zone — Licensing Revenue Lost to Transaction and Litigation Costs

We thus observe that holdout leads to different types of royalty revenue shortfalls for licensors, as licensors may strategically respond to holdout by abstaining from licensing (indemnification effects), or by making significant concessions to larger licensees. Nevertheless, patent holders also have a third possible strategic response — fight.

Different licensors may have different incentives to engage in litigation. For example, many companies may be unwilling to engage in litigation, which may divert managerial attention, compromise other business relationships with the opposing party, and produce negative reputational effects. Litigation incentives are largest for patent assertion entities that have few business relationships at risk and are most reliant on upholding a credible threat of enforcement to produce a royalty revenue.

Several studies have tried to measure the economic impact of patent holdup in the context of PAEs.[95] However, each of these studies fails to identify a frame of reference from which to interpret the results. These studies make the implicit assumption that every litigation by a NPE in their sample of over 4000 litigations can be categorized as "excessive litigation" and that the total effect that they measure is an unnecessary cost to the defendant/licensee leading to a welfare loss to society.[96] This would be like assuming that the sale of 5,000 dollars of stock is all capital gains without taking into account the initial price paid for the stock. Without knowing the initial price, we do not know whether the sale resulted in a gain or a loss. Similarly, in these NPE litigation studies, we only know the aggregate results, not the distribution of value and the determination of social loss.

However, Bessen, Ford, and Meurer have provided an approximation for the size of patent holdout related to NPE litigation from 1990 to 2010.[97] Equation 1 below shows the holdout/up value (V_H) based on the empirical results of their market value study.

$V_H = V_E - V_A$ (Equation 1)
V_H = Aggregate Patent Holdout
V_E = Expected Value of NPE Patents
$V_A = R_A$ = Actual Value Received by NPEs Based on Actual Royalties

The two main variables, V_E and V_A, are determined as follows:

The expected value of the NPE patents (V_E) during the 1990 to 2010 timeframe is determined using the loss in the stock market value of the defendants of the NPE litigations during the period. The assumption is based on the basic economic theory that the market value of a patent is equal to the price a buyer would be willing to pay, which should equal the expected loss in the market value of a buyer's stock associated with the enforcement of the patent in question. Bessen, Ford, and Meurer calculated this amount to be $501,775 million.[98]

The actual value received by NPEs (V_A) during the 1990 to 2010 timeframe is determined from the results of 14 publicly traded NPEs from 2000 to 2010 by Bessen, Ford, and Meurer, which is calculated to be 7.6 billion dollars or nine percent of the total loss to the subset of defendants facing litigation from these public NPEs over the period.[99]

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95. *See generally* James Bessen, Jennifer Ford & Michael J. Meurer, *The Private and Social Costs of Patent Trolls*, 34 REGULATION 26 (2011); Stephen Kiebzak, Greg Rafert, & Catherine E. Tucker, *The Effect of Patent Litigation and Patent Assertion Entities on Entrepreneurial Activity*, 45 RSCH. POL'Y 218 (2016).

96. *See* Bessen et al*., supra* note 95, at 30.

97. *Id.* at tbl.3.

98. *Id.*

99. *Id.* at 32.

Using the nine percent as a proxy across the entire cohort from 1990 to 2010 generated a value of 45,160 million dollars.[100]

Thus, the amount of patent holdout value experienced by NPEs during the period 1990 to 2010 is calculated below:

$V_H = V_E - V_A$ = \$501,775 *million* – \$45,160 *million* = \$456,615 *million*

This sum of approximately 457 billion dollars represents the difference in the amount of money that defendants would have been willing to pay for NPE patents in licensing payments minus what they actually paid to NPEs (i.e., the patent holdout value). This implies a revenue shortfall of approximately ninety percent.

Furthermore, PAEs spend significant resources on litigation in order to actually collect this revenue. Baron et al. (2023) calculate that "PAEs spend more than half of their royalty revenue on licensing costs (leaving less than half for the acquisition of patent rights and PAEs' net profits)."[101] This would indicate that less than five percent of potential licensees' willingness to pay for PAE licenses results in actual net revenue for PAEs.[102]

Overall, we have described that patent holders have three strategic responses to implement holdout: abstain from licensing, make concessions, or fight. Each of these responses is associated with significant losses in revenue, leading actual collected royalty revenue to be significantly below expected royalty revenue.

V. EVIDENCE OF THE ECONOMIC IMPACT OF PATENT HOLDOUT IN AGGREGATE CELLULAR SEP ROYALTIES

As discussed above, patent holdout elicits specific business responses that can manifest themselves through circumstantial, systematic, and systemic effects. This section is focused on the evidence of systematic patent holdout and the measurement of royalty gap in aggregate cellular SEP royalties.

In the process of investigating the evidence of patent holdup and royalty stacking, several studies were conducted to measure the actual aggregate SEP royalties paid by implementing firms in the context of

100. The 9% approximation for the period 2000 to 2010 could be affected positively and negatively by both the influx of patent litigation after the dotcom bust as well as the weakening of injunctive relief due to the *eBay* decision, respectively.

101. BARON ET AL., *supra* note 32, at 136.

102. This follows from our previous estimation that PAEs' collected royalty revenue only accounts for approx. 10% of the licensees' willingness to pay; combined with the estimation by Baron et al. that PAEs spend more than half of the collected royalty revenue in litigation and other licensing costs; thus leaving only less than 5% of the licensees' willingness to pay for PAEs' net royalty revenue.

cellular standards (i.e., the actual aggregate royalty yield).[103] Table 1 below provides their results.

Table 1: Studies Measuring the Actual Aggregate Royalty Rates in Cellular SEP Licensing

Source	**Standard**	**Year**	**Actual Aggregate Royalty Yield**
Galetovic et al. (2018)	Cellular	2016	2.8%[104]
Sidak (2015)	Cellular	2013-14	3.45%[105]
Mallinson (2015)	Cellular	2014	~3.5%[106]

While the results of these studies debunked the notion that royalty stacking was anywhere close to the predictions of patent holdup theory, there has not been an investigation into whether these results are evidence of patent holdout. In other words, if there is not a royalty stacking problem, is there instead a royalty lacking problem or what has been termed in patent holdout theory as a royalty gap?[107] The equations and variables necessary to estimate the patent royalty gap/stack and approximate patent holdout/up are derived below.

$g = r_E - r_A$ (Equation 2)
g = Royalty Gap / Stack
r_E = Expected Royalties
r_A = Actual Royalties

103. *See* Galetovic et al., *supra* note 64, at 266; Gregory Sidak, *What Aggregate Royalty Do Manufacturers of Mobile Phones Pay to License Standard-Essential Patents?*, 1 CRITERION J. ON INNOVATION 701, 718 (2015); Keith Mallinson, *Cumulative Mobile-SEP Royalty Payments No More than Around 5 Percent of Mobile Handset Revenues*, IP FINANCE (Aug. 19, 2015), http://www.ip.finance/2015/08/cumulative-mobile-sep-royalty-payments.html [https://perma.cc/FA8Z-UR3D].

104. Calculated by removing actors that do not have cellular SEP royalties from the aggregate royalty yield (3.4 %).

105. Calculated by subtracting the implicit cross-licensing revenue (1%) from the total licensing revenue (4.45%) so as to only include actual licensing payments.

106. Calculated by subtracting the other revenue category (1.5%) from the total licensing revenue (5%) so as to only include substantiated licensing payments.

107. Heiden & Petit, *supra* note 25, at 181–83, for an initial theoretical framing and empirical investigation of the "royalty gap" concept in the context of patent holdout theory in contrast to the patent holdup concept of the "royalty stack."

$G = R_E - R_A$ (Equation 3)
G = Aggregate Royalty Gap / Stack
R_E = Expected Aggregate Royalties
R_A = Actual Aggregate Royalties

$R_E = B \times (\sigma - \lambda)$ (Equation 4)

$R_A = B \times (\alpha)$ (Equation 5)
B = Aggregate Royalty Base
σ = Expected Aggregate Royalty Yield
λ = Cross Licensing of f Set
α = Actual Aggregate Royalty Yield

$G = B \times (\sigma - \lambda - \alpha)$ (Equation 6)

Using Equation 6 above, the following key variables are estimated:

(1) **Expected aggregate royalty rate (σ)**

A frame of reference that defines the expected level of aggregate royalties is required as mentioned in Sections II and III in order to determine a baseline for comparison as the royalty gap and patent holdout is a measure of the deviation from the norm. In order to determine this expected level, there is a need to estimate the maximum royalty rate to be paid by an implementer to license all SEPs.

Table 2: Court Determined Expected Aggregate Royalty Rates

Source	Standard	Year	Expected Aggregate Royalty Rate
TCL v. Ericsson[108]	4G/3G/2G	2017	6-10%
TCL v. Ericsson[109]	3G/2G	2017	5%
Unwired Planet v. Huawei[110]	4G/3G/2G	2017	8.8%
Unwired Planet v. Huawei[111]	3G/2G	2017	5.6%

(2) **Cross-licensing offset (λ)**

As many cellular licensors and licensees are both SEP holders and implementers, this will lower the expected aggregate royalty yield through cross-licensing depending on the ratio of exposure between licensors and licensees. Therefore, in a heterogeneous market, the expected aggregate royalty yield will be lower than the maximum rate.

Table 3: Measure of the Cross-licensing Offset

Source	Standard	Year	Cross-Licensing Offset
Sidak (2016)[112]	Cellular	2013-14	1%

Applying the estimates for the expected royalty yield (Table 2), the cross-licensing offset (Table 3), and the actual aggregate royalty yield (Table 1) to Equation 6, a sensitivity analysis of the aggregate royalty gap by royalty yield for cellular standards is constructed in Table 4 below.

108. TCL Commc'n Tech. Holdings v. Telefonaktiebolaget LM Ericsson, No. CV 15-2370, 2018 WL 4488286, at *13 (C.D. Cal. Sept. 14, 2018).

109. *Id.* at *12.

110. Unwired Planet Int'l Ltd v. Huawei Techs. Co. Ltd [2017] EWHC 711 (Pat) [478].

111. *Id.*

112. Sidak, *supra* note 103, at 715–16. The 1% figure was calculated as an average between 1.03% (2013) and 0.97 (2014).

Table 4: Sensitivity Analysis of Aggregate Patent Holdout by Royalty Yield for Cellular Standards

Actual/Expected	**6%**	**8%**	**10%**
3.45%	1.55%	3.55%	5.55%
2.8%	2.2%	4.2%	6.2%

Applying the 2021 global mobile phone revenues of 455 billion dollars as the royalty base (B) to the estimates in Table 4 above generates an aggregate royalty gap value ranging from approximately 7 to 28 billion dollars (1.55-6.2%). This estimate is understated by the amount of non-SEP licensing revenue and non-mobile Internet of Things ("IoT") SEP revenue that may be included in the actual aggregate royalty income reported by firms and used in this calculation.[113] It may also be overstated in relation to the difference between the manufacturer's sales price and the retail sales price captured in the estimated global mobile phone revenues (B). The potential underestimation of the royalty base used in this calculation will be discussed below.

VI. CONCLUSION

This paper has attempted a comprehensive investigation of the economic impact of patent holdout by (1) providing a theoretical foundation of patent holdout and its economic implications; (2) identifying three types of strategic responses to holdout (abstain from licensing, make concessions, or fight), producing different types of costs and revenue shortfalls for patent holders; and (3) quantifying the overall impact of holdout with empirical data from the context of cellular SEP licensing.

As a starting point, we define patent holdout as a transactional phenomenon linked to the rational behavior of firms to willfully infringe, rather than seek to obtain, a license based on the risks and rewards of the given patent regime. Identifying patent holdout requires a frame of reference that assesses the reasonableness of the infringer's behavior in light of industry context and prevailing norms.

Following our definition, patent holdout only arises in situations where the patent owner is prepared to make licenses available on

113. *See* Keith Mallinson, *Modest SEP Royalties on Smartphones Have Declined and Licensing Is Stabilizing*, IP FINANCE (Sept. 7, 2021), http://www.ip.finance/2021/09/modest-sep-royalties-on-smartphones.html [https://perma.cc/V4MY-JT5V] (presenting data that one-sixth of Qualcomm's licensing revenue is from non-smartphone SEPs).

reasonable terms. Patent owners that commonly offer their patents for license, such as universities and other innovation specialists, and owners of patents subject to licensing commitments, such as declared SEPs, are at higher risk of holdout than companies relying on their patents to protect their own exclusive use of their patented technology. Thus, different patent licensing contexts can lead to different business responses, including litigation, licensing or settling on inadequate terms, and abstaining from licensing, where much of the impact of patent holdout is not easy to observe directly.

As a first step, we identify three types of significant losses of royalty revenue: losses of royalty revenue from potential licenses that do not materialize, losses due to concessions that are necessary in order to persuade implementers to take a license, and losses of net revenue due to transaction costs (including litigation and other legal costs). We operationalize and calculate the financial impact of systematic patent holdout from evidence of aggregate cellular standards, resulting in the measurement of a "royalty gap" range of seven to twenty-eight billion dollars per year in 2021. Using global mobile phone sales data from 2015, we estimate that between 614 to 1023 million dollars of this royalty gap could be attributed to "revenue indemnification," which is the systematic underlicensing of smaller vendors. The other types of royalty revenue loss may be even more significant. There is evidence that SEP licensors frequently make concessions to large implementers that may reach or even exceed eighty percent of the royalty rate, and licensors such as InterDigital have explicitly indicated that large implementers' bargaining power forces them to offer these concessions. Finally, licensors that do engage in litigation in order to license implementers on adequate rates may incur litigation costs of hundreds of millions of dollars, and licensors that routinely rely on litigation (such as PAEs) on average lose more than half of their royalty revenue to litigation and other transaction costs.

To the authors' knowledge, this is the first study of the economic impact of patent holdout measured in financial terms, which is crucial to understanding the empirical reality, not only the theoretical potentiality. Continued research in this field will be helpful to provide companies and policymakers with better information on the direction and extent of patent holdout and holdup in support of policies that create more efficient markets for technology and greater social welfare from innovation.