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Antitrust Policy Toward Patent Licensing: Why Negotiation Matters

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ABSTRACT

Major technological changes driving the Fourth Industrial Revolution combine complementary inventions to form complex innovations. These include the Internet of Things (IoT), 5G mobile communications, artificial intelligence (AI), cloud computing, data analytics, autonomous vehicles, additive manufacturing, and augmented/virtual reality. This article shows that negotiation of patent license contracts fully eliminates many influential antitrust concerns about complementary inventions, including "royalty stacking," "SEP hold-up," "patent thickets," "blocking patents," the "Tragedy of the Anti-Commons," and "regulatory patent pools." Negotiation of patent license contracts implies that total royalties will be less than those charged by a bundling monopoly. Negotiation of patent license contracts in a competitive market avoids distortions from royalties per unit of output and eliminates the multiple-marginalization problem. Negotiation generates contract provisions consistent with contingent royalty arrangements. Negotiation also has important implications for antitrust policy toward patent pools. The analysis shows that patent pools serve to mitigate transaction costs rather than to regulate total royalties. This article suggests that antitrust policy makers should continue to be neutral between negotiation of patent license contracts and patent pools. This article supports the view that negotiation is pro-competitive as expressed by the

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2017 United States Department of Justice and the Federal Trade Commission Antitrust Guidelines for the Licensing of Intellectual Property.

Keywords: antitrust, intellectual property, competition policy, patent, license, Standard Essential Patents, patent pools, hold-up, royalty stacking, patent thicket, blocking patents, negotiation, bargaining, technology standards

JEL codes: K00, K11, K12, L24, O30, O33, O34, O38

I. INTRODUCTION

Technological change increasingly depends on complex innovations that combine many complementary inventions.[1] Technological advances based on complex innovations include the Internet of Things (IoT), 5G mobile communications, artificial intelligence (AI), cloud computing, data analytics, autonomous vehicles, additive manufacturing, and augmented/virtual reality.[2] These significant technological advances have been described as the Fourth Industrial Revolution (4IR).[3] This article considers antitrust policy toward patent licensing when there are complementary inventions and shows why negotiation of patent license agreements is fundamental for formulating antitrust policy.

The growing importance of complementary inventions and complex innovations has raised a number of antitrust concerns.[4] Various policy makers question whether patent licensing in a competitive market achieves economic efficiency.[5] Some express

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1. *See* Herbert A. Simon, *The Architecture of Complexity*, 106 PROC. AM. PHIL. SOC'Y. 467, 468 (1962) ("Roughly, by a complex system I mean one made up of a large number of parts that interact in a nonsimple way. In such systems, the whole is more than the sum of the parts, not in an ultimate, metaphysical sense, but in the important pragmatic sense that, given the properties of the parts and the laws of their interaction, it is not a trivial matter to infer the properties of the whole.").

2. *See generally* EUROPEAN PATENT OFFICE, PATENTS AND THE FOURTH INDUSTRIAL REVOLUTION: THE INVENTIONS BEHIND DIGITAL TRANSFORMATION (2017) (providing a broad discussion on these and related topics).

3. Klaus Schwab, *The Fourth Industrial Revolution: What It Means and How to Respond*, FOREIGN AFF. (Dec. 12, 2015), https://www.foreignaffairs.com/articles/2015-12-12/fourth-industrial-revolution; KLAUS SCHWAB, THE FOURTH INDUSTRIAL REVOLUTION 1, 7 (2017).

4. *See* U.S. DEP'T OF JUSTICE & FED. TRADE COMM'N, ANTITRUST GUIDELINES FOR THE LICENSING OF INTELLECTUAL PROPERTY 7 (2017), https://www.ftc.gov/system/files/documents/public_statements/1049793/ip_guidelines_2017.pdf [hereinafter ANTITRUST GUIDELINES] ("While intellectual property licensing arrangements are typically welfare-enhancing and procompetitive, antitrust concerns may nonetheless arise.").

5. *See* FED. TRADE COMM'N, THE EVOLVING IP MARKETPLACE: ALIGNING PATENT NOTICE AND REMEDIES WITH COMPETITION 5, 22 (2011), https://www.ftc.gov/sites/default/files/documents/reports/evolving-ip-marketplace-aligning-patent-notice-and-remedies-competition-report-federal-trade/110307patentreport.pdf (discussing the effects on competition of patent notice and remedies); *see also* Richard A. Epstein, F. Scott Kieff & Daniel F. Spulber, *The FTC, IP, and SSOs: Government Hold-Up Replacing Private Coordination*, 8 J. COMPETITION L. & ECON. 1, 5–6 (2012) (discussing policy concerns about patent license markets).

concerns that complementary inventions could increase total patent license royalties and discourage innovation, often without empirical support.[6] Policy discussions also raise the issue of increased costs of coordination between patent holders and technology implementers.[7] Some policy analysts and researchers ask whether market institutions such as standards organizations are pro-competitive.[8] This article addresses these antitrust concerns and shows that market negotiation of patent licenses promotes competition and protects consumer welfare.

Practically all patent license agreements form through market negotiation, with the exception of licenses offered by patent pools. The present discussion develops a framework that examines market negotiation of patent license contracts with complementary inventions. The analysis shows that market negotiation between patent holders and technology implementers achieves economic efficiency with complementary inventions. The present study finds that market negotiation between technology providers and technology implementers promotes innovation and is pro-competitive.

The main insight is that negotiation in a competitive market generates total royalties that are strictly less than those of a bundled monopoly patent holder. Negotiation between patent holders and technology implementers avoids distortionary royalties from running royalties that are constant per unit of output and solves the multiple-marginalization problem. Royalties are contingent on prices in the product market, which accords with most observed royalty arrangements such as shares of sales

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6. *See* Kirti Gupta, *The Patent Policy Debate in the High-Tech World*, 9 J. COMPETITION L. & ECON. 827, 857 (2013) ("The empirical basis for some of the specific concerns raised, however, is decidedly mixed.").

7. *See id.* at 844–45 (noting that technology implementers need to reach "multiple independent licensing negotiations," which results in increased costs and lower margins); *see also* Michael Abramowicz, *The Danger of Underdeveloped Patent Prospects*, 92 CORNELL L. REV. 1065, 1068 (2007) (discussing ways that patent holders lack sufficient incentives to fully utilize their IP); Ted Sichelman, *Commercializing Patents*, 62 STAN. L. REV. 341 (2009) (same).

8. Damien Geradin & Miguel Rato, *Can Standard-Setting Lead to Exploitative Abuse? A Dissonant View on Patent Hold-Up, Royalty Stacking and the Meaning of FRAND*, 3 EUR. COMPETITION J. 101, 128–29 (2007) ("[W]hile the theoretical literature is fairly rich, the empirical literature testing the validity of the royalty stacking and anti-commons theories in the real world is sparse and often not very rigorous."); *see also* Jay P. Choi, *Standardization and Experimentation:* Ex Ante *vs.* Ex Post *Standardization*, 12 EUR. J. POL. ECON. 273 (1996) (analyzing when standardization yields optimal results).

revenues, lump-sum fees based on prices, profit shares, equity shares, options, milestones, cross-licensing, alliances, joint-venture agreements, and bundling of goods and services with intellectual property (IP). With competition, both the upstream market for patent license contracts and the downstream product market will be efficient. This, in turn, provides incentives for efficiency in invention, innovation, and standardization.

These conclusions have useful implications for antitrust policy toward patent licensing. The present analysis supports the joint position of the United States Department of Justice (DOJ), United States Patent and Trademark Office (USPTO), and National Institute for Standards and Technology (NIST) regarding the importance of negotiation for efficiency and patent licensing.[9] This joint Policy Statement points out that negotiation promotes efficiency for patent licensing generally and for licensing standard essential patents (SEPs) subject to Fair, Reasonable, and Non-Discriminatory (FRAND) Commitments.[10] The present analysis also supports a key principle set forth by the DOJ Antitrust Division and the Federal Trade Commission (FTC) Antitrust Guidelines: "intellectual property licensing allows firms to combine complementary factors of production and is generally procompetitive."[11]

Patent licensing with complementary inventions has raised four types of antitrust policy concerns that this article argues are misguided. These antitrust issues are as follows: (1) patent holders generate "royalty stacking" by choosing royalties that exceed what a bundling monopoly patent holder would charge; (2) patent holders engage in "SEP hold-up" by raising royalties to

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9. U.S. Patent & Trademark Office, U.S. Dep't of Justice, & Nat'l Inst. of Standards and Tech., Policy Statement on Remedies for Standards-Essential Patents Subject to Voluntary F/RAND Commitments (2019), https://www.uspto.gov/sites/default/files/documents/SEP%20policy%20statement%20signed.pdf [hereinafter Policy Statement].

10. *Id*. at 5 ("[G]ood faith in negotiations involving F/RAND commitments, supported by availability of data and application of best practices, can promote licensing efficiency, just as it can in negotiations involving commitments for patents that are not essential to standards.").

11. *See* U.S. DEP'T OF JUSTICE & FED. TRADE COMM'N, *supra* note 4, at 2. Additionally, the Agencies state: "(a) for the purpose of antitrust analysis, the Agencies apply the same analysis to conduct involving intellectual property as to conduct involving other forms of property, taking into account the specific characteristics of a particular property right; (b) the Agencies do not presume that intellectual property creates market power in the antitrust context . . . ." *Id.*

take advantage of adopters conforming to technology standards; (3) patent holders build "patent thickets," have "blocking patents," and cause the related "Tragedy of the Anti-Commons" because licensing complementary inventions creates coordination problems for adopters; and (4) to address these alleged problems, antitrust authorities should encourage patent holders to form what this article will term "regulatory patent pools" that address various public policy objectives.

These four misguided antitrust policy concerns are based on erroneous economic reasoning and inaccurate descriptions of markets and institutions. Despite this, these four antitrust concerns have been influential in agency policies and legal cases. "Royalty stacking" appears in antitrust agency reports[12] and prominent legal cases such as *Microsoft Corp. v. Motorola*, *Ericsson v. D-Link*, and *Unwired Planet v. Huawei*.[13] SEP and patent "hold-up" are cited in antitrust agency reports[14] and a large number of legal cases,[15] including *Ericsson v. D-Link*, *Huawei v. ZTE*, and *Unwired Planet v. Huawei*.[16] "Patent thickets" are discussed in various antitrust agency reports[17] and addressed by the Affordable Prescriptions for Patients (APP) Act proposed to the Senate in 2019 by Senators John Cornyn (R-TX) and Richard

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12. *See, e.g.*, U.S. DEP'T OF JUSTICE & FED. TRADE COMM'N, ANTITRUST ENFORCEMENT AND INTELLECTUAL PROPERTY RIGHTS: PROMOTING INNOVATION AND COMPETITION 8, 61 (2007), http://www.ftc.gov/reports/innovation/P040101PromotingInnovationandCompetitionrpt0704.pdf.

13. *See* Microsoft Corp. v. Motorola, Inc., No. C10-1823JLR, 2013 WL 2111217 (W.D. Wash. Apr. 25, 2013); Ericsson, Inc. v. D-Link Sys., Inc., 773 F.3d 1201 (Fed. Cir. 2014); Unwired Planet Int'l Ltd. v. Huawei Techs. Co. [2017] EWHC 711 (Pat).

14. *See, e.g.*, U.S. DEP'T OF JUSTICE & FED. TRADE COMM'N, *supra* note 12, at 8, 35 n.11; Fed. Trade Comm'n, The Evolving IP Marketplace: Aligning Patent Notice and Remedies with Competition 5, 22 (2011), https://www.ftc.gov/sites/default/files/documents/reports/evolving-ip-marketplace-aligning-patent-notice-and-remedies-competition-report-federal-trade/110307patentreport.pdf.

15. From 2007 to 2018 about 140 U.S. legal cases involving SEPs mention patent "hold-up." *See* J. Gregory Sidak, *Is Patent Holdup a Hoax?*, 3 CRITERION J. ON INNOVATION 401, 476–77 fig.3 (2018).

16. *Ericsson, Inc.*, 773 F.3d 1201; Case C-170/13, Huawei Technologies Co. v. ZTE Corp., ECLI:EU:C:2014:2391 (November 20, 2014); Unwired Planet Int'l Ltd. v. Huawei Techs. Co. [2017] EWHC 711 (Pat).

17. *See, e.g.*, FED. TRADE COMM'N, TO PROMOTE INNOVATION: THE PROPER BALANCE OF COMPETITION AND PATENT LAW AND POLICY 6 (2003), http://ftc.gov/os/2003/10/innovationrpt.pdf [hereinafter 2003 FTC IP Report]; Fed. Trade Comm'n, *supra* note 14, at 56.

Blumenthal (D-CT).[18] The World Intellectual Property Organization (WIPO) in an antitrust report states that "two mutually blocking patents are complementary from a legal point of view."[19] "Blocking patents" are considered in various cases such as *Acorda Therapeutics, Inc. v. Roxane Laboratories, Inc.*, decided in 2018.[20]

Finally, advocates urge antitrust policy makers to push for "regulatory patent pools" as a means of achieving public policy objectives.[21] The argument is that "regulatory patent pools" decrease royalties in comparison to the market for patent license agreements.[22] A USPTO report suggested biotechnology patent pools as solutions to "royalty stacking" and "blocking patents."[23]

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18. *Cornyn, Blumenthal Introduce Bill to Prevent Drug Companies from Abusing Patent System*, CORNYN.SENATE.GOV (May 9, 2019), https://www.cornyn.senate.gov/content/news/cornyn-blumenthal-introduce-bill-prevent-drug-companies-abusing-patent-system ("To help prevent drug companies from deliberately abusing the patent system, the *Affordable Prescriptions for Patients Act* would codify definitions of product hopping and patent thicketing within the Federal Trade Commission (FTC) Act."); Susannah Luthi & Sarah Owermohle, *'Patent Thicket' Bill Caught in Tug-of-War over Drug Pricing Reforms*, POLITICO (Oct. 25, 2019), https://www.politico.com/news/2019/10/25/patent-thicket-bill-caught-in-tug-of-war-over-drug-pricing-reforms-056858; Steve Brachmann, *Affordable Prescriptions for Patients Act Would Allow FTC to Prosecute Pharma Patent Thickets, Product Hopping*, IPWATCHDOG (May 20, 2019), https://www.ipwatchdog.com/2019/05/20/affordable-prescriptions-patients-act-allow-ftc-prosecute-pharmaceutical-patent-thickets-product-hopping/id=109384/.

19. WORLD INTELLECTUAL PROP. ORG., PATENT POOLS AND ANTITRUST—A COMPARATIVE ANALYSIS 4 (2014); *see also* Communication from the Commission, Guidelines on the Application of Article 101 of the Treaty on the Functioning of the European Union to Technology Transfer Agreements, 2014 O.J. (C 89) 10–11.

20. Acorda Therapeutics, Inc. v. Roxane Labs., Inc., 903 F.3d 1310 (Fed. Cir. 2018); *see also* Galderma Labs., L.P. v. Tolmar, Inc., 737 F.3d 731 (Fed. Cir. 2013); Merck & Co., Inc. v. Teva Pharm. USA, Inc., 395 F.3d 1364 (Fed. Cir. 2005); Merck Sharp & Dohme Corp. v. Hospira, Inc., 874 F.3d 724 (Fed. Cir. 2017).

21. *See* Richard J. Gilbert, *Ties That Bind: Policies to Promote (Good) Patent Pools*, 77 ANTITRUST L.J. 1, 4 (2010) ("I . . . propose policies that will promote the formation of beneficial patent pools . . . ."); Jorge L. Contreras, *Fixing FRAND: A Pseudo-Pool Approach to Standards-Based Patent Licensing*, 79 ANTITRUST L.J. 47, 54 (2013) (promoting the use of a "pseudo-pool" approach and noting that "relatively few standards have utilized pools, most likely because they require high startup costs and extensive planning.").

22. *See id.*, at 4 (noting that patent pools have the potential to "lower[] total royalties relative to independent licensing").

23. JEANNE CLARK ET AL., U.S. PATENT AND TRADEMARK OFFICE, PATENT POOLS: A SOLUTION TO THE PROBLEM OF ACCESS IN BIOTECHNOLOGY PATENTS?

The U.S. Antitrust Guidelines identify integrating complementary technologies and clearing blocking positions among the benefits of patent pools but generally focus on preventing anticompetitive effects of patent pools.[24] The European Union (EU), however, suggests both encouragement and the potential for regulation of complementary patent pools: "Measures to encourage the setting up of pools for key standardi[z]ed technologies should be encouraged, e.g. facilitating access to pool management offers and technical assistance by SDO [(standard developing organization)]. The European Commission will consider further measures if these efforts are ineffective in IoT sectors."[25]

The four misguided antitrust concerns appear to be very different at first, but they are all branches from the same tree. The common source is an economic model that is nearly two hundred years old.[26] The Cournot complementary monopolies model (the "Cournot model") makes a prediction known as the "Cournot Effect."[27] The "Cournot Effect" prediction is that total royalties with complementary inventions will be even greater than what a monopoly inventor would offer for a bundle of those inventions.[28] In short, the "Cournot Effect" involves price distortions worse than with a bundled monopoly.[29]

Many academic studies apply the Cournot model to the design of public policy toward patent licensing. The Cournot model and its prediction of the "Cournot Effect" are the economic basis

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8 (2000) ("A first benefit associated with the pooling of patents is the elimination of problems caused by 'blocking' patents or 'stacking' licenses.").

24. U.S. DEP'T OF JUSTICE & FED. TRADE COMM'N, *supra* note 4, at 30.

25. *Setting Out the EU Approach to Standard Essential Patents*, at 8, COM (2017) 712 final (Nov. 29, 2017); *see also* Communication from the Commission, *supra* note 19, at 45 ("Technology pools can produce pro-competitive effects, in particular by reducing transaction costs and by setting a limit on cumulative royalties to avoid double marginali[z]ation.").

26. AUGUSTIN COURNOT, RESEARCHES INTO THE MATHEMATICAL PRINCIPLES OF THE THEORY OF WEALTH, (Nathaniel T. Bacon trans., The Macmillan Company 1897) (1838). The Cournot complementary monopolies model is based on Cournot's output competition model in the same book; it simply relabels outputs as prices.

27. *See* Daniel F. Spulber, *Licensing Standard Essential Patents with FRAND Commitments: Preparing for 5G Mobile Telecommunications*, 18 COLO. TECH. L.J. 79, 138 (2020).

28. *See id.* ("Cournot's theoretical analysis shows that monopolists supplying complementary inputs to competitive downstream producers will choose prices whose total is greater than what a monopolist would charge for a bundle of those inputs. This inefficiency is known as the 'Cournot Effect.'").

29. *See id*.

for "royalty stacking,"[30] "SEP hold-up,"[31] "patent thickets,"[32] "blocking patents,"[33] and the "Tragedy of the Anti-Commons."[34] Various studies apply the Cournot model and the "Cournot Effect" to argue that patent pools would choose lower total royalties in comparison to market negotiation of patent license agreements.[35] Some studies recommend that antitrust authorities

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30. *See* Mark A. Lemley & Carl Shapiro, *Patent Holdup and Royalty Stacking*, 85 TEX. L. REV. 1991, 2013 (2007); Richard Schmalensee, *Standard-Setting, Innovation Specialists and Competition Policy*, 57 J. INDUS. ECON. 526, 530 (2009); Yann Meniere & Sarah Parlane, *Decentralized Licensing of Complementary Patents: Comparing the Royalty, Fixed-Fee and Two-Part Tariff Regimes*, 22 INFO. ECON. & POL'Y 178, 178 (2010); Jorge L. Contreras, *Standards, Royalty Stacking, and Collective Action*, CPI ANTITRUST CHRON., Mar. 2015, at 2–3; Gastón Llanes & Joaquín Poblete, Ex Ante *Agreements in Standard Setting and Patent-Pool Formation*, 23 J. ECON. & MGMT. STRATEGY 50, 51 (2014).

31. *See* Joseph Farrell et al., *Standard Setting, Patents, and Hold-Up*, 74 ANTITRUST L.J., 603, 641–42 (2007); Josh Lerner & Jean Tirole, *Standard-Essential Patents*, 123 J. POL. ECON. 547, 574 (2015); A. Douglas Melamed & Carl Shapiro, *How Antitrust Law Can Make FRAND Commitments More Effective*, 127 YALE L.J. 2110, 2138–39 (2017). A study of land sales obtains the "Cournot Effect" without citing Cournot's model. *See* Wolfgang Eckart, *On the Land Assembly Problem*, 18 J. URB. ECON. 364, 371 (1985) ("[C]omplementarity of the traded goods reverses the conclusions drawn from standard oligopoly theory: collusion turns out to be socially desirable in so far as it favors both sides of the market.").

32. *See* Carl Shapiro, *Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard Setting*, *in* 1 INNOVATION POL. & ECON. 119, 122–24 (Adam B. Jaffe et al. eds., 2001); Ian Ayres & Gideon Parchomovsky, *Tradable Patent Rights*, 60 STAN. L. REV. 863, 872 (2007) ("[P]atent thickets present a classic complements problem.").

33. See Carl Shapiro, *Antitrust Limits to Patent Settlements*, 34 RAND J. ECON. 391, 396–97 (2003); Jay Pil Choi, *Patent Pools and Cross-Licensing in the Shadow of Patent Litigation*, 51 INT'L ECON. REV. 441, 447–48 (2010).

34. *See* James Buchanan & Yong J. Yoon, *Symmetric Tragedies: Commons and Anticommons*, 43 J.L. & ECON. 1, 5–10 (2000) (presenting a geometric-algebraic model that shows the non-realized economic value inherent in the anticommons problem is analogous to the "Cournot Effect"); Paul A. David, *Mitigating "Anticommons" Harms to Science and Technology Research*, 2 WIPO J. 59, 62 (2010).

35. *See* Shapiro, *supra* note 32, at 134 ("In many respects, a patent pool . . . is the purest solution to the complements problem . . . ."); Richard J. Gilbert, *Antitrust for Patent Pools: A Century of Policy Evolution*, 2004 STAN. TECH. L. REV. 3; Gilbert, *supra* note 21, at 21–22. *C.f.* Atsushi Kato, *Patent Pool Enhances Market Competition*, 24 INT'L REV. L. & ECON. 255, 266 (2004) (arguing that a patent pool of substitute patents may raise social welfare, presenting a slight variation on the "Cournot Effect"); Sung-Hwan Kim, *Vertical Structure and Patent Pools*, 25 REV. INDUS. ORG. 231, 248 (2004) (applying the "Cournot model" to the analysis of the interaction between vertically integrated firms and patent pools to conclude it leads to the reductions of double marginalization and lowers incentive to raise rivals' costs); Josh Lerner & Jean Tirole, *Public Policy*

promote "regulatory patent pools" as a means of controlling patent license royalties and imposing arbitrary technology benchmarks.[36] Gilbert states that "antitrust authorities and the courts should encourage policies that promote the formation and durability of beneficial pools that combine complementary patents . . . ."[37] Contreras calls for the formation of pseudo patent pools that would choose patent royalties before technology standards are established.[38]

This article shows that the "Cournot Effect" should not be used as a basis for antitrust policy toward patent licensing. The Cournot model makes several unrealistic and extreme assumptions about markets and institutions. These assumptions are highly misleading in the context of patent licensing. The Cournot model assumes that patent holders set license royalties through

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Toward Patent Pools, 8 INNOVATION POL'Y & ECON. 157, 177 (2007); Steffen Brenner, *Optimal Formation Rules for Patent Pools*, 40 ECON. THEORY 373, 374 (2009); Vianney Dequiedt & Bruno Versaevel, *Pools and the Dynamic R&D Incentives*, 36 INT'L REV. L. & ECON. 59, 66 (2013) (showing patent pools stimulate research and development and accelerate the rate at which essential technologies reach market and benefit consumers); Josh Lerner & Jean Tirole, *Efficient Patent Pools*, 94 AM. ECON. REV. 691, 706 (2004) (arguing that patent pools increase welfare if patents are complimentary); Choi, *supra* note 33, at 447; Llanes & Poblete, *supra* note 30, at 63 (finding that patent pools formed after a standard is chosen may negatively impact welfare even when complimentary); Gastón Llanes & Stefano Trento, *Patent Policy, Patent Pools and the Accumulation of Claims*, 50 ECON. THEORY 703, 706 (2012) (explaining that pools of complementary patents increase welfare with "endogenous innovation"); Klaus Schmidt, *Standards, Innovation Incentives, and the Formation of Patent Pools* (GESY, Working Paper No. 342, 2010), http://www.sfbtr15.de/uploads/media/342.pdf ("[P]atent pools can play an important role in lowering royalties, reducing transaction costs, disseminating new technologies, and fostering innovation incentives."); Klaus Schmidt, *Complementary Patents and Market Structure*, 23 J. ECON. & MGMT. STRATEGY 68, 70 (2014) ("We conclude that the current shift in U.S. competition policy to permit patent pools for complementary patents is a move in the right direction.").

36. *See* Shapiro, *supra* note 32, at 123 ("This basic theory of complements (used in fixed proportions) gives strong support for businesses to adopt, and for competition authorities to welcome, either cross licensees, package licenses, or patent pools to clear such blocking positions."); Gilbert, *supra* note 21, at 45. *C.f.* Contreras, *supra* note 21, at 94 ("This proposal calls for the encouragement of joint ex ante negotiation of royalty rates prior to lock-in of a standard, conduct that has been viewed favorably by several regulatory agencies and acknowledged as offering various procompetitive benefits.").

37. Gilbert, *supra* note 21, at 45.

38. Contreras, *supra* note 21, at 63.

"take-it-or-leave-it" pricing.[39] The Cournot model assumes that royalties are constant per unit of output, ruling out lump-sum payments and various contingent arrangements.[40] The Cournot model assumes that the product market has 100% cost pass-through because it assumes that market supply is infinitely elastic.[41] The Cournot model further assumes that patent holders have 100% market power in the market for patent licenses and in the downstream product market.[42] This combination of implausible assumptions generates the "Cournot Effect."[43]

The present analysis shows that negotiation in a competitive market eliminates, and indeed reverses, the "Cournot Effect." Market negotiation of patent license agreements removes the basis for "royalty stacking," "SEP hold-up," "patent thickets," and the "Tragedy of the Anti-Commons." Market negotiation of patent licenses also obviates the need for antitrust authorities to promote "regulatory patent pools" as a means of solving these alleged antitrust problems. The market negotiation framework presented here holds generally for any cost pass-through of less than 100% and for any patent holder bargaining power of less than 100%. The predictions of the market negotiation framework conform much more closely to observed market outcomes than the Cournot model.

Antitrust policy concerns based on the "Cournot Effect" are misguided because the underlying economic analysis does not apply to markets for patent licensing. In addition, the predicted "Cournot Effect" offers highly inaccurate descriptions of the market for patent licenses. Antitrust policy should be based on economic models that are consistent with market institutions and reflect empirical analysis of market conditions. Antitrust policy

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39. *See* Spulber, *supra* note 27, at 138 ("The theoretical 'Cournot Effect' is the result of assuming that complementary monopolists offer take-it-or-leave-it prices to producers.").

40. *See* Daniel F. Spulber, *Finding Reasonable Royalty Damages: A Contract Approach to Patent Infringement*, 2019 U. ILL. L. REV. 615, 696 ("[T]he 'Cournot Effect' is based on the assumption that complementary input monopolists choose 'posted prices.' This means that the input monopolists announce prices that they will charge to downstream producers.'").

41. *See* Daniel F. Spulber, *Complementary Monopolies and Bargaining*, 60 J.L. & ECON. 29, 42 (2017) ("In Cournot's model, input suppliers choose prices r_i (i = 1, . . . , n), and downstream producers choose how much of the inputs to purchase.").

42. *See id.*

43. *See generally* COURNOT, *supra* note 26 (establishing the economic principle of the "Cournot Effect").

should recognize that patent license agreements are formed through negotiation rather than "take-it-or-leave-it" prices. Antitrust policy also should recognize that the market power of patent holders is less than 100% and cost-pass through for royalties is less than 100%.

Table 1 summarizes the discussion. The discussion is organized as follows. Section II examines why patent license agreements are negotiated and considers how negotiation affects the provisions of patent license agreements. Section III explains the Cournot model and shows how its application to patent licensing is misleading for antitrust policy. Section IV examines the antitrust policy implications of negotiation in the market for patent licensing. Section V concludes the discussion.

	FRAMEWORK NEGOTIATION **Bilateral negotiation of patent license contracts**	**FRAMEWORK TAKE-IT-OR-LEAVE-IT PRICING** **Cournot complementary monopolies model applied to patent licensing**
ANTITRUST POLICY **Antitrust policy toward patent licensing**	Reverses "Cournot Effect" Total royalties are less than a bundling monopolist patent holder. Royalties and prices are efficient.	"Cournot Effect" (1) "Royalty stacking", (2) "SEP holdup", (3) "Patent thickets", "Blocking patents", "Tragedy of the Anti-Commons".
ANTITRUST POLICY **Antitrust policy toward patent pools**	Neutral policy Patent pools offer total royalties that are less than a bundling monopolist patent holder. Patent pools serve to mitigate transaction costs.	(4) Encourage "regulatory patent pools" Patent pools offer total royalties that are the same as a bundling monopolist patent holder.

Table 1. Antitrust policies toward patent licensing and patent pools

II. NEGOTIATION OF PATENT LICENSE AGREEMENTS

Practically all patent license agreements are negotiated, with the exception of those offered by patent pools. This section examines why patent license agreements are negotiated and introduces a negotiation framework. The analysis shows that negotiated patent license agreements are efficient in competitive markets. With complementary inventions, total royalties are less than what a bundled monopoly inventor would offer. The discussion also explains that patent pools serve to mitigate transaction costs.

A. WHY PATENT LICENSE AGREEMENTS ARE NEGOTIATED

Patent license agreements require negotiation because they are contracts between patent holders and technology adopters.[44] Patent license agreements resist standardization because the provisions of the contract are tailored to the characteristics and requirements of the parties.[45] Each patent licensing agreement includes rights and obligations specific to the combination of the licensor and licensee.[46] This explains the considerable variation across patent license agreements.[47]

Technology provides another source of variation across patent license agreements. The patented technology is necessarily unique to the patent holder because inventions must be novel

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44. *See* Daniel F. Spulber, *Intellectual Contract and Intellectual Law*, 23 J. TECH. L. & POL'Y 1, 18 (2018) ("Through [Intellectual Contracts] such as licensing agreements, patent holders and technology adopters determine how technology will be applied. Firms require [Intellectual Contracts] to form agreements with employees, suppliers, partners, distributors, investors, and customers."); Spulber, *supra* note 40, at 620 ("[A] patent license agreement is a *contract*.") (emphasis original).

45. Raymond C. Nordhaus, *Patent License Agreements*, 21 BUS. LAW. 643, 643 (1966) ("Because of the infinite variety of rights and obligations that may be established between a patent licensor and his licensee, there is no 'standard' form of license agreement that may be used in all situations. Each license agreement must be carefully tailored to the specific circumstances of the particular case.").

46. *See generally* ANATOLE KRATTIGER ET AL., *Contracts and Agreements to Support Partnerships*, *in* GUIDE TO INTELLECTUAL PROPERTY MANAGEMENT IN HEALTH AND AGRICULTURAL INNOVATION: A HANDBOOK OF BEST PRACTICES (2007), www.ipHandbook.org (explaining contracting and appropriate provisions for intellectual property).

47. *See* Christian Bessy & Eric Brousseau, *Technology Licensing Contracts: Features and Diversity*, 18 INT'L REV. L. & ECON. 451, 470 (1998).

and non-obvious.[48] The benefits from applying that unique technology likely will vary across adopters because adopters operate different businesses. This implies that the combination of the licensor's technology with the licensee's application and business characteristics is likely to produce unique outcomes and variation across patent license agreements.

Negotiation is required because the purpose of the agreement is to maximize the parties' gains from trade generated by the technology transfer.[49] These gains from trade depend on the characteristics of the technology provided by the patent holder and the profit generated by the adopter's application of the technology.[50] Ronald Coase emphasized that negotiation allows parties to reach efficient agreements by adjusting for the allocation of property ownership and legal constraints.[51] The parties to patent license agreements adjust for the allocation of intellectual property (IP) and the effects of patent law and other regulatory restrictions.

Further, negotiation of patent license agreements is necessary because these licenses are contracts rather than immediate transactions.[52] The adoption and application of technology takes time. It takes time for technology adopters to obtain market returns to innovation. The technology adopter may need to invest resources to understand and absorb the new technology.[53] This can involve hiring and training employees, investing in capital

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48. 35 U.S.C. §§ 101–103 (2018).

49. *See* ANATOLE KRATTIGER ET AL., *Technology and Product Licensing*, *in* GUIDE TO INTELLECTUAL PROPERTY MANAGEMENT IN HEALTH AND AGRICULTURAL INNOVATION: A HANDBOOK OF BEST PRACTICES (2007), www.ipHandbook.org.

50. *C.f.* Daniel F. Spulber, *How Patents Provide the Foundation of the Market for Inventions*, 11 J. COMP. L. & ECON. 271, 291 (2015) ("The interaction of demand and supply in the market for innovation control determines the market value of inventions. Inventors compete to supply producers with inventions, and producers compete to obtain inventions or develop their own inventions. The market value of an invention reflects competition from both substitute and complementary inventions on the supply side of the market for inventions. The market value of inventions depends on the stock of inventions and anticipation of future discoveries that may enhance the demand for particular inventions or render those inventions obsolete.").

51. Ronald Coase, *The Problem of Social Cost*, 3 J.L. & ECON. 1, 8 (1960).

52. *See, e.g.,* ANATOLE KRATTIGER ET AL., *supra* note 46, at 85.

53. *See* Daniel F. Spulber, *Tacit Knowledge with Innovative Entrepreneurship*, 30 INT'L J. INDUS. ORG. 641, 644 (2012).

equipment, and acquiring complementary technologies.[54] The technology adopter may develop inventions that are complementary to the transferred technology. The technology adopter may also develop innovations that apply the transferred technology. The technology adopter may realize the revenues and cost savings from the new technology over some period of time.

Because application of the technology takes time, the provisions of the patent license agreement typically reflect repeated interactions in the context of the business relationship between the patent holder and the technology implementer. Radauer and Dudenbostel emphasize the need for negotiation because "considerable interaction must take place between licensors and licensees, on a bilateral and rather informal level."[55] Krattiger et al. observe that, "[i]n sum, licensing is about the development of relationships. As important as the terms of agreements are, few are more important than the long-term opportunities offered by forging good partnerships . . . . Negotiating an agreement is just the beginning of what may—or should—become a long-lasting and beneficial relationship."[56]

Application of inventions involves risk because the properties of new technologies are not fully understood. The combination of inventions to generate innovative products involves various types of risk as well.[57] There are risks involved in the designing of new products, developing new production processes, and using new transaction methods.[58] The market risks of

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54. Spulber, *supra* note 50, at 295 ("The market for innovative control also provides incentives to invest efficiently in complementary assets. Assets that are complementary to inventions include human resources, absorption of inventions, IP, product design, capital equipment, marketing, sales, procurement, and establishment of new firms.").

55. ALFRED RADAUER & TOBIAS DUDENBOSTEL, EUROPEAN COMMISSION, EUR 26114 EN PATLICE SURVEY: SURVEY ON PATENT LICENSING ACTIVITIES BY PATENTING FIRMS 51 (2013), http://ec.europa.eu/research/innovation-union/pdf/patlice-survey.pdf.

56. ANATOLE KRATTIGER ET AL., *supra* note 46, at 128.

57. *Cf.* F. Scott Kieff, *Property Rights and Property Rules for Commercializing Inventions*, 85 MINN. L. REV. 697, 703 (2001) ("[T]he treatment of patents as property rights is necessary to facilitate investment in the complex, costly, and risky commercialization activities required to turn nascent inventions into new goods and services.").

58. *Cf. id*. at 707–08 ("The invention must be developed into some commercial embodiment. Capital may have to be raised. Production facilities and labor must be made available. Distribution channels must be created. Consumers must be educated about the existence and benefits of this new good or service.").

introducing innovations can be greater than for existing products, production processes, and transaction methods.[59]

Negotiation of patent licensing agreements is necessary because licensing often occurs where invention meets innovation. There is empirical evidence for complementarities between internal research and development (R&D) and the acquisition of external knowledge.[60] The IP owner provides inventions created through R&D.[61] The IP adopter provides applications for the inventions and complementary assets.[62] Innovation occurs when the application of invention introduces something new to the market.[63]

Patent license contracts are the basis of the "market for innovative control."[64] Patent holders not only receive returns to their inventions but also exercise control over how the invention will be improved, commercialized, applied in innovation, and used in production.[65] Ownership of assets includes both financial returns and control rights.[66] The same applies to IP.[67] Patent

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59. *Id*. at 708–09 (noting that later entrants to the market frequently bear less risk).

60. *See* Ashish Arora & Alfonso Gambardella, *Complementarity and External Linkages: The Strategies of the Large Firms in Biotechnology*, 38 J. INDUS. ECON. 361, 373–74 (1990); Iain M. Cockburn & Rebecca M. Henderson, *Absorptive Capacity, Coauthoring Behavior and the Organization of Research in Drug Discovery*, 46 J. INDUS. ECON. 157, 158 (1998); Marco Ceccagnoli et al., *Productivity and the Role of Complementary Assets in Firms' Demand for Technology Innovations*, 19 INDUS. & CORP. CHANGE 839, 863–64 (2010); Marco Ceccagnoli et al., *Behind the Scenes: Sources of Complementarity in R&D*, 23 J. ECON. & MGMT. STRATEGY 125, 144 (2014); Bruno Cassiman & Reinhilde Veugelers, *In Search of Complementarity in Innovation Strategy: Internal R&D and External Knowledge Acquisition*, 52 MGMT. SCI. 68, 80 (2006).

61. *See* Spulber, *supra* note 50, at 297 ("Inventors create inventions by applying effort, knowledge, ingenuity, capabilities, insights, and scientific observations. If R&D is successful, the discovery may be valuable in commercial applications or as an input to further R&D.").

62. *See id*. at 294 ("The market for innovative control also allows the entry of specialized intermediaries who can invest in commercialization, innovation, and complementary assets.").

63. *See* Marshall Leaffer, *Patent Misuse and Innovation*, 10 J. HIGH TECH. L. 142, 142 (2010) ("Innovation therefore differs from invention. It includes not only the initial discovery or the creation of potential new products or processes, but also their subsequent development and commercialization.") (citations omitted).

64. *See* Spulber, *supra* note 50, at 274.

65. *See id*.

66. *See id*. at 290.

67. *See id*. at 290–91.

holders receive returns from licensing and their own use.[68] Patent holders also have rights of control.[69] For this reason, the market value of a patent reflects both financial returns and control rights.[70] The price of transferred patents reflects the value of financial returns and control rights.

The licensor delegates some innovative control to the licensee. The patent licensing contract grants rights to practice the invention to the licensee.[71] The patent licensing contract specifies consideration, usually in the form of patent royalties to the licensor.[72] Consideration is based on the IP adopter's expected returns from innovation.[73] The IP owner also may innovate by making improvements on the invention.[74] The interaction between invention and innovation through patent licensing contracts has a number of implications.[75]

Companies that are patent holders occasionally make announcements regarding expected royalties, but these announcements usually are initial bargaining positions that differ substantially from the outcomes of negotiations between patent owners and producers.[76] Stasik observes that "an 'announced' royalty rate may be significantly different than the 'actual' royalty rate resulting from a bi-lateral negotiation. Having made a public announcement, a potential licensee might reasonably expect this to be the opening offer in a negotiation. That is all that should be assumed from these announcements."[77] In discussing LTE royalties, Stasik predicts that "[t]hose companies who have negotiation power will pay less—the best ones will pay much

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68. *Id*. at 290.

69. *Id*.

70. *See id*. at 290–93.

71. *Id*. at 295 ("[T]he market for innovative control allows separation of ownership and control. The patent owner can obtain returns from the patented invention while delegating control over innovation to licensees who employ the technology.").

72. *See* Gerard Llobet & Jorge Padilla, *The Optimal Scope of the Royalty Base in Patent Licensing*, 59 J.L. & ECON. 45, 45 (2016).

73. *See* Spulber, *supra* note 40, at 618.

74. *See* Spulber, *supra* note 50, at 274.

75. *See generally* Spulber, *supra* note 50 (discussing how patents and patent licensing creates a "market of inventions" that includes the various methods of innovating based on the patented inventions).

76. *See* Eric Stasik, *Royalty Rates and Licensing Strategies for Essential Patents on LTE (4G) Telecommunication Standards*, 2010 NOUVELLES 114, 116–17 (2010).

77. *Id*. at 116–117.

less."[78] Bargaining power is an important determinant of patent license royalties.[79]

Negotiation of patent license contracts is necessary because new business agreements require creativity. Goldscheider's guide to negotiating IP license agreements suggests that such agreements "should be creative in both organization and structure."[80] Goldscheider finds that "by combining resources from several aspects of various intra-party business dealings, practitioners can frequently generate greater income for both parties to a negotiation."[81] He argues that royalty rates should not be standardized because "royalties are essentially an expression of underlying contemplated profitability."[82] Goldscheider warns that that "a 'bad' royalty standard drives out innovation in industry."[83]

There is considerable empirical evidence that parties negotiate IP license contracts. The World Intellectual Property Organization (WIPO) and the International Trade Centre (ITC) provide a training manual ("WIPO Manual") that is devoted to license negotiation.[84] Referring to the royalty rate in license agreements, the WIPO Manual states "[i]t is important that the rate results in a good business proposition for both parties, and so negotiation of the royalty rate is fundamental to the success of the agreement."[85] The WIPO manual further observes "[a] successful ongoing relationship is based on a contract with mutually acceptable terms. In this context, the importance of negotiation cannot be underestimated."[86] The WIPO manual points out that negotiating a technology licensing agreement is an art.[87]

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78. *Id.*

79. Mariko Sakakibara, *An Empirical Analysis of Pricing in Patent Licensing Contracts*, 19 INDUS. & CORP. CHANGE 927, 927–45 (2010).

80. Robert Goldscheider, *The Negotiation of Royalties and Other Sources of Income from Licensing*, 36 IDEA 1, 1 (1995).

81. *Id.*

82. *Id.* at 16.

83. *Id.* at 16 n.6.

84. WORLD INTELL. PROP. ORG. & INT'L TRADE CTR., EXCHANGING VALUE, NEGOTIATING TECHNOLOGY LICENSING AGREEMENTS: A TRAINING MANUAL (WIPO publication No. 906(E), Jan. 2005).

85. *Id.* at 57.

86. *Id.* at 10.

87. *Id.* at 82 ("Negotiating a technology licensing agreement is the art of reaching an agreement where the licensor grants and the licensee acquires the right to use the licensor's technology on specified terms and conditions.").

The European Patent Office (EPO) Handbook for Inventors explains in great detail how to negotiate licensing agreements.[88] Significantly, the EPO handbook does not offer any discussion of "take-it-or-leave-it" royalties or standardized contracts. According to the EPO, negotiation of a licensing agreement usually involves two stages.[89] First, the "heads of agreement" stage identifies the terms and conditions of the agreement.[90] Second, at the full agreement stage, the parties prepare the legal agreement based on the heads of agreement.[91]

Although the parties to a licensing agreement negotiate royalties, these are but one aspect of the agreement. The main focus of licensing contracts is on maximizing mutual benefits; the royalties are a way of dividing those benefits. As Goldscheider points out, "royalty rates are merely expressions, or mechanical forms of calculation, employed by parties when making decisions or assumptions based upon profitability."[92] According to Schroeder,

> [i]n reality, most royalties represent an effort to divide between the licensee and the licensor the expected profit on the licensed product above the usual profit of the licensee on products of this type. When the advantage of the invention is a cost savings for the licensee (common in the case of a licensed process), the royalty represents a division of the savings.[93]

Epstein and Malherbe also emphasize that royalties are negotiated and observe that negotiated royalties depend on the availability of alternatives and design-arounds, cost savings, and investment in commercialization and innovation.[94] They point out that negotiated royalties "may be part of a complex transaction that includes joint licensing of other patents (*i.e.*,

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88. *Negotiating a Licensing Agreement*, EUR. PAT. OFF., https://www.epo.org/learning/materials/inventors-handbook/dealing-with-companies/licensing.html (last visited Sept. 2, 2016).

89. *Reaching Agreement*, EUR. PAT. OFF., https://www.epo.org/learning/materials/inventors-handbook/dealing-with-companies/agreement.html (last visited Sept. 2, 2016).

90. *Id*.

91. *Id*.

92. Goldscheider, *supra* note 80, at 1.

93. Robert A. Schroeder, *Licensing of Rights to Intellectual Property*, 50 ALB. L. REV. 455, 460 (1986).

94. Roy J. Epstein & Paul Malherbe, *Reasonable Royalty Patent Infringement Damages After* Uniloc, 39 AIPLA Q.J. 3, 8 (2011).

patent pooling), cross-licenses, know-how, and/or product support."[95]

Some attribute negotiation of IP license agreements to the need for further development of markets for IP. IBM has been a leading recipient of U.S. patents for almost 25 years.[96] IBM's chief patent counsel, Manny Schecter, observes that "it's the leverage we are able to get from the patent [licensing] negotiations."[97] Schecter asks,

> [w]hat if there were no Kelley Blue Book for used cars[?] . . . If the marketplace for used cars were the same as the market for patents it would be very frustrating. We tolerate this in the IP marketplace because we are in the early stages of the development of the marketplace. What must it have been like 50 years ago when you would buy a used car? The amount of information available for the ordinary person was pretty slim.[98]

Schecter explains that "he doesn't expect full transparency because licensing negotiations and litigation settlements go on privately."[99]

Negotiation also is a fundamental element of cross licensing for IBM. For example, IBM entered into a cross licensing deal with Western Digital in 2016.[100] According to William LaFontaine, general manager of intellectual property for IBM, "[t]his agreement with Western Digital illustrates the value of patented IBM inventions and demonstrates our leadership in licensing access to our broad patent portfolio. We look forward to a productive relationship with Western Digital."[101]

Nonprofit institutions also negotiate patent license agreements. A study of university licensing by Siegel et al. observes

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95. *Id*.

96. Daryl K. Taft, *IBM Inks Patent Cross-License Deal with Western Digital*, EWEEK (Jan. 25, 2016), https://www.eweek.com/it-management/ibm-inks-patent-cross-license-deal-with-western-digital.

97. Khurram Aziz, *The Most Innovative Firm in the World: IBM's Patent Strategy*, INTELL. PROP. MAG. (Feb. 1, 2012), https://www.intellectualpropertymagazine.com/patent/the-most-innovative-firm-in-the-world-ibm-s-patent-strategy-90180.htm.

98. Gene Quinn, *IBM's Formula for Success: Patents, Patents and More Patents*, IP WATCHDOG (Jan. 11, 2012), https://www.ipwatchdog.com/2012/01/11/ibms-formula-for-success-patents-patents-and-more-patents/id=21722/.

99. *Id*.

100. *See* Darryl K. Taft, *supra* note 96 (discussing generally the patent deal between IBM and Western Digital).

101. Taft, *supra* note 96.

that once a patent has been awarded, the technology transfer office (TTO) markets the technology to potential corporate licensees: "The next stage of the model involves working with firms or entrepreneurs to negotiate a licensing agreement."[102] Jensen and Thursby find that auctions are not a good description of licensing by universities because TTOs experience difficulties in locating licensees for early stage inventions, which is what is usually licensed by universities.[103]

Government agencies also negotiate patent license agreements. For example, the National Aeronautics and Space Administration (NASA) negotiates royalties for all of its licenses: "All NASA licenses are individually negotiated with the prospective licensee, and each license contains terms concerning transfer (practical application), license duration, royalties, and periodic reporting."[104] At the Department of Energy, the Agreement for Commercializing Technology (ACT) allows contractors who operate government-owned laboratories "to negotiate terms and conditions that are more consistent with private industry practice, such as IP rights, payment arrangements, indemnification, and development of multi-party R&D partnerships."[105]

The Courts recognize that patent license agreements are negotiated. The Courts often calculate reasonable royalty damages from patent infringement based on the hypothetical negotiation between a willing licensor and a willing licensee. The hypothetical negotiation framework is inconsistent with evidence because it is based on conjectures about what the parties would have expected before infringement began.[106] Imagining a hypothetical negotiation imposes an impossible burden on the court because it must construct expectations that would not have been available even to the parties involved. Rather, the reasonable royalty

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102. Donald S. Siegel et al., *Toward a Model of the Effective Transfer of Scientific Knowledge from Academicians to Practitioners: Qualitative Evidence from the Commercialization of University Technologies*, 21 J. ENG'G & TECH. MGMT. 115, 118 (2004).

103. Richard Jensen & Marie Thursby, *Proofs and Prototypes for Sale: The Licensing of University Inventions*, 91 AM. ECON. REV. 240, 245 (2001).

104. *How to License an Ames Patent or Patent Application*, NASA, https://technology-arc.ndc.nasa.gov/licensing (last visited Aug. 24, 2014).

105. NAT'L INST. STANDARDS & TECH., RETURN ON INVESTMENT INITIATIVE FOR UNLEASHING AMERICAN INNOVATION 61 n.158 (Apr. 2019), https://doi.org/10.6028/NIST.SP.1234.

106. Daniel F. Spulber, *Finding Reasonable Royalty Damages: A Contract Approach to Patent Infringement*, 2019 U. ILL. L. REV. 615, 656 (2019).

damages should be based on constructing an "informed contract" applying the evidence uncovered by the patent case.[107] The "informed contract" reflects the characteristics of the parties in the patent dispute, the extent of the infringement, and the patents having been found to be valid and infringed upon.[108]

Many legal decisions emphasize negotiation of patent license agreements. The influential *Georgia-Pacific* case sets forth fifteen factors that might be used to estimate royalties from a hypothetical negotiation.[109] The last factor recognizes that royalties are established through negotiation:

> The amount that a licensor (such as the patentee) and a licensee (such as the infringer) would have agreed upon (at the time the infringement began) if both had been reasonably and voluntarily trying to reach an agreement; that is, the amount which a prudent licensee — who desired, as a business proposition, to obtain a license to manufacture and sell a particular article embodying the patented invention — would have been willing to pay as a royalty and yet be able to make a reasonable profit and which amount would have been acceptable by a prudent patentee who was willing to grant a license.[110]

Judge Tenney points out that patent license negotiation takes place within the context of market forces.[111] The *Georgia Pacific* factors include the other terms of the contract and the characteristics of the licensor and the licensee.[112]

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107. *Id.* at 623.

108. *Id.*

109. *See* Ga.-Pac. Corp. v. U.S. Plywood Corp., 318 F. Supp. 1116, 1120 (S.D.N.Y. 1970).

110. *Id.* at 1120 (Tenney, J.) ("The rule is more a statement of approach than a tool of analysis. It requires consideration not only of the amount that a willing licensee would have paid for the patent license but also of the amount that a willing licensor would have accepted. What a willing licensor and a willing licensee would have agreed upon in a supposititious negotiation for a reasonable royalty would entail consideration of the specific factors previously mentioned, to the extent of their relevance.").

111. *Id.* at 1121 (Tenney, J.) ("Where a willing licensor and a willing licensee are negotiating for a royalty, the hypothetical negotiations would not occur in a vacuum of pure logic. They would involve a market place confrontation of the parties, the outcome of which would depend upon such factors as their relative bargaining strength; the anticipated amount of profits that the prospective licensor reasonably thinks he would lose as a result of licensing the patent as compared to the anticipated royalty income; the anticipated amount of net profits that the prospective licensee reasonably thinks he will make; the commercial past performance of the invention in terms of public acceptance and profits; the market to be tapped; and any other economic factor that normally prudent businessmen would, under similar circumstances, take into consideration in negotiating the hypothetical license.").

112. *Id.* at 1120.

Negotiation of patent license contracts is the primary means of settling patent disputes. Lanjouw and Schankerman find that 95% of patent disputes are settled out of court.[113] The terms of the patent license agreement depend on various factors including legal costs, reasonable royalty damages for patent infringement, and the likelihood that an infringement lawsuit will be successful.[114] Kesan and Ball observe, "[o]bviously, an out-of-court negotiation of a licensing agreement is similar to a negotiation of a settlement agreement once the case has been filed."[115]

Implementers of technology standards often must negotiate licenses with many holders of SEPs. Combining complementary inventions entails substantial coordination costs.[116] Creating complex innovations requires technology providers and implementers to engage in many interrelated market transactions.[117] Producer profits depend on the provisions of multiple IP contracts.[118] Also, the technical specifications of parts, components, products, and services must allow compatibility and interoperability.[119] To address these coordination costs, industries establish standards organizations and create technology standards.[120]

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113. Jean O. Lanjouw & Mark Schankerman, *Protecting Intellectual Property Rights: Are Small Firms Handicapped?*, 47 J.L. ECON. 45, 48 (stating that "lowering the cost of enforcement is the fact that postfiling settlement rates are high (about 95 percent) and that most settlement occurs soon after the suit is filed, often before the pretrial hearing is held.").

114. Jay P. Kesan & Gwendolyn G. Ball, *How Are Patent Cases Resolved? An Empirical Examination of the Adjudication and Settlement of Patent Disputes*, 84 WASH. U.L. REV. 237, 243 (2006) (stating that in deciding whether to litigate or license, economic theory favors weighing various factors to determine potential costs and benefits).

115. *Id.* at 254.

116. Gupta, *supra* note 6, at 844–45 (discussing how complex technologies involve negotiating multiple licenses which may increase transaction costs).

117. *Id.* at 844 ("[I]t is widely understood that the nature of complex technologies involves many patents owned by different parties reading on single product.").

118. *Id.* (discussing the effects of "royalty stacking" on downstream manufacturers of complex technologies).

119. Daniel F. Spulber, *Innovation Economics: The Interplay Among Technology Standards, Competitive Conduct, and Economic Performance*, 9 J. COMP. L. & ECON. 777, 788–90 (2013) (explaining the economic benefits and desirability of modularity in technological systems and that interoperability is necessary to modularity).

120. *See* Daniel F. Spulber, *Licensing Standard Essential Patents with FRAND Commitments: Preparing for 5G Mobile Telecommunications*, 18.1 COLO. TECH. L.J. 79, 82–83 (2020) (stating that industries create Standard

Negotiation is the basis of the requirement that holders of standard essential patents (SEPs) license on terms that are "Fair, Reasonable And Non-Discriminatory" (FRAND). Standard setting organizations (SSOs) require SEP holders to commit to licenses on terms that are FRAND as a condition for including their patents in technology standards.[121] SSOs include standard development organizations (SDOs), umbrella organizations, and industry consortia.[122] SSOs do not spell out the meaning or implications of FRAND commitments but instead rely on market negotiation to determine the content of FRAND commitments.[123] There is considerable evidence that SEP holders and implementers negotiate patent license agreements.[124] The large number of SEPs and the widespread implementation of technology standards indicate the significant scope of the market for patent license agreements.[125] Market negotiation of SEP licenses generally involves bilateral negotiation between each SEP holder and each implementer.[126]

Intermediated transactions in the market for patent license contracts typically involve negotiation. Intermediaries reduce transaction costs and offer the convenience of one-stop shopping.[127] Intermediaries may achieve greater transaction efficiencies and bargaining power in patent licensing negotiation than

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Setting Organizations that facilitate development of technology standards, and broadly outlining the effects of technology standards).

121. *Id.* at 82.

122. *Id.* at 86.

123. *Id.* at 83.

124. TIM POHLMANN & KNUT BLIND, LANDSCAPING STUDY ON STANDARD ESSENTIAL PATENTS (SEPS) 36, (2016), https://www.iplytics.com/wp-content/uploads/2017/04/Pohlmann_IPlytics_2017_EU-report_landscaping-SEPs.pdf (stating the majority of SEPs are individually licensed, partially out of fear that negotiating leverage will be lost in a patent pool).

125. Spulber, *supra* note 120, at 121–22.

126. *See* J. Gregory. Sidak, *The Meaning of FRAND, Part I: Royalties*, 9(4) J. COMPETITION L. ECON. 931, 985 (2013) ("The hypothetical negotiation at the time of standard adoption is properly cast as *a series of simultaneous, bilateral negotiations* between the SEP holder and each of the implementers.").

127. Naomi R. Lamoreaux & Kennith L. Sokoloff, *Intermediaries in the U.S. Market for Technology, 1870–1920*, *in* FINANCE, INTERMEDIARIES, AND ECONOMIC DEVELOPMENT 209, 209–13 (Stanley L. Engerman et al. eds., 2003). *See generally* James F. McDonough III, *The Myth of the Patent Troll: An Alternative View of the Function of Patent Dealers in an Idea Economy*, 56 EMORY L.J. 189, 189–228 (2006) (arguing there is greater market efficiency as a result of intermediaries).

individual patent holders.[128] Hagiu and Yoffie observe "[t]he patent market consists mainly of bilateral transactions, either sales or cross-licenses, between large companies. Such deals are privately negotiated and might involve hundreds or thousands of patents."[129] An FTC study of "Patent Assertion Entities" (PAEs) found substantial reliance on negotiation.[130]

B. WHY NEGOTIATION MATTERS FOR PATENT LICENSING

This section introduces a patent licensing negotiation framework. The main insight is that with negotiation, royalties are strictly less than what would be chosen by a monopolist licensing the bundle of complementary inventions. This establishes that patent licensing with complementary inventions should not be viewed as an antitrust problem.

In the negotiation framework, royalties are established through negotiation by pairs of patent holders and technology adopters. The negotiation framework recognizes that patent holders do not make commitments in the form of take-it-or-leave-it royalty offers. The analysis is sufficiently general that it allows a patent holder and a technology adopter to have asymmetric bargaining power. The analysis allows patent holders to have any relative bargaining power greater than zero and less than 100%.

The downstream product market is presumed to be perfectly competitive as in the textbook model of supply and demand. This means that the market price in the product market is such that total demand equals total supply. Buyers choose the quantity of

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128. *See* Erica S. Mintzer & Suzanne Munck, *The Joint U.S. Department of Justice and Federal Trade Commission Workshop on Patent Assertion Entity Activities—"Follow the Money,"* 79 ANTITRUST L.J. 423, 429 (2014); John E. Dubiansky, *The Licensing Function of Patent Intermediaries*, 15 DUKE L. & TECH. REV. 269, 271 (2017).

129. Andrei Hagiu & David B. Yoffie, *The New Patent Intermediaries: Platforms, Defensive Aggregators, and Super-Aggregators*, 27 J. ECON. PERSP. 45, 45 (2013). Some intermediaries such as Avanci, however, offer fixed prices. *See* AVANCI, ACCELERATING IOT CONNECTIVITY (2020), https://www.avanci.com/wp-content/uploads/2020/03/Avanci-White-Paper.pdf (offering fixed prices as opposed to privately negotiating deals).

130. FED. TRADE COMM'N, PATENT ASSERTION ENTITY ACTIVITY: AN FTC STUDY 1, (2016), https://www.ftc.gov/system/files/documents/reports/patent-assertion-entity-activity-ftc-study/p131203_patent_assertion_entity_activity_an_ftc_study_0.pdf ("PAEs monetize their patents primarily through licensing negotiations with alleged infringers, infringement litigation, or both.").

the good to demand based on the market price. Technology adopters are the sellers in the downstream market and they choose the quantity of the good to supply based on the market price. The assumption of perfect competition allows for a comparison to the Cournot model, which also assumes that the product market is perfectly competitive.[131]

The negotiation framework assumes that patent holders take the downstream product market price as given. Patent holders negotiate with adopters and choose royalties that are contingent on the realization of the product market price. Adopters and patent holders should have consistent perspectives on the market price. If adopters take the product market price as given, it is reasonable to believe that patent holders also take the product market price as given. This contrasts with the Cournot model in which adopters are price takers in the downstream market but patent holders are price setters in the downstream market. In the Cournot model, adopters choose royalties with full knowledge of the effects of royalties on the downstream market price.

Also, the perspectives of the negotiating parties should be consistent over time. The negotiating parties should not be able to anticipate the effects of royalties on the market price during negotiations and later take the product market price as given. This would require that adopters have knowledge about the effects of royalties on product prices during negotiation and then forget these effects after negotiation when the product market clears.

The negotiation framework allows the parties to choose the form of royalty arrangements. Negotiated patent license agreements in practice involve many types of royalty arrangements that are contingent on market outcomes. These arrangements can involve profit shares, equity, and options.[132] Varner finds

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131. The analysis can be extended to allow for imperfect competition in the downstream product market but that is beyond the present discussion.

132. *See* Nicos Savva & Niyazi Taneri, *The Role of Equity, Royalty, and Fixed Fees in Technology Licensing to University Spin-Offs*, 61(6) MGMT. SCI. 1323, 1324 (2015) ("[I]t is optimal for [a university Technology Transfer Office (TTO)] to offer contracts that include royalties alongside equity."); Pascale Crama, Bert De Reyck & Niyazi Taneri, *Licensing Contracts: Control Rights, Options, and Timing*, 63(4) MGMT. SCI. 1131, 1145 (2017) (demonstrating "how control rights, options, and timing can be used, in conjunction with various payment terms, to address the inefficiencies that may occur when innovators and marketers form partnerships to develop and market new products.").

that patent licenses includes various contingent arrangements: "joint venture agreements, product bundling or re-branding agreements, distribution agreements, settlement agreements, manufacturing and supply agreements, employment agreements, and acquisition agreements."[133] Varner finds elsewhere that when patent license agreements involve running royalties, 90% are contingent on sales revenue rather than units of output sold.[134] Elfenbein observes that royalties in university licensing agreements involve payments contingent on sales, lump-sum license fees, milestones, maintenance fees and minimums, and equity.[135] Finch finds that some biotechnology companies seek alliances and mergers and acquisitions in addition to negotiating licenses.[136]

In the market for patent licenses, as in many other markets, the parties are involved in many bilateral negotiations. Technology adopters negotiate with multiple patent holders and patent holders negotiate with multiple technology adopters.[137] Those bilateral negotiations are inevitably interdependent because one party's returns from one agreement can affect that party's

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133. Thomas R. Varner, *An Economic Perspective on Patent Licensing Structure and Provisions*, 46 BUS. ECON. 229, 230 (2011) (referencing analysis results from his previous paper in 2010) [hereinafter Varner, *Patent Licensing*]. *See generally* Thomas R. Varner, *Technology Royalty Rates in SEC Filings*, 45 NOUVELLES 120, 120–27 (2010) (presenting results from analysis of technology licenses containing various types of agreements) [hereinafter Varner, *Royalty Rates*].

134. Varner, *Royalty Rates*, *supra* note 133, at 233.

135. *See* Daniel W. Elfenbein, Contract Structure and Performance of University-Industry Technology Transfer Agreements 11 (July 30, 2009), https://ssrn.com/abstract=1452717 (listing the five subcategories of payment provisions that are common in contracts for university technology licensing agreements); *see also* Deepak Hegde, *Tacit Knowledge and the Structure of License Contracts: Evidence from the Biomedical Industry*, 23 J. ECON. & MGMT. STRATEGY 568 (2014) (comparing the characteristics that make up biomedical license agreement contracts between inventors and developers); Richard Jensen & Marie Thursby, *Proofs and Prototypes for Sale: The Licensing of University Inventions*, 91 AM. ECON. REV. 240 (2001) (exploring the parameters that comprise university licensing agreements, and arguing that without an economic incentive for the inventor, sponsored research alone is insufficient to foster development).

136. Sharon Finch, *Royalty Rates: Current Issues and Trends*, 7 J. COM. BIOTECH. 224, 230 (2001).

137. *See* Sidak, *supra* note 126, at 985.

returns from other agreements.[138] In practice, individuals typically enter into many contracts simultaneously, such as those with employers, insurance companies, and service providers. Firms simultaneously engage in many contracts with employees, customers, suppliers, and partners.[139] This is why the firm in general has been characterized as a "nexus for contracting relationships."[140]

Negotiation has been studied extensively by economists. An important approach characterizes the outcomes of bargaining based on a set of desirable properties stated as axioms. John Nash set forth a set of basic axioms that should be satisfied by bargaining between two parties.[141] The Nash bargaining solution is the unique outcome that satisfies those axioms.[142] The Nash bargaining solution involves equal division of the gains from trade for the two parties.[143] Nash's characterization of bargaining extends readily to allow different relative bargaining powers of the two parties.[144] Then, the outcome of bargaining is a unique solution that specifies different shares of the net benefits from exchange.[145] The negotiation framework presented here allows asymmetric bargaining power.

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138. *See generally* Spulber, *supra* note 41; Daniel F. Spulber, *Patent Licensing and Bargaining with Innovative Complements and Substitutes*, 70 RES. ECON. 693 (2016) [hereinafter Spulber, *Patent Licensing*].

139. Michael C. Jensen & William H. Meckling, *Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure*, 3 J. FIN. ECON. 305, 310 (1976).

140. *Id.* at 311.

141. John F. Nash, Jr., *The Bargaining Problem*, 18 ECONOMETRICA 155, 155–62 (1950) [hereinafter Nash, *Bargaining Problem*]; John F. Nash, Jr., *Two-Person Cooperative Games*, 21 ECONOMETRICA 128, 136–40 (1953) [hereinafter Nash, *Cooperative Games*].

142. Nash, *Cooperative Games, supra* note 141, at 129.

143. Nash, *Bargaining Problem*, *supra* note 141, at 155.

144. *See* Ken Binmore, Ariel Rubinstein, & Asher Wolinsky, *The Nash Bargaining Solution in Economic Modelling*, 17 RAND J. ECON. 176, 186 (1986) ("Modellers [sic] often use the asymmetric Nash solution in an attempt to capture some imprecisely defined differences in 'bargaining power,' where a large exponent α is interpreted as representing a relatively high bargaining power of party 1.").

145. *Id.* at 177 ("A unique perfect equilibrium outcome of such a game is then viewed as the solution to the bargaining situation studied."); Ariel Rubinstein & Asher Wolinsky, *Equilibrium in a Market with Sequential Bargaining*, 53 ECONOMETRICA 1133, 1149 (1985) ("In their models when two agents meet they agree immediately on an equal division of the difference between the unit and the sum of their reservation values. That is, they adopt Nash's bargaining solution."); Ariel Rubinstein, *Perfect Equilibrium in a Bargaining Model*, 50

The negotiation framework presented here applies an important approach known as Nash-in-Nash bargaining.[146] Nash-in-Nash bargaining is useful for examining simultaneous bargaining among multiple bargaining pairs.[147] With Nash-in-Nash bargaining, each bargaining pair takes the equilibrium outcomes of other bargaining pairs as given.[148] The outcome of bargaining for a particular bargaining pair is a "best response" to the outcomes of bargaining for other pairs of market participants.[149] This approach has been extended and applied in a variety of settings such as industry labor negotiations.[150]

The negotiation framework characterizes multiple patent licensing agreements. Based on Nash-in-Nash bargaining, each patent holder and adopter pair takes as given the equilibrium

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ECONOMETRICA 97, 100 (1982) (describing bargaining in terms of "the partition of a pie").

146. Harsanyi extends the Nash bargaining framework to consider simultaneous Nash bargaining between many pairs of economic agents. In Harsanyi's analysis, the negotiated agreements between pairs of economic agents are interrelated. The final outcome depends on what each pair of economic agents can obtain in various groupings of agents and what groups of economic agents can obtain in the set of bilateral agreements. John C. Harsanyi, *A Bargaining Model for the Cooperative n-Person Game*, *in* CONTRIBUTIONS TO THE THEORY OF GAMES IV, 40 ANNALS OF MATHEMATICAL STUDIES, 325 (A. W. Tucker & R. D. Luce, eds., Princeton Univ. Press 1963); John C. Harsanyi, *A Simplified Bargaining Model for the n-Person Cooperative Game*, 4 INT'L ECON. REV. 194 (1963); John C. Harsanyi & Reinhard Selten, *A Generalized Nash Solution for Two-Person Bargaining Games with Incomplete Information*, 18 MGMT. SCI. 80 (1972).

147. This combines the Nash bargaining solution with the non-cooperative Nash equilibrium. The non-cooperative Nash equilibrium is a game theory concept in which individual players take the equilibrium moves of other players as given when formulating their strategies. John Nash, *Non-Cooperative Games*, 54 ANNALS MATHEMATICS 286, 287 (1951).

148. Allan Collard-Wexler, Gautam Gowrisankaran & Robin S. Lee, *Nash-in-Nash Bargaining: A Microfoundation for Applied Work*, 127 J. POL. ECON. 163, 165 (2019).

149. *Id.* at 184.

150. Horn and Wolinsky further develop the Nash-in-Nash bargaining framework. Henrick Horn & Asher Wolinsky, *Bilateral Monopolies and Incentives for Merger*, 19 RAND J. ECON. 408 (1988). For an overview of applications and extension of the Nash-in-Nash bargaining framework to allow strategic interaction over time with repeated counter offers, see Allan Collard-Wexler, Gautam Gowrisankaran & Robin S. Lee, *Nash-in-Nash Bargaining: A Microfoundation for Applied Work*, 127 J. POL. ECON. 163 (2019). For a study on Nash-in-Nash bargaining in comparison to the Cournot complementary monopolies model, see Spulber, *supra* note 41. Nash-in-Nash bargaining can also be considered with patent licensing when inventions can be imperfect complements or substitutes. Spulber, *Patent Licensing*, *supra* note 138.

royalties for other patent holder and adopter pairs. Negotiation results in a division of each adopter's profit from applying the patented inventions net of the value of the best alternative. This approach is not restrictive, because similar results would hold for almost any bargaining model. Most bargaining models imply sharing of benefits among multiple players.

The negotiation framework has the following features. Consider an industry in which there are N patent holders and M technology adopters. Both patent holders and adopters take the product market price p as given so that negotiation is contingent on the market price. To simplify the discussion, suppose that adopters have the same production cost function C(q) where q is an adopter's output. The framework can be extended to allow for cost differences among adopters.

The cost function is such that marginal costs are increasing in output.[151] So, each adopter has an upward-sloping supply curve. This rules out the extreme assumption of an infinite elasticity of supply for technology adopters that is assumed in the Cournot model. An upward sloping supply function means that royalties are passed through to final prices at any rate that is greater than zero and less than 100%.

The N inventions are perfect complements and an adopter must apply all of the inventions to operate in the market. Patent holders and adopters negotiate bilaterally over royalties. Each patent holder and adopter pair negotiates a per-unit royalty and a lump-sum royalty. So, each patent holder indexed by i from 1 to N has revenue per adopter equal to a running royalty multiplied by output $r_i q$ and a lump-sum royalty R_i. Because adopters are price takers, each adopter chooses the profit-maximizing output q that equates marginal cost to the market price net of total per-unit royalties. The adopter's supply function depends on the price net of total per-unit royalties.[152]

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151. Each adopter's marginal cost function C′(q) is increasing in q. If the market price is p, the profit maximizing output is such that marginal cost equals price, C′(q) = p. This gives the supply function q = S(p). The supply function S is the inverse of its marginal cost function so the supply function is increasing in the price.

152. The profit maximizing output of a producer sets marginal cost equal to the price net of total per-unit royalties, $p - \sum_{i=1}^{N} r_i = C'(q)$. This can be rewritten as the traditional supply function, which depends on the price net of per-unit royalties. $q = S(p - \sum_{i=1}^{N} r_i)$.

Each adopter's benefit V from the patent license agreements equals revenue minus production costs and minus patent license royalties.[153] If the adopter does not obtain licenses from all of the patent holders, the adopter must pursue an alternative opportunity. The value of the best alternative opportunity is v, which is the disagreement payoff for the adopter in bilateral bargaining. The adopter's net benefit from patent licensing is V – v.

To simplify the discussion, every patent holder has the same bargaining power relative to each adopter. Let A be the relative bargaining power of a patent holder. The patent holder's relative bargaining power is a factor that can take any value that is greater than zero and less than 100%. The patent holder's disagreement payoff is zero for each bilateral negotiation. If the patent holder does not form a patent license agreement with a particular adopter, then the patent holder obtains no royalties from that adopter. The analysis would still apply if there was a disagreement payoff such as damages for infringement.

The patent holder and adopter choose royalties to maximize their joint benefits and also to divide the joint benefits.[154] The negotiation framework generates the important conclusion that any patent holder and adopter pair will rely exclusively on a lump-sum royalty. The negotiating parties will not use a per-unit royalty because it would distort the adopter's profit-maximizing output decision. The per-unit royalty is an inefficient way of dividing profit. Because negotiation divides profit between the parties, they both want the adopter to maximize profit.[155]

The per-unit royalty transfers some profit from the adopter to the patent holder but decreases profit in the process. To avoid the joint loss from decreasing profit, the patent holder and an adopter do not have a per-unit royalty. To illustrate this, suppose that there is only one patent holder and one adopter. A royalty per unit of output would decrease the adopter's output.[156] If

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153. This can be written as follows, $V = pq - C(q) - \sum_{i=1}^{N} r_i q - \sum_{i=1}^{N} R_i$.

154. The standard Nash bargaining outcome maximizes the product of net benefits with exponents equal to relative bargaining power, that is, $(V - v)^{1-A}(r_i q + R_i)^A$.

155. The bargaining pair chooses an outcome such that one party cannot be made better off without making the other party worse off. This efficiency criterion, known as Pareto optimality, is a standard property of economic models of bargaining.

156. To illustrate this, consider the effect of a per-unit royalty on profit excluding royalties, which is given by $pS(p - r) - C(S(p - r))$. The supply function equates the net price to marginal cost, $p - r = C'(S(p - r))$. So, the effect of an

there were a royalty r per unit of output, an adopter's supply function would be increasing in the market price net of the per-unit royalty. Because the supply curve is upward sloping, the profit maximizing adopter would choose a lower output $S(p - r)$ in response to the imposition of the per-unit royalty. Without a per-unit royalty, the supply of output $S(p)$ maximizes profit $pq - C(q)$, so that output corresponds to the supply $S(p)$. Royalty payments aside, the lower output due to a per-unit royalty decreases the adopter's profit in comparison to the profit-maximizing output. So, the bargaining pair would choose a zero per unit royalty. This argument holds with multiple patent license agreements. None of the bargaining pairs will choose a per-unit royalty.

The negotiation framework establishes that the parties choose a lump-sum royalty that is a share of the adopter's profit net of the value of the best alternative. Negotiation equalizes the net benefits of the patent holder and technology adopter weighted by relative bargaining powers.[157] Because there are no per-unit royalties, the adopter's output choice depends only on the market price.[158] The adopter's profit net of the value of the best alternative is contingent on the product market price and equals $pS(p) - C(S(p)) - v$. The share of net profit depends on the patent holder's relative bargaining power and the number of patent holders, $A/(1 - A + AN)$. Because the adopter's profit is increasing in the market price, the royalty is increasing in the market price. The royalty is increasing in the patent holder's bargaining power, decreasing in the value of the best alternative opportunity, and decreasing in the number of patent holders.[159]

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increase in the per-unit royalty is $[p - C'(S(p - r))]S'(p - r) = - r\, S'(p - r))$. This is less than zero because the supply curve is upward sloping. So, a royalty lowers profit excluding royalties. Put differently, profit $pS(p - r) - C(S(p - r))$ is less than $pS(p) - C(S(p))$.

157. The standard bargaining solution equalizes the net benefits of the parties weighted by their relative bargaining powers, $A(V - v) = (1 - A)(r_i q + R_i)$.

158. Because lump-sum royalties are equal, the bargaining can be written as $A(pq - C(q) - NR - v) = (1 - A)R$. Solving for the royalty gives $R = [A/(1 - A + AN)](pq - C(q) - v)$. The output is given by the adopter's supply decision, $q = S(p)$.

159. The product market demand function is $D(p)$ so that the market-clearing price equates market demand to total supply, $D(p) = MS(p)$. The market clearing price does not depend on the number of patent holders, the allocation of bargaining power, or royalties. Each adopter has a benefit V that corresponds to profit minus royalties $pq - C(q) - NR$. So, the adopter's profit minus royalties is a weighted average of profit and the value of the best alternative opportunity, $V = [(1 - A)/(1 - A + AN)](pq - C(q)) + [NA/(1 - A + AN)]v$.

The negotiation framework gives royalties that are contingent on the realization of the market price. The negotiated outcome is consistent with a variety of royalty arrangements including royalties that are a share of the product price or product revenues. The negotiated outcome also is consistent with combinations of equity arrangements, up-front payments, milestones, and various other contingent arrangements. The negotiated outcome is consistent with royalty arrangements that adjust to variations in product market prices.

Because royalties are a share of the adopter's profit net of the value of the best alternative, it follows that the interests of each patent owner and adopter pair are aligned. All of the patent holders licensing to a particular adopter prefer that the adopter maximize profit. An adopter can bargain with each of the patent holders, and all the licensing agreements will be consistent with each other. The adopter chooses output to maximize profit by equating marginal cost to the market price. Because there are no royalties per unit of output, the problem of multiple-marginalization does not arise.

The negotiation framework provides insights into antitrust policy debates. The royalties that a monopolist offering a bundle of the complementary inventions would choose provides an important benchmark. For consistency with negotiation, the bundling monopolist takes product market prices as given. The outcome with negotiation and the outcome with a bundling monopolist are comparable. If the bundling monopolist were to exercise market power downstream in addition to its market power in the market for patent licenses, it would obtain even greater royalties and earn more revenues.

The bundling monopolist can choose a combination consisting of a royalty r^M per-unit of output and a lump-sum royalty R^M for the bundle of patents. As was the case with negotiation, the bundling monopolist wishes to choose the per-unit royalty such that the adopter has the greatest profit. As before, each producer's supply curve is upward sloping so that a per-unit royalty would distort the outcome by decreasing the producer's output. The adopter's profit is decreasing in the per-unit royalty so that the bundling monopolist chooses a zero per-unit royalty. As was observed with negotiation, the bundling monopolist avoids using a per-unit royalty so that the adopter chooses the output that maximizes profit. The bundling monopolist then chooses

royalties to capture economic rents without diminishing adopter profit.

The bundling monopolist increases the lump-sum royalty to the level at which an adopter is indifferent between adopting the complementary inventions and choosing the best alternative. The bundling monopolist chooses a lump-sum royalty equal to the adopter's profit net of the adopter's value of the best alternative. The bundling monopolist chooses a lump-sum royalty R^M equal to the adopter's profit contingent on the market price net of the value of the best alternative, $pS(p) - C(S(p)) - v$.

The discussion establishes that total royalties with bilateral negotiation are strictly less than royalties with a bundling monopolist, $NR < R^M$. This outcome is the reverse of the "Cournot Effect." The bundling monopolist chooses greater royalties than the total with negotiation for any rate of cost pass-though less than 100%, that is, for any individual adopter supply curve with a positive slope. The bundling monopolist chooses greater royalties than the total with negotiation for any patent holder bargaining power that is less than 100%. This conclusion holds for any number of patent holders and for any value of the best alternative opportunity. The royalties the bundling monopolist chooses correspond to a limiting case of the negotiated outcome. The bundling monopolist's royalties corresponds to the limit of the total negotiated royalties when the relevant bargaining power of each inventor approaches 100%, that is, when A approaches the limit of 1.

The negotiation framework presented here has additional implications for the economic and legal analysis of patent pools. The standard economic model characterizes patent pools as bundling monopolists.[160] In practice, however, technology adopters and patent holders may have the option of negotiating contracts. This suggests that patent pool royalties will not exceed negotiated prices. So, patent pools with this option will have total royalties less than or equal to the negotiated outcome. This implies that market negotiation of patent license agreements provides an important benchmark for patent pools. The negotiation framework presented here then implies that patent pools will have total royalties substantially lower than a bundling monopolist patent holder. The bundling monopolist is not an accurate

160. *See, e.g.*, Spulber, *supra* note 41, at 36–38; Spulber, *Patent Licensing*, *supra* note 138, at 707–08.

description of patent pools. This suggests that patent pools serve economic functions that differ from regulating royalties. Under some market conditions, patent pools serve to mitigate transaction costs and improve coordination among patent holders and technology adopters.

C. ANTITRUST POLICY IMPLICATIONS OF NEGOTIATION

The negotiation framework establishes that complementary inventions should not raise antitrust concerns. The parties do not rely exclusively on distortionary running royalties. Patent holders do not commit to take-it-or-leave-it royalty offers. Both patent holders and technology adopters have bargaining power. Cost pass-through is not 100%. The negotiated outcome avoids multiple marginalizations so that the competitive downstream product market will be efficient. Royalty arrangements are contingent on the downstream market price so that they adjust to market conditions. Total royalties with negotiation are less than those of a bundling monopolist.

Negotiation of patent license agreements reverses the influential "Cournot Effect." The observation that total royalties with negotiation are strictly less than those of a bundling monopolist ($NR < R^M$) has a number of important implications. Negotiation eliminates the basis for predictions of "royalty stacking," "SEP hold-up," "patent thickets," "blocking patents," the "Tragedy of the Anti-Commons," and the promotion of "regulatory patent pools." In short, negotiation removes the branches from the Cournot tree.

The negotiation framework is comparable to the Cournot model as applied to patent licensing. Both approaches involve multiple patent holders and multiple producers that are technology adopters. Adopters choose to license patents rather than infringing. The inventions are strict complements, so adopters must license all of the patents to engage in production and supply final products. A patent holder's entire portfolio of patents might contain many different types of technologies and inventions.[161] The downstream market is perfectly competitive with

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161. For ease of discussion, suppose that patent owners do not have any licensing costs and also do not have any opportunity cost from licensing. The analysis of negotiation can readily incorporate these costs. Because all inventions are strict complements to each other, it is not possible to identify the contribution of individual inventions. All of the inventions are necessary for the final product and may be considered symmetrically as a consequence. There are

price-taking producers. Each producer's profit equals revenues minus production costs. Each producer's net benefit from adopting the inventions is profit minus total royalties paid to patent holders and minus the value of the best alternative.

Antitrust policy should not presume that there is a competition problem in industries with complementary inventions. Antitrust policy does not need to apply extra scrutiny to industries with technology standards and SEPs. Competitive markets with negotiation of patent license agreements are sufficient to provide the coordination needed for complex innovation. Antitrust policy makers should avoid following an overly simplistic "Standards, Conduct, Performance" paradigm.[162] Technology standards in themselves do not imply that there are problems with either competitive conduct or economic performance.

As noted previously, many patent pools provide patent holders and technology adopters the option of directly negotiating patent licenses. Even if this option is not exercised, the potential for market negotiation of patent license agreements limits patent pool royalties. The negotiation framework demonstrates that patent pools should not be characterized as bundling monopolists. This implies that the purpose of the patent pool is not to generate excessive revenues through bundling complementary inventions.

The negotiation framework suggests that antitrust policy markets should not promote patent pools as a means for controlling total royalties for complementary inventions. Antitrust policy should continue to emphasize the beneficial role of patent pools as mechanisms for mitigating transaction costs and improving coordination. Antitrust policy makers should maintain neutrality, allowing markets to determine the best mix of patent pools, intermediaries, and bilateral negotiation.

The antitrust policy implications of the negotiation framework are robust to very different market conditions. The results of the analysis continue to apply for any cost pass-through rate ranging from very small to very large percentages. Put differently, the analysis allows for any producer supply curves that

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no other differences between the inventors in terms of patent validity or licensing costs. This means that the inventions can be viewed as symmetric and total royalties will be the same for every invention.

162. Daniel F. Spulber, *Innovation Economics: Technology Standards, Competitive Conduct and Economic Performance*, 9 J. COMP. L. & ECON. 777, 778–79 (2013).

are not infinitely elastic. The analysis also continues to apply for any patent holder bargaining power ranging from very low to very high. The analysis applies for general demand conditions in the downstream market. Finally, the negotiation framework holds for any numbers of patent holders and producers.

The perfect complements assumption is a "worst-case scenario." The perfect complements assumption is standard in discussions of antitrust policy.[163] Inventions are perfect complements if a particular set of technologies must be used in combination to create a specific complex innovation.[164] This also could occur because the technologies are SEPs declared to SSOs that are necessary for producers to implement a technology standard. The main conclusions apply if the inventions are substitutes or imperfect complements, as long as the benefits of using all of the inventions exceed the benefits of using only some of the inventions. This is because negotiation between patent holders and technology adopters will choose the optimal mix of inventions. If only some of the inventions are needed to create complex innovations or to comply with standards, the results apply to negotiation between active patent holders and technology adopters. Also, if there is competition between substitute inventions, this will constrain royalties. The conclusions also extend to heterogeneous inventions with each combination of inventions having different effects on the adopter's profit.[165]

The antitrust implications of the negotiation framework presented here extend to other competitive environments. The results still apply if downstream producers engage in imperfect competition, and patent holders and producers negotiate over total royalty payments. When royalties are a share of profits, producers that engage in imperfect competition will continue to maximize their profits. This is because producers that retain a share of profits have the same incentives to maximize profits.

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163. *See, e.g.*, Spulber, *Patent Licensing*, *supra* note 138, at 706.

164. COURNOT, *supra* note 26, at 100–03; *see also* Spulber, *supra* note 41 (applying perfect complementary models in the downstream market); Spulber, *Patent Licensing*, *supra* note 138, at 706 (applying perfect complementary models in intellectual property rights).

165. *See* Spulber, *Patent Licensing*, *supra* note 138, at 696–97.

This observation holds for practically any economic model of monopolistic competition.[166]

Negotiation of patent license agreements may be inefficient under some conditions. These conditions are not relevant to the present analysis because they would risk violating antitrust policy. The market equilibrium can be distorted when downstream producers engage in imperfect competition and upstream patent holders are able to choose royalties and other restrictive contract terms that increase prices downstream. Such distortions could foster collusion among downstream producers and generate higher total royalties. This problem is not unique to patents and would apply to any type of vertical restraints involving productive inputs.

Patent license agreements that create anticompetitive horizontal or vertical restraints would be ruled out by antitrust policy. The Antitrust Guidelines state "[t]he Agencies apply the same general antitrust principles to conduct involving intellectual property that they apply to conduct involving any other form of property."[167] The Antitrust Guidelines caution that

> [a] restraint in a licensing arrangement may harm such competition, for example, if it facilitates market division or price-fixing. In addition, license restrictions with respect to one market may harm such competition in another market by anticompetitively foreclosing access to, or significantly raising the price of, an important input, or by facilitating coordination to increase price or reduce output.[168]

In particular, the guidelines state "[l]icensing arrangements raise concerns under the antitrust laws if they are likely to affect adversely the prices, quantities, qualities, or varieties of goods and services either currently or potentially available."[169]

III. THE "COURNOT EFFECT" AND PATENT LICENSE AGREEMENTS

This section summarizes the Cournot model and examines its application to patent licensing. The Cournot model predicts that complementary monopolists will choose input prices greater

166. *See* Daniel F. Spulber, *Standard Setting Organisations and Standard Essential Patents: Voting and Markets*, 129 ECON. J. 1477, 1480 (2018) https://doi.org/10.1111/ecoj.12606.

167. ANTITRUST GUIDELINES, *supra* note 4, at 3.

168. *Id*. at 8.

169. *Id*.

than the price that a bundling monopolist would choose.[170] Applied to patents, the "Cournot Effect" predicts that the total of per-unit royalties chosen by patent holders is greater than what a bundling monopolist patent holder would choose.[171] This section explains why the Cournot model should not apply to patent licensing. The section reviews standard discussions of antitrust policy toward complementary inventions based on the "Cournot Effect."

A. THE COURNOT MODEL AND THE "COURNOT EFFECT"

The Cournot model examines two upstream monopolists that supply complementary inputs to downstream producers. One complementary monopolist supplies copper and the other supplies zinc. The two input monopolists sell to downstream producers of brass. The Cournot model assumes that the two inputs must be used in fixed proportions to produce a unit of the final output. Output cannot be produced without using a particular mix of the inputs, so that the inputs are said to be perfect complements in production.[172]

Producers of brass have constant unit costs and infinite elasticity of supply. The final product price in the Cournot model equals the per-unit prices of the two inputs, copper and zinc, plus any other unit costs of producing brass. As a consequence, a $1 increase in the price of copper or the price of zinc or the sum of input prices results in a $1 increase in the price of brass.[173]

In the Cournot model, input suppliers make take-it-or-leave-it price offers to the downstream producers.[174] Input suppliers choose their price offers "non-cooperatively."[175] This means that the input suppliers make independent price offers

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170. Fritz Machlup & Martha Taber, *Bilateral Monopoly, Successive Monopoly, and Vertical Integration*, 27 ECONOMICA 101, 103–04 (1960).

171. Spulber, *Patent Licensing*, *supra* note 138, at 706–07.

172. COURNOT, *supra* note 26, at 100–03; *see also* Machlup & Taber, *supra* note 170 (surveying the historical literature on Cournot's work).

173. The Cournot complementary monopolies model is as follows. The per-unit prices are r_1 for copper and r_2 for zinc. Any other per-unit costs of production are constant and equal c. The equilibrium is obtained as follows. The market demand for brass is $Q = D(P)$, where Q is the total market output of brass and P is the price of brass. The elasticity of supply is infinite so that the final output price is $P = r_1 + r_2 + c$. This is the horizontal industry supply curve that generates 100% cost pass-through. COURNOT, *supra* note 26, at 100–03.

174. *Id.* at 99.

175. *Id.*

without knowledge of the negative effects of their price offers on other input suppliers. An input supplier makes a price offer that is a profit-maximizing best response to what each supplier believes will be the offer of the other producer.

The Cournot model assumes that the downstream market for brass is perfectly competitive. Implicitly, there are many small downstream producers of brass. Those producers take the market price of brass as a given and do not believe that their output could affect the price of output. The small downstream producers also take the prices of the two inputs as given. The producers do not believe that their input demand could affect the prices of either of the two inputs. Downstream producers have constant unit costs of production so that they have an infinite elasticity of supply. The market price of the downstream output exactly equals the total of the input prices plus any other unit costs of producers.

The input suppliers face a "free rider" problem because they do not coordinate their "take-it-or-leave-it" price offers. A complementary input monopolist does not recognize that an increase in its input price will lower the revenues of the other input monopolist. Both increase their prices such that the total is greater than what they would choose by coordinating their actions. This implies that the total of prices is greater than what a bundling monopolist would choose. The input monopolists do not attain the joint profit maximum. "[T]he composite commodity will always be made more expensive, by reason of separation of interests than by reason of the fusion of monopolies."[176]

The Cournot model suffers from an inconsistency in its assumptions. Downstream producers take the product price as given but upstream input suppliers do not. Upstream input suppliers are able to affect the downstream product price by controlling input prices. It seems unlikely that input suppliers have market power in product markets when producers have no market power in product markets.

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176. *Id*. at 103 observing, "An association of monopolists, working for their own interest, in this instance will also work for the interest of consumers, which is exactly the opposite of what happens with competing producers." *Id*.

B. THE COURNOT MODEL AND PATENT LICENSE AGREEMENTS

Antitrust policy recommendations in economics and law often are based on the Cournot model.[177] Such antitrust policy prescriptions illustrate the fallacy of overgeneralization or jumping to conclusions.[178] The hypothetical inefficiencies in Cournot's model of complementary monopolies do not imply that complementarities always have such effects.[179] The special conditions set forth in Cournot's complementary monopolies model do not apply to patents. Under more realistic assumptions about market conditions, complementary patents do not cause the "Cournot Effect."

Economic and legal studies that apply the Cournot model to patent licensing make a number of assumptions that do not conform to institutions in the market for patent licenses. These assumptions are contrary to negotiation of patent license agreements between patent holders and technology adopters.

Applications of the Cournot model to patents assume that patent holders are price makers, offering royalties using "take-it-or-leave-it" pricing, and technology adopters are price takers.[180] Patent holders are able to exercise indirect market power in a vertically distinct market. Patent holders have all market power in upstream technology markets and technology adopters have no countervailing market power. There are no viable substitute technologies that could compete with the complementary technologies. Technology adopters do not add value because they do not provide their own assets, capabilities, or technologies.

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177. Herbert Hovenkamp, *Harvard, Chicago, and Transaction Cost Economics in Antitrust Analysis*, 55 ANTITRUST BULL. 613, 635 (2010) ("Double marginalization problems occur in both vertically related markets and markets for complements. The latter the situation is sometimes referred to as the 'Cournot complements' problem, but the fundamental analysis is the same.").

178. *See* PATRICK J. HURLEY, A CONCISE INTRODUCTION TO LOGIC (10th ed. 2007). *See generally* Hans Hansen, *Fallacies*, *in* STANFORD ENCYCLOPEDIA OF PHILOSOPHY (Edward Zalta ed., 2019), https://plato.stanford.edu/archives/fall2019/entries/fallacies/ (explaining fallacies generally).

179. The "Cournot Effect" fallacy is not a criticism of Cournot's complementary monopolies model, but rather of its application in situations with different conditions.

180. Saul H. Hymans, *The Price-Taker: Uncertainty, Utility, and the Supply Function*,7 INT'L ECON. REV. 346, 347 (1966) (describing a firm that accepts a given price as a "price-taker"); John Riley & Richard Zeckhauser, *Optimal Selling Strategies: When to Haggle, When to Hold Firm*, 98 Q. J. ECON. 267, 267 (1983) ("A seller encountering risk-neutral buyers one at a time should, if commitments are feasible, quote a single take-it-or-leave-it price to each.").

Patent holders control the final product price and producers have no control over the final product price.

Applications of the Cournot model to patent licensing are extensions of Arrow's classic model.[181] In Arrow's framework, a monopoly inventor offers licenses to a competitive product market in which producers have an infinite elasticity of supply.[182] The monopoly inventor chooses a running royalty that is constant per unit of output.[183] The monopoly inventor chooses the per-unit royalty such that the equilibrium in the product market corresponds to a product market monopoly.[184] This analysis implies that patent royalties generate the standard deadweight welfare loss due to monopoly. Nordhaus applies Arrow's model to the question of what should be the optimal patent life.[185] Because royalties are distortionary, Nordhaus concludes that patent life should be just long enough to cover the costs of research and development.[186]

The Cournot approach misses the complexities involved in transferring and adopting technologies. Because the Cournot model simply involves price announcements, it follows that applications of the Cournot model to patent licensing assume that technology transfers are spot market transactions rather than contractual transactions. The spot market approach to patent licensing fails to recognize that technology transfers and adoption unfold over time. The spot market approach misses the complexity of contracting for technology transfers. Unlike basic productive inputs, technology transfers often are bundled with knowledge transfers and complementary goods and services. Bundling of knowledge, goods, and services requires contractual agreements.

The Cournot model, as applied to patents, represents technology transfers as basic inputs such as copper and zinc, which

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181. Kenneth J. Arrow, *Economic Welfare and the Allocation of Resources for Invention*, *in* NAT'L BUREAU OF ECON. RES., THE RATE AND DIRECTION OF INVENTIVE ACTIVITY 609 (Princeton Univ. Press ed. 1962).

182. *Id.* at 619–22.

183. *Id.* at 619.

184. *Id.*

185. *See* WILLIAM D. NORDHAUS, INVENTION, GROWTH, AND WELFARE: A THEORETICAL TREATMENT OF TECHNOLOGICAL CHANGE (1969) [hereinafter NORDHAUS, TECHNOLOGICAL CHANGE]; *see also* William D. Nordhaus, The Optimum Life of a Patent: Reply, 62 AM. ECON. REV. 3, 428–31 (1972) [hereinafter Nordhaus, *Patent Life*].

186. Nordhaus, *Patent Life supra* note 185, at 430–31.

are divisible and depletable.[187] Producers use up these inputs in producing brass.[188] According to this view, patent holders provide access to technology in return for royalties that are constant per unit of output.[189] Unlike such basic inputs, however, technology transfers are indivisible and non-rivalrous. There is no need for metered pricing to ration usage.

An anomaly in applications of the Cournot model to patent licensing is that input prices and royalties apply to very different things. In the Cournot model, input prices are based on the number of units of those inputs, e.g. the weight of copper and of zinc.[190] When applying the Cournot model to patent licensing applications, royalties are based on the number of units of output of producers using the patents. This would be equivalent to pricing copper and zinc based on the weight of brass. When the relationship of inputs to outputs can vary, as in the relationship between patents as inputs and output of products, the Cournot approach will be misleading.

Applications of the Cournot model to patent licensing restrict royalties to running royalties that are constant per unit of output.[191] Such royalties can cause price distortions from double marginalization and deadweight welfare losses.[192] Restricting royalties to constant charges per unit of output overstates the effects of royalties on product prices. So, royalties that are constant per unit of output overstate the effects of complementary inventions on product prices. Relying only on such royalties means that all economic transfers from technology adopters to patent holders are distortionary. In contrast, lump-sum royalties and various revenue and profit-sharing royalty arrangements mitigate or avoid such distortionary effects.

Applications of the Cournot model to patent licensing typically do not consider the complexities of patent license

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187. *See, e.g.*, COURNOT *supra* note 26, at 100 (using copper and zinc as inputs).

188. *Id*.

189. *Id*.

190. *Id*.

191. Spulber, *supra* note 44, at 678 ("If running royalties are *specific*, running royalties consist of a royalty r multiplied by the number of units sold *Q*.")

192. *See, e.g.*, *id.* (stating that using lump-sum royalties instead would be a way to avoid the "distortionary effects of double marginalization" caused by running royalties).

agreements.[193] Running royalties that are constant per unit of output do not adjust to changes in output prices and revenues. This approach ignores the many types of contingent royalty arrangements such a profit sharing. Contingent royalty arrangements offer risk sharing to patent holders and technology adopters.[194] Contingent royalties serve to provide incentives for performance and sharing of information that addresses moral hazard and adverse selection problems.[195]

The Cournot model assumes that patent holders have all market power in downstream product markets.[196] Technology adopters and final customers have no market power in downstream product markets. Input suppliers to downstream producers have no market power. Downstream products are homogeneous so that there are no substitute products in downstream product markets.[197] Simply by choosing patent royalties, patent holders fully control prices in downstream product markets. Finally, patent holders behave non-cooperatively and free-rider effects generate distortions in total royalties.[198]

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193. *See, e.g.*, Spulber, *supra* note 44, at 696 (observing that the "Cournot Effect" does not apply to patent license agreements).

194. *See generally* Hayne E. Leland, *Optimal Risk Sharing and the Leasing of Natural Resources, with Applications to Oil and Gas Leasing on the OCS*, 92 Q. J. ECON. 413 (1978) (modeling royalty payments as risk-sharing between parties to a transaction).

195. Richard Jensen & Marie Thursby, *Proofs and Prototypes for Sale: The Licensing of University Inventions*, 91 AM. ECON. REV. 240, 241 (2001) ("A lump-sum payment provides no incentive for the inventor to expend further effort in development . . . royalties solve this moral-hazard problem by linking the inventor's license income to additional effort."); Emmanuel Dechenaux, Jerry Thursby, & Marie Thursby, *Inventor Moral Hazard in University Licensing: The Role of Contracts*, 40 RES. POL'Y 94, 94 (2011) ("[T]o the extent that faculty inventors prefer to solve new puzzles rather than develop existing inventions, obtaining cooperation requires financial incentives tied to development."); Daniela Marinescu & Dumitru Marin, *Optimal Licensing Contracts with Adverse Selection and Informational Rents*, 6 THEORETICAL & APPLIED ECON. 27, 40–43 (2011) (analyzing how to optimize contingent-royalty contracts to best align incentives).

196. *See generally* Spulber, *supra* note 44, at 696 (discussing the assumption that input monopolists, here patent holders, announce prices they will charge to downstream producers).

197. COURNOT, *supra* note 26, at 100.

198. *See, e.g.*, Spulber, *supra* note 44 at 696 (discussing one way to eliminate the "free rider problem").

C. THE COURNOT MODEL AND COST PASS-THROUGH

The Cournot model assumes that individual producers have constant unit costs consisting of production costs and per-unit royalties.[199] This means that producers have an infinite elasticity of supply and the aggregate supply function also is infinitely elastic. The market price equals unit production costs plus total per-unit royalties.[200] This means that there is 100% pass-through of royalties to the final product price. Royalties are a constant amount per unit of output so per unit royalties are passed on fully to consumers of the final product.

In most markets, individual producers have upward sloping supply curves.[201] The rate of cost pass-through is between zero and 100%, where a cost pass-through rate of less than one is said to be incomplete and a cost pass-through rate equal to one is said to be complete.[202] In the basic competitive market model with upward-sloping supply, the rate of cost pass-through is incomplete. The classic formula for cost pass-through in a competitive market is $1/(1 + E^D/E^S)$, where E^D is the elasticity of demand and E^S is the elasticity of supply.[203] The Cournot model assumes that the product market has a downward sloping demand so that the elasticity of demand is positive.[204] The Cournot model further assumes that the product market supply is infinitely elastic—that is, the supply curve is a horizontal line.[205] With a positive elasticity of demand and infinitely elastic supply, the cost pass-through rate is 100%.[206] Any price responsiveness in supply—

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199. *See* COURNOT, *supra* note 26 at 100.

200. *Id*.

201. Alexei Alexandrov & Sergei Koulayev, *Using the Economics of the Pass-Through in Proving Antitrust Injury in* Robinson-Patman *Cases*, 60 ANTITRUST BULL. 345 (2015).

202. *See id.* at 352 (showing that a cost pass-through of greater than 100% is inconsistent with the terminology because it would indicate a greater price reaction than the cost increase, while acknowledging that cost increases may trigger various price increases); *see also* Alexei Alexandrov, *Pass-Through Rates in the Real World: The Effect of Price Points and Menu Costs*, 79 ANTITRUST L. J. 349 (2013).

203. *See* Henry Charles Fleeming Jenkin, *On the Principles Which Regulate the Incidence of Taxes*, *in* PROCEEDINGS OF THE ROYAL SOCIETY OF EDINBURGH 618, 631 (1871).

204. COURNOT, *supra* note 26, at 44–46.

205. *Id*.

206. *Id.* at 108.

that is, an upward sloping supply curve—would decrease the cost pass-through rate below 100%.[207]

The rate of cost pass-through generally is incomplete in market models with imperfect competition.[208] This can be illustrated by considering a downstream monopolist. The reasoning is similar with imperfect competition downstream. If the downstream producer is a monopolist with constant unit costs, an increase in costs will generate a change in the price equal to the ratio of the slope of the demand curve to the slope of the marginal revenue curve.[209] This is because a monopolist maximizes profit by equating marginal revenue to marginal cost. Any increase in cost will cause the monopolist to adjust their price to keep marginal revenue equal to cost, so the cost increase is passed through to marginal revenue, but not to price. The monopolist's amount of cost pass-through is necessarily less than one, because the slope of the demand curve is greater than the slope of the marginal revenue curve. The slope of the demand curve is greater than that of the marginal revenue curve because average revenue is greater than marginal revenue. Put differently, the monopolist's marginal revenue is always less than price because selling one more unit requires lowering the price.

The extreme assumption of 100% cost pass-through does not apply to most markets. Empirical studies demonstrate that cost-pass through tends to be very incomplete.[210] As Bonnet et al. observe, "[a] large theoretical and growing empirical literature explains what could be contributing to incomplete retail price transmission of upstream cost, shocks, or incomplete transmission of exchange rate shocks into countries' domestic consumer

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207. *Id*.

208. *See* Jeremy I. Bulow & Paul Pfleiderer, *A Note on the Effect of Cost Changes on Prices*, 91 J. POL. ECON. 182–85 (1983); *see also* E.G. Weyl & M. Fabinger, *Pass-Through as an Economic Tool: Principles of Incidence Under Imperfect Competition*, 121 J. POL. ECON. 528 (2013).

209. Bulow & Pfleiderer, *supra* note 208, at 183 (explaining that "for a given increase in marginal cost, the monopolist will contract output so that marginal revenue increases by the same amount, causing the price to rise by an amount equal to the ratio of the slope of the demand curve to the slope of the marginal revenue curve times the amount of the cost change").

210. *See, e.g.*, Celine Bonnet et al, *Empirical Evidence on the Role of Nonlinear Wholesale Pricing and Vertical Restraints on Cost Pass-Through*, 95 REV. ECON. & STAT. 500, 562 (2013) (explaining incomplete pass-through rates in the German coffee market).

retail prices."[211] Hellerstein and Villas-Boas observe that micro-economic and industrial organization studies "provide possible mechanisms for formalizing the reasons that price does not equal costs and thus for why changes in costs may not be passed through into prices."[212] Many studies of cost pass-through based on currency exchange rates find that prices are not responsive to changes in exchange rates.[213] According to one survey, "incomplete pass-through is a common and pervasive phenomenon across a broad range of countries."[214] Brun-Aguerre et al. find that the short-run and the long-run exchange rate pass-through elasticities for the US "appear to be at the low-end of the spectrum for [developed markets] in line with previous studies."[215] The rate of cost pass-through for excise taxes is higher in some retail markets but this may be due to slim margins in retail and uniformity in pricing.[216]

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211. *Id.* at 500; *see also* José Manuel Campa & Linda S. Goldberg, *Exchange Rate Pass-Through into Import Prices*, 87 REV. ECON. & STAT. 679, 682 (2005).

212. Rebecca Hellerstein & Sofia B. Villas-Boas, *Outsourcing and Pass-Through*, 81 J. INT'L ECON. 170, 171 (2010).

213. Charles Engel, *Expenditure Switching and Exchange-Rate Policy*, 17 NAT'L BUREAU ECON. RES. 231, 268 (2002) (stating "consumer prices are not very responsive to exchange rates").

214. Jayant Menon, *Exchange Rate Pass-Through*, 9 J. ECON. SURV. 197, 224 (1995).

215. Raphael Brun-Aguerre, Ana-Maria Fuertes, & Kate Phylaktis, *Exchange Rate Pass-Through into Import Prices Revisited: What Drives it?*, 31 J. INT'L MONEY & FIN. 818, 825 (2012); *see also* Janine Aron, Ronald Macdonald & John Muellbauer, *Exchange Rate Pass-Through in Developing and Emerging Markets: A Survey of Conceptual, Methodological and Policy Issues, and Selected Empirical Findings*, 50 J. DEV. STUD. 101, 136 (asserting that micro-data studies for industrial countries on exchange rate pass-through (ERPT) find that "[h]eterogeneous ERPT estimates are typically reported at the sectoral and goods levels, and ERPT is delayed and incomplete for imports and both retail and wholesale domestic prices"); Pinelopi Koujianou Goldberg & Michael M. Knetter, *Goods, Prices, and Exchange Rates: What Have We Learned?*, 35 J. ECON. LITERATURE 1243 (1997); Jiawen Yang, *Exchange Rate Pass-Through in U.S. Manufacturing Industries*, 79 REV. ECON. & STAT. 95, 95 (1997).

216. *See* Alberto Cavallo, *More Amazon Effects: Online Competition and Pricing Behaviors* (Nat'l Bureau of Econ. Res., Working Paper No. 25138, 2018); *see also* Gunter J. Hitsch, Ali Hortacsu, & Xiliang Lin, *Prices and Promotions in U.S. Retail Markets: Evidence from Big Data* 17–18 (Nat. Bureau of Econ. Res. Working Paper 26306, 2019); Stefano DellaVigna & Matthew Gentzkow, *Uniform Pricing in U.S. Retail Chains*, 1, 22 (Nat'l Bureau of Econ. Res., Working Paper No. 23996, 2019) (explaining the uniform pricing puzzle in retail); Tuomas Kosonen & Riikka Savolainen, A Case for Aero Effect of Sin Taxes on Consumption? Evidence from a Sweets Tax Reform (June 6, 2019) (unpublished article) (on file with the National Tax Association) (showing a high rate of pass-

IV. ANTITRUST POLICY TOWARD PATENT LICENSING

This section explores the implications of market negotiation for antitrust policy toward patent licensing. Negotiation of patent license agreements allows both patent holders and technology adopters to share in the benefits of technology transfers. A more accurate view of market institutions and market outcomes should help avoid the significant economic and legal costs of misguided antitrust policies. Hypothetical predictions based on the "Cournot Effect" have generated antitrust scrutiny, regulatory interventions, and many court decisions.[217] These policy cures can be much worse than the imagined disease. The result is antitrust policies that impede competitive conduct, discourage invention and innovation, and weaken protections for IP rights. Antitrust policies based on inaccurate descriptions of market institutions and market outcomes would adversely impact the rate and direction of technological change.

A. "ROYALTY STACKING"

"Royalty stacking" refers to the possibility that patent holders with complementary inventions will choose total royalties that exceed the royalties that would be chosen by a bundling monopoly patent holder. The "royalty stacking" concern is simply a restatement of the "Cournot Effect" in terms of royalties per unit of output. The "royalty stacking" concern is just the multiple marginalization problem described by Cournot.[218]

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through of excise taxes in retail); R. Andrew Butters, Daniel W. Sacks, & Boyoung Seo, How do National Firms Respond to Local Shocks? Evidence from Excise Taxes (Sept. 11, 2020) (unpublished article) (on file with the National Bureau of Economic Research); Etienne Gagnon & David Lopez-Salido, *Small Price Responses to Large Demand Shocks*, 18 J. EUR. ECON. ASS'N 792, 794 (2019).

217. *See, e.g.,* Microsoft Corp. v. Motorola, Inc., No. C10-1823JLR, 2013 WL 2111217 (W.D. Wash. Apr. 25, 2013) (discussing "royalty stacking"); Ericsson, Inc. v. D-Link Sys., Inc., 773 F.3d 1201 (Fed. Cir. 2014) (same); Unwired Planet Int'l Ltd. v. Huawei Techs. Co. [2017] EWHC 711 (Pat) (same).

218. Damien Geradin, Anne Layne-Farrar & Jorge Padilla, *The Complements Problem Within Standard Setting: Assessing the Evidence on Royalty Stacking*, 14 B.U. J. SCI. & TECH. L. 144, 148 (2008); Damien Geradin & M. Rato, *Can Standard-Setting Lead to Exploitative Abuse? A Dissonant View on Patent Hold-up, Royalty Stacking, and the Meaning of FRAND*, 3 EUR. COMPETITION J. 101, 122 (2007); J. Gregory Sidak, Holdup, *Royalty Stacking, and the Presumption of Injunctive Relief for Patent Infringement: A Reply to Lemley and Shapiro*, 92 MINN. L. REV. 714 (2008); *see* Einar Elhauge, *Do Patent Holdup and*

The issue of "royalty stacking" arises as a possibility in various legal cases, yet without any evidence. For example, *Ericsson v. D-Link* states that "[r]oyalty stacking can arise when a standard implicates numerous patents, perhaps hundreds, if not thousands. If companies are forced to pay royalties to all SEP holders, the royalties will 'stack' on top of each other and may become excessive in the aggregate."[219] *Huawei v. ZTE* cites the European Commission:

> [a]ccording to the Commission, 'hold-up is exacerbated where a large number of SEPs, covering various standards, are applied to a single product. In such circumstances, the number of potential licensors may cause the combined royalty payments made to the various SEP-holders to become excessive. This phenomenon is known as 'royalty stacking.'[220]

Negotiation of patent license agreements in a competitive market is sufficient to avoid the problem of "royalty stacking." Patent royalties involve more than constant charges per unit of output.[221] Royalties may be contingent on prices, revenues, or profits.[222] The negotiation framework shows that with bilateral negotiation, patent holders and technology adopters will avoid royalties that are constant per unit of output and will rely instead on contingent royalties. This framework further shows that a bundling monopolist will avoid royalties that are constant per unit of output, relying instead on contingent royalties.

Negotiation in a competitive market avoids "royalty stacking" because the total share of producer profit, net of the value of the best alternative, will be lower with negotiation than with a bundling monopoly patent holder. So, total royalties will be lower with negotiation than with a bundling monopoly patent holder. With negotiation, each pairing of patent holder and technology adopter chooses royalties as a best response to the royalties they anticipate the adopter will pay other patent holders. This important institutional feature of negotiation avoids the free-rider effects associated with take-it-or-leave-it pricing. So,

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Royalty Stacking Lead to Systematically Excessive Royalties?, 4 J. COMP. L. & ECON. 535, 566 (2008) (critically discussing these issues).

219. *Ericsson*, 773 F.3d at 1209.

220. Case C-170/13, Huawei Technologies Co. v. ZTE Corp., ECLI:EU:C:2014:2391 n.14 (November 20, 2014).

221. *See generally* Goldscheider, *supra* note 80 (discussing the nature and calculation of patent royalties as a whole).

222. *Id*.

negotiation is sufficient to lower royalties below the bundling monopoly level.

"Royalty stacking" concerns should not drive antitrust policy or legal decisions. Because most patent license agreements are negotiated, hypothetical predictions of "royalty stacking" based on the "Cournot Effect" are invalid. In addition, evidence shows that the predictions of "royalty stacking" are highly inaccurate.[223] For example, in mobile telecommunications, it is estimated that royalties make up around 5 per cent of mobile handset revenues and less than 2 per cent of total of handset revenues and mobile telecommunications operator revenues.[224] The high profitability of handset producers and mobile telecommunications operators further suggests that predictions of "royalty stacking" are incorrect.[225]

Markets for patent license agreements in industries with technology standards refute predictions of market failure with complementary inventions. The market for mobile wireless products is an important example because mobile phone handsets include many complementary inventions. Royalties for patent license agreements involving mobile phones have been contentious issues for multiple generations of technology standards, 2G, 3G, 4G, and 5G.[226] Stasik writes:

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223. *See, e.g.* Keith Mallinson, *Cumulative Mobile-SEP Royalty Payments No More Than Around 5% of Mobile Handset Revenues*, WISEHARBOR (Aug. 19, 2015, 7:59 PM) ("Vested interests including leaders at the mobile operator dominated NGMN Alliance1 promote the notion that patent licensing fee rates are 'perceived' to be too high in mobile technologies; but without substantiation for such claims . . . . [sometimes] based on theories of hold-up and royalty stacking that lack empirical support . . . ").

224. *See id.* ("As a percentage of all consumer charges, including handset costs and $1.13 trillion in mobile operator services, which are also highly dependent on SEP technologies, the cumulative royalty yield shrinks to 1.3 percent.").

225. *See* Keith Mallinson, *Don't Fix What Isn't Broken: The Extraordinary Record of Innovation and Success in the Cellular Industry Under Existing Licensing Practices*, 23 GEO. MASON L. REV. 967, 968 (2016) ("This Article argues that the enormous value produced by patented technologies—as compared to the relatively low costs to producers of obtaining that technology—enables the explosion of innovation and market development occurring around the world, indicating that patent royalties are far from excessive.").

226. *See* Stasik, *supra* note 76, at 114–19 (providing an overview of current issues in establishing royalty rates through the lens of LTE); *see also* LARRY GOLDSTEIN & BRIAN KEARSEY, TECHNOLOGY PATENT LICENSING: AN INTERNATIONAL REFERENCE ON 21ST CENTURY PATENT LICENSING, PATENT POOLS, AND PATENT PLATFORMS (2004). For a discussion of 5G technology standards, *see e.g.*, INS. OF ELEC. AND ELECS. ENG'RS., IEEE 5G AND BEYOND TECHNOLOGY

> Like a sequel to a successful movie, LTE includes many elements of the original release and offers a few new twists. This is especially true when it comes to the matter of licensing essential IPRs for the LTE standard. Audiences can expect to see the same licensing challenges that first appeared in GSM (2G) and which re-appeared in UMTS (3G) starring again in LTE (4G). The plot is essentially the same: lots of essential patents and many different patent holders.[227]

In mobile telecommunications, profit margins have remained stable, the quality and variety of consumer devices has increased rapidly, and average prices of smartphones have fallen while quality and functionality have increased.[228]

Empirical evidence shows that companies at various levels of the value chain have market power in industries with technology standards.[229] This fully refutes the notion that patent owners have complete or even significant market power, as suggested by applications of the Cournot model to SEP licensing. The telecommunications industry has evolved from full vertical integration to a value chain with considerable outsourcing, and then to a complex value network with many important players.[230]

In mobile communications, carriers, handset manufacturers, and various component and parts suppliers have market power.[231] As Jason Dedrick et al. find, "carriers capture the greatest value (in terms of gross profit) from each handset, followed closely by handset makers, with suppliers a distant third . . . [h]owever, the situation is reversed in terms of

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ROADMAP WHITE PAPER (2017), https://futurenetworks.ieee.org/images/files/pdf/ieee-5g-roadmap-white-paper.pdf.

227. Stasik, *supra* note 76, at 114.

228. *See* Kirti Gupta, *Technology Standards and Competition in the Mobile Wireless Industry*, 22 GEO. MASON L. REV. 865, 891, 893, 895 (2015) (analyzing each level of the mobile wireless industry to conclude that consistent profit margins, growth in consumer products, and decreasing average smartphone prices all point to a thriving, competitive industry.).

229. *Id.* at 891 ("[F]irms in the mobile wireless industry do not display any first-order indication of competitive harm from patent hold-up or royalty stacking.").

230. *See* Feng Li & Jason Whalley, *Deconstruction of the Telecommunications Industry: From Value Chain to Value Networks*, 26 TELECOMM. POL'Y 451 (2002) (providing an overview and analysis of the rapidly evolving telecommunications industry, with specific focus on increasing complexities in the value chain).

231. *See, e.g.*, Upender Subramanian, Jagmohan S. Raju & Z. John Zhang, *Exclusive Handset Arrangements in the Wireless Industry: A Competitive Analysis*, 32 MARKETING SCI. 246 (2013) (discussing negotiation between carriers and handset providers, with focus on exclusive arrangements).

operating profit."[232] Dedrick et al. show that "[c]ompanies at all levels of the supply chain compete with rivals for market share and profits and negotiate with their suppliers and customers to appropriate more of the profits from innovation."[233] Patent holders are only one set of players in a complex industry value network that also consists of the carriers, handset manufacturers, and suppliers.

B. "STANDARD ESSENTIAL PATENT HOLDUP"

Negotiation between technology adopters and patent holders helps realize the benefits of technology standards. "SEP holdup" provides an inaccurate characterization of patent license negotiation. "SEP holdup" should not be used to guide either antitrust policy or court decisions. Studies of "SEP holdup" provide very weak evidence of either patent holdup or royalty stacking.[234]

i. "SEP Holdup" and the "Cournot Effect"

"SEP holdup" alleges that complementary inventions create problems in industries with technology standards.[235] On the basis of "SEP holdup," there are calls for industries to turn back the clock so that technology adopters and patent holders negotiate patent license agreements before standardization.[236] The

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232. Jason Dedrick, Kenneth L. Kraemer & Greg Linden, *The Distribution of Value in the Mobile Phone Supply Chain*, 35 TELECOMM. POL'Y 505, 505 (2011).

233. *Id.* at 517.

234. *See, e.g.*, Vincenzo Denicolò et al., *Revisiting Injunctive Relief: Interpreting* eBay *in High-Tech Industries with Non-Practicing Patent Holders*, 4 J. COMP. L. & ECON. 571, 600 (2008) ("Taking all of the evidence together, we find the proof of prevalent, recurring patent holdup, and royalty stacking in high-tech industries to be extremely weak.").

235. *See id.* at 573 ("According to the holdup argument, once a manufacturer has invested in a plant and equipment to produce a particular good, the firms with patents relevant for that good can ask for and receive more than their fair share of the profits, since the manufacturer risks losing its entire investment if it cannot obtain a license to the patent."); Farrell et al., *supra* note 31 (providing an overview of patent holdup and standardization issues); Melamed & Shapiro, *supra* note 31, at 2111 ("Without some checks, SEP owners could opportunistically engage in patent holdup, taking advantage of the fact that the firms and users adopting the standard become individually and collectively locked in to the standard over time.").

236. *See* Farrell et al., *supra* note 31, at 621 ("[A]llowing hold-up is a costly way to provide rents to patent holders. For instance, users fearing patent ambush would have an incentive to . . . insist on ex ante negotiation.").

"SEP holdup" concern also motivates recommendations for weakening IP rights, including limits on injunctions.[237]

The concept of "SEP holdup" combines the effects of standardization on negotiation and "royalty stacking." In *Ericsson v. D-Link*, the court notes both concepts as potentially problematic for standard adoption, asserting that "patent hold-up exists when the holder of an SEP demands excessive royalties after companies are locked into using a standard."[238] *Huawei v. ZTE* identifies injunctions as a cause of excessive royalties:

> [a]ccording to the referring court, SEP-holders are in a powerful position when negotiating licences [sic] because of their right to bring an action for a prohibitory injunction. Consequently, it should be ensured that SEP-holders cannot, for example, impose excessive royalties in breach of their commitment to grant licences [sic] on FRAND terms, thereby engaging in conduct which has become known as 'patent hold-up.'[239]

Unwired v. Huawei, in contrast, finds that FRAND commitments are sufficient to address holdup.[240]

The concept of "SEP holdup" is based on contradictory arguments because patent holders are said to both negotiate and not to negotiate.[241] This concept applies two economic models with assumptions that are inconsistent with each other. "SEP holdup" asserts that patent holders take advantage of adopters in negotiation after technology standards are developed.[242] The argument is that adopters are "locked in" to a technology and

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237. *Id.* at 610 (noting that potential patent reforms in response to holdup concerns could include "in some cases limiting patent holders' ability to obtain injunctions").

238. *Ericsson,* 773 F.3d at 1208.

239. C-170/13, Huawei Technologies Co. v. ZTE Corp., ECLI:EU:C:2014:2391477 ¶ 41 (November 20, 2014).

240. Unwired Planet Int'l Ltd. v. Huawei Technologies Co. Ltd. [2017] EWHC 711 (Pat), at 155 ("An appropriate way to determine a FRAND royalty is to determine a benchmark rate which is governed by the value of the patentee's portfolio. That will be fair, reasonable and generally non-discriminatory. The rate does not vary depending on the size of the licensee. It will eliminate hold-up and hold-out. Small new entrants are entitled to pay a royalty based on the same benchmark as established large entities.").

241. Lemley & Shapiro, *supra* note 30 (analyzing patent holdup and royalty stacking with two models: a model with bilateral negotiation and a variant of the Cournot model, which assumes royalties that are per unit of output and 100% cost pass-through). The downstream producer is a monopolist, however, which would suggest that patent holders would not choose royalties that are constant per unit of output. *Id.*

242. *See* Melamed & Shapiro, *supra* note 31, at 2111.

therefore pay higher royalties than they would before standardization.[243] At the same time, however, "SEP holdup" asserts that patent holders collectively engage in "royalty stacking" by setting royalty rates without negotiation.[244] "SEP holdup" concludes that "royalty stacking" due to the "Cournot Effect" magnifies the effects of technology standards on negotiation.[245]

The negotiation framework presented here is useful in untangling these inconsistent aspects of the "SEP holdup" argument. Because most patent license agreements are negotiated, including those involving SEPs, it is inconsistent to assert that alleged "royalty stacking" based on the "Cournot Effect" will occur. Although there may be many SEPs in industries with technology standards, the number of complementary patents does not in itself indicate a problem. Negotiation takes into account the royalties in other patent license agreements so that total royalties for SEPs do not exceed what a bundling monopolist would choose. Contrary to "SEP holdup," "royalty stacking" does not magnify the effects of technology standards.

The remaining question raised by "SEP holdup" is how standardization affects negotiation between patent holders and technology adopters. "SEP holdup" suggests that standardization removes technological options in comparison to what might have existed before standardization. This is an example of the problem identified by Demsetz of comparing existing market institutions to some hypothetical ideal norm.[246]

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243. *Id.* ("Put simply: without some checks, SEP owners could opportunistically engage in patent holdup, taking advantage of the fact that the firms and users adopting the standard become individually and collectively locked in to the standard over time.").

244. *Id.* at 2114 ("[A]s a practical matter, patent holders are generally able to recover more than the ex ante [negotiated] value of the patent when litigation occurs after the implementers are locked in.").

245. *See* Shapiro, *supra* note 32, at 128 ("The need to solve the complements problem tends to be especially great in the context of standard setting."); Lemley & Shapiro, *supra* note 30, at 1993 ("As a matter of simple arithmetic, royalty stacking magnifies the problems associated with injunction threats and holdup, and greatly so if many patents read on the same product. In this key sense, the problems of injunction threats and royalty stacking are intertwined . . . . [T]hese added problems result from simple arithmetic: the combined royalty rate owed to all of the patent holders asserting infringement is equal to the sum of the royalties owed to each individual patent holder."); *see also* Lemley & Shapiro, *supra* note 31, at 2007–08 (discussing the Cournot Effect and royalty stacking generally).

246. Harold Demsetz, *Information and Efficiency: Another Viewpoint*, 12 J. L. & ECON. 1, 1 (1969) ("The view that now pervades much public policy

"SEP holdup" chooses a benchmark for negotiation based on technology standards that were never chosen by a standards organization. Such a benchmark would reflect hypothetical technologies that were never fully developed if they existed at all. This benchmark would never arise in market negotiation. Policy concerns should not be based on imaginary technologies that never existed. Negotiating patent licenses before choosing technology standards or even before developing alternative technologies would compare actual patent license negotiation to an impossible ideal.

ii. Negotiation and technology standards

The negotiation framework presented here shows that royalties and the benefits of adopters critically depend on two things: the profit obtained from applying standardized technology and the value of the best alternative technology. This section will show that technology standards increase both adopter profit and the value of the best alternative. With negotiation of patent license agreements, technology standards make adopters better off.

Negotiation of patent license agreements between technology adopters and patent holders makes a number of important contributions to standardization. First, negotiation allows technology adopters and patent holders to share the economic benefits of standardization, with neither side taking unfair advantage of the other.[247] Second, negotiation allows technology adopters and patent holders to avoid distortionary royalties and to design patent license agreements that maximize joint returns.[248] Third, simultaneous bilateral negotiation helps technology adopters and patent holders achieve multilateral coordination. Fourth, negotiation of patent license agreements that takes place after standardization allows technology adopters and patent holders to adapt to technological change.[249] Finally, anticipation of negotiation of patent license agreements gives

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economics implicitly presents the relevant choice as between an ideal norm and an existing 'imperfect' institutional arrangement.").

247. *See* Spulber, *supra* note 120 (broadly covering the advantages of negotiation).

248. *Id*.

249. *Id*.

incentives to technology adopters and patent holders to choose efficient technology standards in standards organizations.[250]

Technology standards established through voluntary organizations make adopters better off in comparison to markets without technology standards. This is evidenced by the extensive participation of adopters in the standards development process, which can be costly and time consuming.[251] Also, new or revised technology standards increase the net benefits to adopters in comparison to previous technology standards, as evidenced by the widespread adoption of standardized technologies in the market.[252] Technology adopters benefit from negotiation that takes place after developing and promoting technology standards. This observation is confirmed by the fact that technology adopters and patent holders almost always choose to negotiate patent license agreements after a process of technological change and technology standardization.[253]

Consider first the effects of the value of the best alternative to adopters. The value of the best alternative is the adopter's disagreement payoff in negotiation. All other things being equal, negotiation implies that royalties are decreasing in the adopter's value of the best alternative technology. An increase in the value of the best alternative technology will decrease royalties for each complementary invention. An increase in the value of the best alternative technology also will increase profit net of royalties for technology adopters, for a given profit level. This is the case for standard bilateral negotiation.[254] This also is the case in the more general negotiation framework with multiple patent holders and multiple technology adopters.

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250. *Id*.

251. *See, e.g.*, Gupta, *supra* note 228, at 877–80 (discussing the consensus method for standards setting, where even "noncontributing firms have power to influence what is or isn't adopted as a standardized solution").

252. *Id.* at 880 ("The widespread adoption of standards across the mobile wireless industry and incredible performance improvements from 2G to 3G to 4G indicates that the standard-setting process is likely working.").

253. *See* Farrell et al., *supra* note 31, at 630–31 (asserting that negotiation before an industry standard is chosen is exceedingly rare).

254. Lemley & Shapiro, *supra* note 30, at 2007 ("The mitigation strategies therefore raise the joint profits of the patent holder and the downstream firm in bilateral bargaining."); Melamed & Shapiro, *supra* note 31, at 2138 (presenting an equation for royalties under bilateral negotiation); Gilbert, *supra* note 21, 46–47 (a sample equation for royalties).

Standardization achieved through voluntary standards organizations increases the value of the best alternative for adopters in comparison to previous technology standards. By increasing the value of the best alternative for technology adopters, standardization decreases royalties for each of the complementary inventions, all other things equal. Standardization also increases the profits of patent holders net of royalties.

The observation that standardization increases the value of the best alternative for adopters runs contrary to the concern expressed by "SEP holdup." The problem lies in choosing the appropriate benchmark for negotiation. The benchmark for private negotiation should not be chosen by public policy makers. The institutionally correct benchmark for negotiation should be based on the alternatives available to market participants rather than hypothetical technologies. The alternatives available to market participants reflect existing technologies that satisfy new or revised standards and prior standards.

Standardization by industry consensus is based on technological change, which adds new technologies to the marketplace. New or revised consensus technology standards recognize the appearance of additional technologies. Despite a superficial reading of the term, standardization does not arbitrarily remove potentially valuable technological alternatives. Rather, technology standards often serve to recognize and illuminate technological change. As noted by the International Standards Organization (ISO), "[a]n ISO International Standard represents a global consensus on the state of the art in the subject of that standard."[255] This is distinct from government regulatory standards, which can narrow the number of technologies and limit innovation.[256]

Standardization through voluntary standards organizations increases the number and quality of technological alternatives available to adopters. Consensus standards increase technological alternatives because they promote invention and innovation.

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255. INTERNATIONAL ORGANIZATION FOR STANDARDIZATION, ECONOMIC BENEFITS OF STANDARDS 1 (1st ed. 2011), https://www.iso.org/publication/PUB100288.html.

256. *See, e.g.*, Mehreen Khan, *The EU Seeks for Force Through a Single Standard Phone Charger*, FIN. TIMES (Jan. 27, 2020), https://www.ft.com/content/65a2dd48-4140-11ea-bdb5-169ba7be433d (discussing the European Commission's mobile phone charger standards, which provide an example of government standards that have had unintentionally restrictive effects).

"[S]tandardization is an essential part of the microeconomic infrastructure: it enables innovation and acts as a barrier to undesirable outcomes."[257] Standards organizations develop and revise standards to facilitate application and absorption of new technologies. Increasing the number and quality of technologies increases the value of the best alternative technology for adopters.

Technology standards increase the value of technological alternatives because they specify performance quality and improve interoperability of technologies, particularly in information and communications technology (ICT). The ISO creates "document[s] that provid[e] requirements, specifications, guidelines or characteristics that can be used consistently to ensure that materials, products, processes and services are fit for their purpose."[258] ISO has published 22,936 international standards.[259] According to the organization, "ISO standards provide solutions and achieve benefits for almost all sectors of activity, including agriculture, construction, mechanical engineering, manufacturing, distribution, transport, medical devices, information and communication technologies, the environment, energy, quality management, conformity assessment and services."[260]

Standardization increases the value to adopters from applying new technologies. An advantage of standardization is reduction in the costs of coordination.[261] Companies do not need to

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257. G. M. PETER SWANN, THE ECONOMICS OF STANDARDIZATION: AN UPDATE (2010), https://www.gov.uk/government/publications/economics-of-standardisation-update-to-report; *see also* G. M. PETER SWANN, THE ECONOMICS OF STANDARDIZATION (2000), https://sites.google.com/site/gmpswann/home/cv/policy-reports/economics-of-standards (analyzing the economics of standardization prior to 2000).

258. *ISO Standards*, INST. OF ENVTL. SCI. & TECH., https://www.iest.org/Standards-RPs/ISO-Standards (last visited Oct. 19, 2020); *see Standards*, ISO, https://www.iso.org/standards.html (last visited Oct. 19, 2020) (illustrating the ISO's own description and definition of ISO standards).

259. *The ISO Story*, ISO, https://www.iso.org/the-iso-story.html (last visited Oct. 19, 2020).

260. INTERNATIONAL ORGANIZATION FOR STANDARDIZATION, *supra* note 255, at 1.

261. *See* Frank A.G. den Butter, et al., *The Transaction Costs Perspective on Standards as A Source of Trade and Productivity Growth*, TINBERGEN INST. DISCUSSION PAPER NO. 07-090/3, at 20 (Nov. 26, 2007), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1032135 (concluding that standards are important means to reduce transaction costs and thus may enhance coordination of production processes).

negotiate each time to establish technical specifications and interoperability.[262] Transaction cost reductions help more companies adopt standard technologies. Standardization increases the value of the best alternative for adopters because standards increase industry knowledge about technologies and provide interoperability that promotes access to multiple technologies.[263] Many technologies can comply with a standard by conforming to quality and interoperability requirements.

Standardization does not provide a mechanism for patent holders to "lock in" adopters.[264] Instead, standardization makes it easier to switch to new technologies because other industry participants have compatible technologies.[265] By helping to coordinate technical specifications and interoperability, standardization facilitates adoption of new technologies.[266] This decreases the costs of adjustment to new technologies and increases the value of technological alternatives for adopters.[267]

Rather than narrowing industry choices, standardization is a process of developing product quality and interoperability specifications.[268] Standardization makes it easier to provide parts, components, and final products that conform to industry standards.[269] These specifications provide opportunities for entry of producers of parts, components, and final products that meet technological specifications.[270] Standardization reduces the transaction costs associated with industry coordination,

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262. *See id.* at 11 ("When product specifications are standardized and know [sic] to trading partners, the bargaining process will cover only the price and conditions of delivery.").

263. *See* DIN GERMAN INSTITUTE FOR STANDARDIZATION, ECONOMIC BENEFITS OF STANDARDIZATION 13 (2000), https://www.iec.ch/about/globalreach/academia/pdf/academia_governments/economic_benefits_standardization.pdf (discussing potential competitive advantage through standards in terms of knowledge).

264. Daniel F. Spulber, *Unlocking Technology: Antitrust and Innovation*, 4 J. COMP. L. & ECON. 915, 915 (2008).

265. *Id*.

266. *Id.* at 946–47.

267. *Id*.

268. *See, e.g.*, DIN, *supra* note 263, at 14 ("Standards offer a wider choice of suppliers with the same degree of quality.").

269. *Id.* ("The application of standards and participation in standards work relevant to the supplier market can therefore enable a company to exert market pressure on their suppliers."). Therefore, under the increased pressure, the suppliers are more likely to supply products that conform to industry standards.

270. Id.

which also serves to reduce adoption costs. In other words, standardization increases the benefits of technology adopters without "lock in".

Standardization increases the value obtained from the technology used by adopters and the value of the best alternative technology that complies with the standard. Some SEPs may be substitutes rather than complements for particular adopters.[271] Also, an adopter may choose to supply only some of the many products that comply with a technology standard.[272] For example, an adopter may choose to produce many varieties of mobile phones, each of which involves different combinations of technologies. A technology adopter may choose among different types of products, such as say mobile phones versus tablet computers, each of which would involve different combinations of technologies. This creates alternatives for the technology adopter.

Adopters may not need to obtain all of the SEPs associated with a particular standard to comply with that standard. SEPs are declared essential for a standard but a standard potentially covers a wide range of products.[273] Despite their classification as "essential", not all SEPs are necessary for every product.[274] It may not be necessary to obtain every SEP declared for a particular standard for every product. Also, some declared SEPs may be substitutes.[275] There are many declared SEPs, with one estimate exceeding 200,000.[276] There is evidence of over-declaration of SEPs.[277]

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271. *See, e.g.*, Spulber, *supra* note 120, at 156 (mentioning that SEPs can be "innovative complements" or "innovative substitutes").

272. For many standards, compliance is voluntary. *See, e.g.*, *id.* at 94 ("Membership in SSOs and adoption of technology standards is voluntary for all industry participants"). Therefore, an adopter is not forced to supply all products that comply with a technology standard.

273. *See id.* at 135 ("The technology standard offers . . . interoperability across products. Indeed, a technology standard established by an SSO typically is a class of technologies rather than a particular technology.").

274. *Id.* ("[D]eclared essential patents may not be necessary for companies to conform to the standard.").

275. *Id.* at 156 (mentioning that SEPs can be "innovative complements" or "innovative substitutes").

276. TIM POHLMANN & KNUT BLIND, *supra* note 124, at 24. Bekkers et al. consider a dozen SSOs and find about 4,910 SEP disclosures. Rudi Bekkers et al., *Disclosure Rules and Declared Essential Patents* 49 (Nat'l Bureau Econ. Res., Working Paper No. 23627, 2017), https://www.nber.org/papers/w23627.

277. *See* Robin Stitzing et al., Over-Declaration of Standard Essential Patents and Determinants of Essentiality 17 (Sept. 4, 2018) (available online),

Standardization increases the profits of adopters in other ways besides increasing the number of technological alternatives. New or revised technology standards often represent improvements in product performance.[278] Technology standards increase demand for innovative products by certifying quality and by promoting new product features to consumers.[279] Technology standards increase producer demand for innovative products by improving interoperability and reducing adoption costs.[280] Practically all standard organizations including standards development organizations (SDOs) and industry consortia view their mission as promoting the adoption of technology standards.[281]

Technological change and standardization extend beyond the value of the best alternative technologies available to adopters. The interaction between innovation and standardization increases the profits of adopters and other industry members.[282] By increasing profits, technology standards increase benefits to both patent holders and technology adopters, contrary to the "SEP holdup" allegation. Patent holders and technology adopters benefit from an increase in the size of the pie to be divided through negotiation.[283] An increase in profits minus the returns to the best alternative increases royalties received by patent holders and also increases returns to technology adopters.

Technology standards often are prospective, that is, standardization provides targets and guidance for R&D.[284] Standardization and innovation are related activities that interact over

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http://dx.doi.org/10.2139/ssrn.2951617 (basing the research of the over-declaration of SEPs on 79,257 patents in the ETSI database).

278. *See* Spulber, *supra* note 120, at 136 (noting that a technology standard often represents a goal for which technologies do not exist and improvements in the technology in turn will lead to updates to the standard).

279. *Id*.

280. *Id*.

281. *Id*. at 86 ("SSOs also establish IP policies that utilize FRAND commitments in order to encourage participate in standard setting and promote adoption of technology standards.").

282. DIN, *supra* note 263, at 15 (reaching a conclusion that standardization helps reduce costs and increase profits).

283. *See, e.g.*, Spulber, *supra* note 120, at 131 ("FRAND licensing is achieved by negotiation between those SEP owners and makers of mobile devices and network equipment.").

284. *Id*. at 136.

time.[285] Technologies generally are developed concurrently or even after technology standards.[286] The R&D needed to develop the new technologies is time consuming, costly, and subject to considerable uncertainty.[287] Standards incorporate technology proposals from industry participants, many of which are engaged in R&D to develop those technologies.[288] Standardization targets in turn help to guide R&D conducted while standards are developed.[289] Technologies involved in standardization often have not yet been fully developed during the standardization process.[290] Best alternative technologies often do not exist because they have not yet been developed during the standardization process.[291] Standardization both guides and reflects technological change.[292]

Negotiation of patent license agreements cannot occur before standardization.[293] This is because standardization is more complicated than choosing from a set of available innovative technologies. It would be inaccurate to suppose that the standardization process simply occurs after innovation.[294] Developing new technologies and technology standards takes time. Consider for example, the development of generations of standards in mobile telecommunication. Beginning with 1G in 1981 and continuing to 5G in 2021, the generations of technologies each represent about ten years.[295] It is predicted that developing the 6G

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285. *See id.* (noting that a technology standard often represents a goal for which technologies do not exist and improvements in the technology in turns will lead to updates to the standard).

286. *Id.*

287. Spulber, *supra* note 162, at 810.

288. *Id.* at 794 ("Before, or *ex ante*, multiple technologies may compete to be incorporated into the standard under consideration.").

289. *See* DIN, *supra* note 263, at 16 ("Business can reduce the economic risk of their R&D activities by participating in standardization.").

290. Spulber, *supra* note 120, at 99 ("Standardization typically does not involve a choice between a set of fully developed technology alternatives.").

291. *Id.*

292. *See* Spulber, *supra* note 162, at 825 (concluding that technology standards provide important guide and indication of technological change).

293. Spulber, *supra* note 120, at 98 (noticing that this results from IP policies).

294. Stitzing et al., *supra* note 277, at 12.

295. *See* Azar Taufique et al.,, *Planning Wireless Cellular Networks of Future: Outlook, Challenges and Opportunities*, 5 IEEE ACCESS 4821, 4831 (2017) (discussing this hirtory of cellular technology generations)*; see also* Dino Flore, *Tentative 3GPP Timeline for 5G*, 3GPP.ORG (Mar. 17, 2015),

mobile telecommunications standards and technologies will take another ten years, with a possible introduction after 2030.[296]

Standardization takes time because of the difficulties in information exchange, discussions in technical committees, and decision making within standard development organizations (SDOs). Standardization is a process of industry consensus building by members of standards organizations.[297] The members of standards organizations include not only inventors and innovators, but also suppliers of parts and components and producers of products and services.[298] The process of establishing standards requires extensive discussions because of the time required to understand potential technologies and the time involved in consensus decision making. Standards organizations require declaration of SEPs before the relevant technological specifications are incorporated in standards.[299]

Some argue for restrictions on injunctions because of the alleged effects of "SEP holdup" negotiation.[300] Injunctions, however, are simply a legal mechanism for enforcing IP rights and preventing infringement.[301] The effects of injunctions on patent license agreements are limited because injunctions require court

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https://www.3gpp.org/news-events/1674-timeline_5g (showing a 3GPP endorsed tentative time line for standardizing 5G).

296. 6G RESEARCH VISIONS 1, KEY DRIVERS AND RESEARCH CHALLENGES FOR 6G UBIQUITOUS WIRELESS INTELLIGENCE 6G FLAGSHIP 4 (Matti Latva-aho & Kari Leppänen eds., 2019) ("This new wave of technology will accelerate the digitalisation of economies and society. Historically, a new mobile 'generation' appears approximately every ten years, with 6G expected to emerge around 2030.").

297. *See, e.g.*, *Consumers and Standards: Partnership for a Better World*, ISO, https://www.iso.org/sites/ConsumersStandards/1_standards.html (last visited Oct. 25, 2020) ("An ISO International Standard represents a global consensus on the state of the art in the subject of that standard.").

298. *Id.* ("[T]he process allows for input and consensus building, first among market players and experts at the drafting stages of the standards . . . .").

299. Spulber, *supra* note 120, at 98.

300. *See, e.g.*, Lemley & Shapiro, *supra* note 30, at 1993 ("[T]he threat of an injunction can dramatically influence the negotiations between a single patent owner and an alleged infringer, especially if the patented technology covers one component of a complex product.")

301. *See Injunctions and Restraining Orders in Patent Infringement Cases*, JUSTIA, https://www.justia.com/intellectual-property/patents/infringement/injunctions-and-restraining-orders-in-patent-infringement-cases/ (last visited Oct. 25, 2020) ("If you can show that the defendant likely infringed on a valid patent that you own, you may be able to get an injunction from the judge that orders the defendant to stop the infringement. An injunction is not a substitute for damages . . . .").

approval.[302] The *eBay* decision placed limitations on injunctions by patent holders that have affected subsequent court decisions.[303] SSO FRAND commitments already protect the interests of patent holders and technology adopters in patent license negotiation.[304] Most SSO FRAND policies do not limit injunctions by patent holders, with the exception of the Institute of Electrical and Electronics Engineers (IEEE).[305]

The "SEP holdup" concept extends earlier arguments regarding "patent holdup" in patent license negotiation.[306] The "patent holdup" problem is said to occur if switching costs decrease the value of the adopter's best alternative thus increasing royalties.[307] This purported problem also suggests that patent holders take improper advantage of technology adopters.[308] As noted previously, the "patent holdup" concept has been highly influential.[309]

Adopters benefit from competition among substitute technologies, which increases the value of the best alternative.[310] Firms may incur switching costs when adopting new

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302. *Id.* ("An injunction is an order by a court . . . .").

303. eBay Inc. v. MercExchange, L.L.C., 547 U.S. 388 (2006)*; see* Christopher B. Seaman, *Permanent Injunctions in Patent Litigation After* eBay*: An Empirical Study,* 101 IOWA L. REV. 1949, 2002 (2015) (analyzing the implications of the Supreme Court's 2006 decision in *eBay v. MercExchange* on subsequent patent infringement cases); Ryan T. Holte & Christopher B. Seaman, *Patent Injunctions on Appeal: An Empirical Study of the Federal Circuit's Application of* eBay, 92 WASH. L. REV. 145, 145 (2017) ("More than ten years after the United States Supreme Court's landmark decision in *eBay v. MercExchange*, the availability of injunctive relief in patent cases remains hotly contested.").

304. *See* Spulber, *supra* note 120, at 118 (illustrating that patent license agreements protect the reasonable expectation of parties in the context of SSO FRAND).

305. *Id.* at 125.

306. *Id.* at 133 (mentioning that "'patent holdup' . . . may be termed 'SEP holdup' to distinguish from the basic switching cost story").

307. *Id.* at 132–33 (analyzing two related public policy concerns that "patent holdup" refers to).

308. *Id.*

309. *Id.* at 133 (mentioning that the "patent holdup" concept is popular).

310. Elhauge, *supra* note 218, at 537 (commenting on Lemley and Shapiro, and observing that "their holdup model does not apply in cases where multiple patent-licensees compete downstream. In such cases, competition will likely drive royalties toward patent value. Nor does their holdup model apply in cases where multiple patent-owners compete upstream. In such cases, royalties will tend to be inefficiently low").

technologies.[311] Switching costs include organizational adjustment costs, and absorption costs, such as the costs of learning about the new technology and learning how to use the new technology.[312] These are related to producer adjustment costs normally encountered in installing capital equipment or introducing worker tasks. If a patented technology has high adjustment costs, the producer will be more likely to adopt an alternative. Conversely, if an alternative technology has high adjustment costs, the producer is more likely to adopt a patented technology. Some switching costs only come into play if the technology adopter already is using the patented technology and must design around existing technology before adopting an alternative technology. Producers routinely incur such switching costs as innovations displace existing technologies.

C. "PATENT THICKETS," "BLOCKING PATENTS," AND THE "TRAGEDY OF THE ANTI-COMMONS"

Negotiation of patent license agreements realizes the benefits of increases in the number of patents. Negotiation of patent license agreements in a competitive market avoids multiple marginalization.[313] Negotiation of patent license agreements generates total royalties that are less than what a bundling monopolist inventor would charge.[314] Bilateral negotiation of patent license agreements allows technology adopters and patent holders to achieve multilateral coordination.[315] These advantages of negotiation are not affected by the number of patents.[316]

The negotiation framework presented here shows that increases in the number of patents increases benefits for technology adopters. Increases in the number of patents offer the potential for technological change and economic growth.[317] An increase in patents reflects more inventions and innovations

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311. Spulber, *supra* note 162, at 801.

312. *Id*.

313. Spulber, *supra* note 41, at 61–62.

314. *See generally id.* (discussing the effect negotiations have on a bundled monopolist's price).

315. *See* Spulber, *supra* note 162, at 800 (discussing the impact of bilateral negotiations on adopters and patent holders).

316. Spulber, *supra* note 41 (showing that the number of patents is not a factor for calculating the impact of negotiations).

317. *See Economic Development and Patents*, WIPO, https://www.wipo.int/patent-law/en/developments/economic.html (last visited Oct. 25, 2020) (demonstrating that patents promote economic development).

rather than dispersion of a given amount of IP. An increase in rate of patenting is a positive indicator of the strength of invention and innovation. Complementary patents, in particular, offer the benefits of technological synergies because inventions increase the economic benefits of other inventions.[318] Complementary inventions suggest a virtuous cycle as new inventions increase adopter benefits, and greater adopter benefits provide incentives for further invention and innovation.[319]

Some researchers and policy makers have expressed concerns that there are just "too many patents." Not surprisingly, public policy recommendations argue for reductions in the number of patents. These policy concerns are variously referred to as "patent thickets," "blocking patents," and the "Tragedy of the Anti-Commons." It is suggested that patent holders demand payment like trolls under a bridge.[320] Patent holders are said to collect tolls like medieval barons on the Rhine River.[321] Advocates describe complementary patents as dense bushes or trees that require hacking through or weeds that should be cleared.[322] Ayres and Parchomovsky refer to patents as an "information haze" comparable to environmental pollution and depletion of ocean fisheries.[323] They suggest that the United States Patent and Trademark Office (USPTO) increase renewal fees to decrease the number of patents or institute quantity regulation of the number of the patents combined with tradeable patent rights, another way of raising the costs of obtaining a patent.[324]

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318. Spulber, *supra* note 120, at 137 ("The combination of complementary components often results in complex systems that generate benefits greater than can be achieved by separate groups of components.").

319. *See, e.g.*, *id.* at 82 ("SSOs thus increase the rate of technological change because industry participants create complementary inventions and innovations.").

320. Anne Layne-Farrar & Klaus M. Schmidt, *Licensing Complementary Patents: "Patent Trolls," Market Structure, and "Excessive" Royalties*, 25 BERKELEY TECH. L. J., 1121, 1121 (2010).

321. Michael Heller, *The Tragedy of the Anticommons: A Concise Introduction and Lexicon*, 76 MOD. L. REV. 6, 9–10 (2013).

322. *See, e.g.*, Shapiro, *supra* note 32, at 120 (describing a patent thicket as "a dense web of overlapping intellectual property rights that a company must hack its way through in order to actually commercialize new technology"); Ayres & Parchomovsky, *supra* note 32, at 865 ("[W]e seek to explore two alternative mechanisms that may be used to weed out patent thickets.").

323. Ayres & Parchomovsky, *supra* note 32, at 866.

324. *Id.* at 865.

Many of the arguments for "patent thickets," "blocking patents," and the "Tragedy of the Anti-Commons" are based on the Cournot model.[325] An increase in the number of complementary property rights adversely affects market outcomes by intensifying the "Cournot Effect." Having more complementary patents exacerbates the free-rider effect and thus increases total royalties.[326] In turn, increases in royalties deter invention because future inventors will need to obtain patents to conduct R&D.[327] Also, increases in royalties deter innovation by decreasing adoption of patented technologies.[328]

These concerns hinge on the assumptions of the Cournot model. As has been emphasized, the Cournot model assumes "take-it-or-leave-it" pricing rather than negotiation.[329] The Cournot model assumes that IP holders have 100% of the market power in both markets for invention and downstream product markets. The Cournot model assumes that there is 100% pass through of royalty costs to downstream product prices. Together, these assumptions generate the result that an increase in the number of IP holders increases the severity of the "Cournot Effect."

The arguments for "patent thickets," "blocking patents," and the "Tragedy of the Anti-Commons" also are based on transaction costs.[330] Inventors and innovators are deterred because they

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325. *See, e.g.*, Charles deGrazia, Jesse Frumkin & Nicholas A. Pairolero, *Embracing Invention Similarity for the Measurement of Vertically Overlapping Claims* 1-2 (USPTO ECON. Working Paper, No. 2018-01, 2018), https://ssrn.com/abstract=3166042 (describing the patent thicket problem as being based on the "Cournot complements problem"); Shapiro, *supra* note 32, at 119 (defining a patent thicket as "an overlapping set of patent rights requiring that those seeking to commercialize new technology obtain licenses from multiple patentees").

326. deGrazia, Frumkin, & Pairolero, *supra* note 325, at 1–2.

327. *Id.* ("We propose a new measure of vertically overlapping claims that incorporates invention similarity to more precisely identify inventive overlap. The measure defined in this paper will enable more accurate measurement, and allow for novel economic research on technological complexity, fragmentation in intellectual property, and patent thickets within and across all patent jurisdictions.").

328. Spulber, *supra* note 120, at 153.

329. Spulber, *supra* note 27, at 138.

330. Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 SCIENCE 698, 701 (1998) ("An anticommons in biomedical research may be more likely to endure than in other areas of intellectual property because of the high transaction costs of

must negotiate with too many patent holders. The transaction cost argument, however, is inconsistent with the excessive royalty argument. The transaction cost argument is based on the costs of negotiation whereas the excessive royalty argument is based on the absence of negotiation, which underpins the "Cournot Effect."

The view that there are "too many patents" is fundamentally flawed, even within its own framework. First, the "too many patents" view, whether based on royalty effects or transaction costs, fails to account for the benefits of patented technologies.[331] In this view, patented technologies offer no profits for technology adopters and no benefits for their customers. The entry of inventors into the marketplace imposes costs without benefits.[332] As a consequence, patents appear to be a nuisance that imposes royalty costs and transaction costs on society. Consideration of the effects of the number of patents on efficiency should also include the economic benefits of patented technologies.

Second, the "too many patents" view ignores the need for incentives that would motivate inventors and innovators. Invention and innovation require costly capital investment, human capital, and creativity.[333] In the "too many patents" view, technological change arrives like a windfall, without the need for inventive or innovative effort. The economic and legal analysis ignores the contribution of royalties as returns to inventors and innovators. The number of patents is seen as excessive because royalties are a cost to society without any corresponding benefit.

Third, the "too many patents" view does not consider the contributions of the patent system itself to economic efficiency. Patents provide part of the system of IP rights that allows

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bargaining, heterogeneous interests among owners, and cognitive biases of researchers.").

331. *See* U.S. CONST. art. 1, § 8, cl. 8 ("To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries."); *see also*, Mark A. Lemley, *Property, Intellectual Property, and Free Riding*, 83 TEX. L.R. 1031, 1055 (2005) ("Intellectual property, then, is not a response to allocative distortions resulting from scarcity, as real property law is. Rather, it is a conscious decision to create scarcity in a type of good in which it is ordinarily absent in order to artificially boost the economic returns to innovation.").

332. *See*, *e.g.*, Buchanan & Yoon, *supra* note 34, at 5–10.

333. For a general discussion of this point, *see* Stephen Haber, *Patents and the Wealth of Nations*, 23 GEO. MASON L. REV 811, 834 (2016) ("[T]wo very different bodies of scholarship . . . yield the same answer: there is a causal relationship between strong patents and innovation.").

markets for IP to form.[334] Markets offer efficiencies in the allocation of technologies. Patents decrease transaction costs of technology transfer by standardizing descriptions of inventions and by offering certification of inventions as useful, novel, and nonobvious. Patents support all kinds of related transactions, including cross-licensing and financing based on patents as collateral assets.

Negotiation of patent license agreements addresses the interaction of complementary patent license agreements. There is considerable evidence that there is widespread usage of patent license agreements.[335] A number of institutional solutions address transactions costs and coordination with complementary patents. Many companies offer licenses for patent portfolios, which provide transaction cost efficiencies in comparison with licensing individual patents.[336] Patent license agreements improve coordination when there are complementary inventions.[337] Patents facilitate the entry of innovative specialist firms.[338] Intermediaries such as patent aggregators and patent pools also address transaction costs in comparison with licensing individual patents, as will be discussed further in the next section.

A number of other market institutions address transaction costs with complementary patents. Cockburn et al. find mixed effects of patent ownership diffusion on innovation, with firms adjusting their R&D and in-licensing decisions.[339] Graff et al.

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334. *See generally* Spulber, *supra* note 50 (asserting, for instance, that such a system "increases transaction efficiencies").

335. *See* Bharat N. Anand & Tarun Khanna, *The Structure of Licensing Contracts*, 48 J. INDUS. ECON.103, 103 (2000) ("Licensing is . . . one of the most commonly observed inter-firm contractual agreements."); Spulber, *supra* note 120, at 134.

336. Elyse Dorsey, *Building Patent Portfolios to Facilitate Cross-Licensing Agreements: Implications for Merger Efficiency Analysis*, 15 COLUM. SCI. & TECH. L. REV. 125, 135 (2013) ("[P]ortfolios do play an important role in both reducing litigation and transactions costs.").

337. ASHISH ARORA ET AL., MARKETS FOR TECHNOLOGY: THE ECONOMICS OF INNOVATION AND CORPORATE STRATEGY 171 (2001); Ashish Arora & Robert P. Merges, *Specialized Supply Firms, Property Rights and Firm Boundaries*, 13 INDUS. & CORP. CHANGE 451 (2004); Ashish Arora & Marco Ceccagnoli, *Patent Protection, Complementary Assets, and Firms' Incentives for Technology Licensing*, 52 MGMT. SCI. 293 (2006).

338. Damien Geradin et al., *Elves or Trolls? The Role of Nonpracticing Patent Owners in the Innovation Economy*, 21 INDUS. & CORP. CHANGE 73, 78 (2011).

339. Iain M. Cockburn et al., *Patent Thickets, Licensing and Innovative Performance*, 19 INDUS. & CORP. CHANGE 899, 901 (2010) (providing "the first

find that biotechnology firms use combinations of R&D and merger and acquisition (M&A) strategies.[340] Ziedonis finds evidence that firms address transaction costs by acquiring patents.[341] Galasso & Schankerman suggest that having more complementary patents in an industry may induce more rapid settlement in patent disputes.[342] The court in *Acorda Therapeutics*, which addresses "blocking patents," observed that companies facing patent expiration will pursue strategies such as "product-line extension (new formulations, new combinations), new indications, or a follow-on product."[343]

There is mixed empirical support for the dire predictions of "patent thickets" and "blocking patents." Empirical analyses of "patent thickets" offer minimal evidence of economic inefficiency. Hall et al. conduct an extensive survey that documents growth in the number of patents in the US and UK, but observed that "[o]ur report reveals a lack of empirical evidence on the

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direct evidence of a negative relationship between the fragmentation of upstream IP rights and the innovative performance of in-licensing firms . . . a provocative positive relationship between fragmentation and innovative performance among firms that do not in-license . . . [and] suggestive evidence that the effects of patent thickets may depend on the size of a firm's own patent portfolio").

340. Gregory D. Graff et al., *Agricultural Biotechnology's Complementary Intellectual Assets*, 85 REV. ECON. STAT. 349, 362 (2003) ("These findings support the hypothesis that the industry's recent restructuring is causally driven by the attempt of firms to achieve coordination between complementary intellectual assets in the face of the difficulties or transaction costs of accessing these assets externally.").

341. Rosemarie H. Ziedonis, *Don't Fence Me In: Fragmented Markets for Technology and the Patent Acquisition Strategies of Firms*, 50 MGMT. SCI. 804, 817 ("I find that firms acquire patents more aggressively than otherwise predicted when markets for technological inputs are highly fragmented (i.e., when rights to a firm's complementary patents are widely distributed among outside parties).").

342. Alberto Galasso & Mark Schankerman, *Patent Thickets, Courts, and the Market for Innovation*, 41 RAND J. ECON. 472, 501 (2010) ("We develop a model of patent litigation which predicts that settlement agreements are reached more quickly in the presence of fragmented patent rights and when there is less uncertainty about court outcomes, as was the case after the introduction of the 'pro-patent' appellate court."); *see also* Doug Lichtman, *Patent Holdouts and the Standard-Setting Process* (Coase-Sandor Inst. L. & Econ., Working Paper No. 292, 2006).

343. Acorda Therapeutics, Inc. v. Roxane Labs., Inc., 903 F.3d 1310, 1341 n.18 (Fed. Cir. 2018), cert. denied, 140 S. Ct. 111 (2019) (citing Chie Hoon Song & Jeung-Whan Han, *Patent Cliff and Strategic Switch: Exploring Strategic Design Possibilities in the Pharmaceutical Industry*, 5 SPRINGERPLUS 692, 698–99 (2016)).

effect of thickets on firm behavior, both in terms of performance and innovative activity."[344] Their survey finds that the literature has raised concerns about the social welfare effects of "patent thickets."[345] However "there is so far very little evidence on the effects patent thickets have on firm entry."[346] Blind et al. suggest various strategic motives for patenting by firms, but "the clear distinction between 'discrete' and 'complex' industries in the structure of the patent motives cannot be observed in our sample."[347] Von Graevenitz et al. explain that the growth of patent applications may be based on technological opportunities and complexity.[348]

There is little evidence for the "Tragedy of the Anti-Commons" in biomedical technology.[349] For example, some discussions of the "Tragedy of the Anti-Commons" rely on informal anecdotes.[350] Caulfield et al. find that there is more anecdote than evidence in biotechnology:

> The combination of a lack of empirical evidence of problems and a mismatch between the problems and proposed solutions may explain why there has been little actual policy change. In addition, our review of the lively policy debate and the limited empirical support for the claims that are driving that debate suggest that policy makers may be responding more to a high-profile anecdote or arguments with high face validity than they are to systematic data on the issues.[351]

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344. BRONWYN HALL ET AL., A STUDY OF PATENT THICKETS 51 (2012).

345. *Id*. at 52.

346. *Id.*

347. Knut Blind et al., *Motives to Patent: Empirical Evidence from Germany*, 35 RES. POL'Y 655, 671 (2006); *see also* Knut Blind et al., *The Influence of Strategic Patenting on Companies' Patent Portfolios*, 38 RES. POL'Y 428 (2009).

348. Von Graevenitz et al., *Incidence and Growth of Patent Thickets: The Impact of Technological Opportunities and Complexity*, 61 J. INDUS. ECON. 521 (2013).

349. Richard A. Epstein & Bruce N. Kuhlik, *Is There a Biomedical Anticommons?*, REGULATION, Summer 2004, at 54, 56.

350. *See* Michael A. Heller, *The Tragedy of the Anticommons: Property in the Transition from Marx to Markets*, 111 HARV. L. REV. 621, 621–88 (1998) (developing the theory of anticommons property through the example of post-1990 Moscow); *id*. at 700("When owners have conflicting goals and each can deploy its rights to block the strategies of the others, they may not be able to reach an agreement that leaves enough private value for downstream developers to bring products to the market."); MICHAEL HELLER, THE GRIDLOCK ECONOMY: HOW TOO MUCH OWNERSHIP WRECKS MARKETS, STOPS INNOVATION, AND COSTS LIVES 49–78 (2008) (providing a series of narratives to anticommons theory in the biomedical field).

351. Timothy Caulfield et al., *Evidence and Anecdotes: An Analysis of Human Gene Patenting Controversies*, 24 NATURE BIOTECH. 1091, 1094 (2006).

According to Buckley, the "Tragedy of the Anti-Commons" may simply be a myth in the biotechnology industry.[352] Barnett observes that the lack of evidence for the "Tragedy of the Anti-commons" suggests that this concern should not be used as a guide for public policy:

> [T]he paucity of empirical evidence to support the AC [anti-commons] thesis reduces confidence in proposals to weaken IP rights in order to protect the market from AC effects. Conversely, the abundance of empirical evidence for markets' self-corrective capacities raises confidence that robust IP protection carries little threat of deadlock.[353]

Barnett finds little evidence of persistent effects of the number of patents on markets for IP.[354]

D. "REGULATORY PATENT POOLS"

Negotiation of patent license agreements in competitive markets generally is sufficient to achieve economic efficiency with complementary inventions. As emphasized here, negotiation allows patent holders and technology adopters to form tailored patent license agreements. This helps explain why many industries favor negotiation over patent pools. About ninety percent of SEPs are licensed through negotiation rather than through patent pools.[355]

Patent pools that allow patent holders and technology adopters the option of negotiating individual licenses generate royalties that are comparable to market negotiation.[356] This suggests that antitrust agencies should continue their policy of

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352. TED BUCKLEY, THE MYTH OF THE ANTICOMMONS (2007).

353. *See* Jonathan M. Barnett, *The Anti-Commons Revisited*, 29 HARV. J. L. & TECH. 127, 133 (2015).

354. *Id*. ("Viewed as a whole, the accumulated body of evidence provides little ground to believe that AC effects typically persist in IP-intensive markets or cause any significant adverse effect to innovation.").

355. Tim Pohlmann & Knut Blind, *IPlytics Landscaping Study on Standard Essential Patents (SEPs) in Europe*, at 36 (Dec. 12, 2016), https://ec.europa.eu/docsroom/documents/20741/attachments/1/translations/en/renditions/native ("91% of the worldwide declared SEPs are licensed individually rather than through a patent pool.").

356. *See* Lerner & Tirole, *supra* note 31 (discussing a related point in the context of Cournot and Bertrand pricing); *see also* Josh Lerner, Marcin Strojwas, & Jean Tirole, *The Design of Patent Pools: The Determinants of Licensing Rules*, 38 RAND J. ECON. 610, 610 (2007) (predicting that "pools consisting of complementary patents are more likely to allow members to engage in independent licensing").

neutrality with regards to patent pools and negotiated patent license agreements.

Some policy makers recommend "regulatory patent pools" to address complementary inventions and technology standards. For example, the European Commission states that "[t]echnology pools can also produce pro-competitive effects, in particular by reducing transaction costs and by setting a limit on cumulative royalties to avoid double marginalization."[357] Although patent pools may require complementary inventions, this does not mean that complementary inventions call for "regulatory patent pools."

The antitrust policy recommendation that regulatory authorities should encourage patent pools is based on applications of the Cournot model. According to the "Cournot Effect," total per unit royalties chosen by holders of complementary patents are greater than those chosen by a bundling monopolist.[358] Application of the Cournot model assumes that patent pools choose running royalties that are constant per unit of output and correspond to those of a bundling monopolist. The "Cournot Effect" drives the prediction that a patent pool would lower total royalties with complementary inventions.[359]

Any antitrust policy toward patent pools based on the "Cournot Effect" is misguided for a number of important reasons. The main problem with the Cournot model approach is that it characterizes patent pools as bundling monopolists.[360] The Cournot model approach to patent pools again incorrectly assumes 100% cost pass-through in the downstream market, which does not describe most markets in practice. The Cournot model approach to patent pools further assumes that the patent pool has 100% market power not only in the market for

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357. Commission Notice, Guidelines on the Application of Article 81 of the EC Treaty to Technology Transfer Agreements, 2004 O.J. (C 101) 37, https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2004:101:0002:0042:EN:PDF.

358. *See* Spulber, *supra* note 27, at 138 ("[M]onopolists supplying complementary inputs to competitive downstream producers will choose prices whose total is greater than what a monopolist would charge for a bundle of those inputs.").

359. *See, e.g.*, Shapiro, *supra* note 32, at 123 ("Cournot's theory of complements cast in terms of blocking patents . . . gives strong support for businesses to adopt, and for competition authorities to welcome, either cross licensees, package licenses, or patent pools to clear such blocking positions.").

360. *See* Spulber, *supra* note 27 (discussing the Cournot model).

inventions but also in the downstream product market. The Cournot model approach to patent pools further requires that royalties are constant charges per unit of output, which guaranties price distortions downstream when combined with the monopoly assumptions. Using these assumptions, the Cournot model predicts that a patent pool would choose a total royalty such that the downstream output price equals the textbook monopoly price per unit of output. This is the other side of the "Cournot Effect", which states that patent holders choose royalties greater than the bundling monopoly.[361]

The Cournot model approach mischaracterizes the bundling monopoly patent holder. The bundling monopoly does not face 100% cost pass-through because downstream producers have upward sloping supply curves. As the previous discussion shows, when the bundling monopoly is a price taker in the downstream market, the bundling monopoly has an incentive to choose a zero per unit royalty. The bundling monopoly will choose royalties that are contingent on downstream market prices. Then, royalties will be a share of the profits of downstream producers.

As noted previously, it is also inaccurate to characterize patent pools as bundling monopolists. In practice, patent pools establish some running royalties that are constant per unit of output.[362] These royalties, however, are subject to adjustments that depart from constant running royalties. The royalties can be a schedule of running royalties where the royalty rate is lower for higher numbers of units sold.[363] Some of these royalties are waived for producers with small outputs. Royalties are subject to firm-level caps that limit total royalties. In addition, the patent pool reduces running royalties over time. For example, MPEG LA's running royalty for MPEG-2 Decoders and Encoders declined steadily: $4.00 per unit before January 1, 2002, $2.00 from January 1, 2010 through December 31, 2015, $0.50 from January 1, 2016 through December 31, 2017, and $0.35 starting

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361. *Id*. at 138 ("[E]ach input monopolist chooses its price without taking into account the effect of its price on the demand for all of the complementary inputs.").

362. *See, e.g.*, *MPEG-2 License Terms Summary*, MPEG LA, https://www.mpegla.com/wp-content/uploads/m2web-RoyaltySummary.pdf (displaying the royalty schedules of licensing agreements).

363. *See, e.g.*, License Fees, VIA LICENSING, https://www.via-corp.com/licensing/802-11/802-11-license-fees/ (displaying the royalty schedule for the IEE standard).

January 1, 2018.[364] The level of these running royalties does not appear consistent with the unlimited monopoly power suggested by the Cournot model.

The purpose of patent pools is to provide intermediation between patent holders and technology adopters. Patent pools and other intermediary organizations offer transaction cost savings.[365] As I discuss elsewhere, patent pools and other intermediaries provide transaction cost savings by designing "Intellectual Contracts" (ICs) and coordinating contracting.[366] Patent pools and other intermediaries offer market platforms for ICs that provide the convenience of standardization and one-stop shopping.[367] Merges emphasizes that patent pools offer transaction costs savings of collective rights organizations particularly with high volume licensing.[368] Merges & Mattioli empirically determine transaction cost savings from patent pools.[369] Patent pools also incur transaction costs of formation and costs of determining whether patents are essential to technology standards.[370]

These observations suggest that antitrust policy should not promote patent pools as a mechanism for regulating royalties. The courts have not viewed patent pools as a means of regulating royalties with complementary inventions. A century of litigation involving patent pools shows that competitive effects related to complements have not played an important role.[371]

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364. *MPEG-2 License Terms Summary*, *supra* note 362.

365. den Butter et al., *supra* note 261 at 20.

366. *See* Spulber, *supra* note 44.

367. *Id*.

368. Robert P. Merges, *Contracting into Liability Rules: Intellectual Property Rights and Collective Rights Organizations*, 84 CALIF. L. REV. 1293, 1295–96 (1996).

369. *See* Robert P. Merges & Michael Mattioli, *Measuring the Costs and Benefits of Patent Pools*, 78 OHIO ST. L. J. 281 (2017) (expressing concerns about welfare effects of patent pools); *see also* Steven C. Carlson, *Patent Pools and the Antitrust Dilemma*, 16 YALE J. REG. 359 (1999) (arguing that the Department of Justice and the Federal Trade Commission should not adopt a per se rule of legality for the pooling of blocking patents).

370. Contreras, *supra* note 21, at 76 ("[P]atent pool licensing comes at a steep cost. Most importantly, patent pools typically involve substantial up-front expenses (primarily legal and patent analysis costs) associated with their formation . . . [P]atent pools must ensure, with a high degree of certainty, that all patents placed in the pool are essential.").

371. Richard J. Gilbert, *Anti-Trust for Patent Pools: A Century of Policy Evolution*, 2004 STAN. TECH. L. REV. 3, ¶ 13 ("Patents that are one-way or two-way

The Antitrust Guidelines identify a number of economic benefits of patent pools and cross-licensing of IP:

> These arrangements may provide procompetitive benefits by integrating complementary technologies, reducing transaction costs, clearing blocking positions, and avoiding costly infringement litigation. By promoting the dissemination of technology, cross-licensing and pooling arrangements are often procompetitive.[372]

Patent pools thus offer transaction efficiencies and facilitate technology adoption rather than reducing royalties.

Patent pools generally offer standardized contracts with take-it-or-leave-it provisions and royalty rates. Consider for example the MPEG LA patent pool, which might best be described as a patent supermarket consisting of multiple patent pools. MPEG LA refers to itself as "the world's leading packager and provider of one-stop licenses for standards and other technology platforms."[373] MPEG LA offers patent portfolio licenses related to the IEEE 1394 high speed transfer digital interface, MPEG-2 video and systems coding standards, MPEG-4 (Part 2) Visual patents, VC-1 digital video coding standard, MVC digital video coding standard, and the digital terrestrial television standard, Dynamic Adaptive Streaming over HTTP (DASH), display ports, high-efficiency video coding (HEVC), enhanced voice services, and electric vehicle charging.[374] MPEG continues to develop new patent pools such as the biotechnology CRISPR-Cas9 Joint Licensing Platform.[375]

MPEG LA connects hundreds of patent holders with more than 6000 licensees and involves thousands of patents.[376] MPEG LA emphasizes the avoidance of transaction costs and litigation costs:

> By assisting users with implementation of their technology choices, MPEG LA offers licensing solutions that provide access to fundamental intellectual property, freedom to operate, reduced litigation risk and predictability in the business planning process. In turn, this enables inventors, research institutions and other technology owners to

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blocking are complementary, in the sense that an increase in the price of one patent (or a reduction in its availability) reduces the value of the other patent.").

372. ANTITRUST GUIDELINES, *supra* note 4, at 30.

373. MPEG LA, https://www.mpegla.com/.

374. *Current Programs*, MPEG LA, https://www.mpegla.com/programs/.

375. *Programs in Development*, MPEG LA, https://www.mpegla.com/programs-in-development/.

376. MPEG LA, *supra* note 373.

> monetize and speed market adoption of their assets to a worldwide market while substantially reducing the cost of licensing.[377]

The MPEG LA patent pool emphasizes that it offers an alternative to negotiation:

> To resolve uncertainty and conflict in the use of MPEG-2 intellectual property, as a convenience to users, the licensing model pioneered and employed by MPEG LA revolutionized intellectual property rights management by enabling multiple MPEG-2 users to acquire essential patent rights from multiple patent holders in a single transaction as an alternative to negotiating separate licenses.[378]

Via Licensing, a subsidiary of Dolby Industries, acts as a patent pool.[379] The Via patent pool includes various audio patent licenses: Advanced Audio Coding (AAC), MPEG-4 SLS, and MPEG Surround.[380] The VIA patent pool also includes wireless patent licenses: Multi-Generational (MG) Wireless Program, Connected Motor Vehicles, Mobile Devices & General Products, LTE, WCDMA, and IEEE 802.11.[381] SISVEL also operates multiple licensing programs in wireless communications, digital video and display technology, audio and video coding and decoding, broadband, and localization.[382]

V. CONCLUSION

Negotiation of patent license agreements in competitive markets provides coordination and economic efficiency. Negotiation avoids multiple marginalizations and allows royalties to be contingent on market outcomes. Negotiation helps realize benefits from increases in the number of patents that improve invention and innovation. This counters the view that there are "too many patents." Negotiation also helps industries obtain the benefits of standardization, which increases the returns to adopting technologies and the value of the best alternative technologies.

Public policy makers should continue to carefully consider the institutional features of the market for IP licensing. Proposed policies that discourage negotiation of patent license contracts in competitive markets appear designed to decrease patent license royalties and reduce the returns to invention.

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377. *Id.*

378. *About,* MPEG LA, https://www.mpegla.com/about/.

379. *About*, VIA LICENSING, https://www.via-corp.com/about/.

380. *Innovation*, VIA LICENSING, https://www.via-corp.com/innovation/.

381. *Id.*

382. *Licensing Programs*, SISVEL, https://www.sisvel.com/licensing-programs/background.

Antitrust policies that promote the interests of technology adopters over patent holders would be consistent with rent-seeking.[383] If total royalties are too low, revenues from SEPs will discourage inventors' investment in R&D and diminish the quality of the new technology. This will reduce the rate of technological change and decrease dynamic efficiency. Some have observed diminished incentives to invent, including "lower research intensity," the "creativity crisis," the "end of low-hanging fruit," and the "techcrunch."[384]

The negotiation framework presented here reverses predictions based on the Cournot model. Antitrust policies based on the "Cournot Effect" would weaken protections for IP and diminish incentives for invention, innovation, and standardization. There is little empirical or conceptual support for antitrust policies driven by the "Cournot Effect": "royalty stacking," "SEP holdup," "patent thickets," "blocking patents," and the "Tragedy of the Anticommons." Antitrust policy should not encourage "regulatory patent pools" as a means of reducing royalties. Antitrust policy should view patent pools as a means of mitigating transaction costs under some market conditions.

The Antitrust Guidelines recognize that patent license negotiation with complementary inventions enhances competition. The Antitrust Guidelines reflect the economic performance of markets for patent license agreements. Most patent licensing outside of patent pools involves negotiation. Patent licensing contracts outside of patent pools typically involve contingencies that reflect prices, revenues, or profit. The market power of inventors in markets for IP and in product markets is significantly constrained by competition from substitute technologies,

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383. For information on rent-seeking, *see* Gordon Tullock, *The Welfare Costs of Tariffs, Monopolies, and Theft*, 5 W. ECON. J. 224 (1967); Anne O. Krueger, *The Political Economy of the Rent-Seeking Society*, 64 AM. ECON. REV. 291 (1974); Robert D. Tollison, *Rent Seeking: A Survey*, 35 KYKLOS 575 (1982); GORDON TULLOCK, RENT SEEKING (1993).

384. *See* Richard Florida, *America's Looming Creativity Crisis*, HARV. BUS. REV., Oct. 2004, https://hbr.org/2004/10/americas-looming-creativity-crisis; TYLER COWEN, THE GREAT STAGNATION: HOW AMERICA ATE ALL THE LOW-HANGING FRUIT OF MODERN HISTORY, GOT SICK, AND WILL (EVENTUALLY) FEEL BETTER (2011); Mark R. Anderson, *The Big Shift: The End Of The Era Of Great Invention*, FORBES (Aug. 11, 2013, 10:30 AM), https://www.forbes.com/sites/ciocentral/2013/08/11/the-big-shift/ - 362d627788c9; John G. Fernald & Charles I. Jones, *The Future of US Economic Growth*, 104 AM. ECON. REV. 44 (2014); Erik Brynjolfsson, Andrew McAfee & Michael Spence, *Labor, Capital, and Ideas in the Power Law Economy*, 93 FOREIGN AFF. 44 (2014).

complementary component suppliers, output producers, distributors, and retailers. Royalties in practice are a small fraction of revenues in such industries as mobile telecommunications, where technology standards and SEPs play important roles. A better understanding of patent license negotiation helps address antitrust concerns regarding innovation and standardization.

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