Article

Holdup, Royalty Stacking, and the Presumption of Injunctive Relief for Patent Infringement: A Reply to Lemley and Shapiro

J. Gregory Sidak†

"Patent holdup" is described by its critics as occurring when a patent holder uses a court's issuance of an injunction (or merely the threat of an injunction) to block an infringer's use of the patented invention unless the infringer, who has made sunk investments in expectation of using the patented invention, pays a royalty that is, from the infringer's perspective, excessively high.[1] "Royalty stacking" is described by its critics as occurring when a product sold to end users incorporates many separate patented inputs, and the holder of the patent to one such input—an input lacking immediate substitutes—demands a high royalty from the manufacturer of the end product without regard to the effect that this royalty will have on the total amount of royalties that the manufacturer must pay to all holders of patented inputs and, consequently, the price that the manufacturer must charge end users.[2] Professors Mark Lemley and Carl Shapiro argue that patent holdup and royalty stacking are serious problems,[3] and that legislators or courts (if not both) should limit the circumstances in which a patent holder may avail himself of the existing statutory right to enjoin the infringer's use of the patent—essentially only if the patent protects an input that represents a significant portion of the final value of the product.[4] That is, Lemley

† Visiting Professor of Law, Georgetown University Law Center. E-mail: jgsidak@aol.com.

1. *See* Mark A. Lemley & Carl Shapiro, *Patent Holdup and Royalty Stacking*, 85 TEX. L. REV. 1991, 1992–93 (2007).

2. *Id.* at 1993.

3. *Id.* at 2010–17.

4. *Id.* at 2035–39.

and Shapiro advocate a further weakening of patent holders' rights.

The current debate over patent holdup and royalty stacking resembles the controversy during the previous decade over the setting of regulated prices for the mandatory unbundling of telecommunications networks. There, the network owner (the analog to the patent holder) disputed whether it had an obligation to sell access to particular unbundled network elements at regulated rates.[5] For those network elements found to be subject to mandated unbundling at regulated rates, the debate then shifted to the calculation of an efficient, forward-looking price for use of the network element (the analog to the reasonable royalty rate that would prevent holdup).[6] On this issue, the proposals of would-be patent licensees to eliminate injunctive relief are analogous to the actions of regulators to reject access prices calculated on the basis of either opportunity cost[7] or the real option value of network access at low, regulated rates.[8]

5. AT&T Corp. v. Iowa Utils. Bd., 525 U.S. 366, 370–77 (1999).

6. Verizon Commc'ns Inc. v. FCC, 535 U.S. 467, 496–507 (2002).

7. *See* WILLIAM J. BAUMOL & J. GREGORY SIDAK, TOWARD COMPETITION IN LOCAL TELEPHONY 93–94, 108–16 (1994) (noting that the optimal input price of a product should equal its "average-incremental cost, including all pertinent incremental opportunity costs"); J. GREGORY SIDAK & DANIEL F. SPULBER, DEREGULATORY TAKINGS AND THE REGULATORY CONTRACT: THE COMPETITIVE TRANSFORMATION OF NETWORK INDUSTRIES IN THE UNITED STATES 319–35 (1997) (arguing that the FCC's rejection of the efficient component-pricing rule (ECPR) as a proper method for setting prices is due to its incorrect definition of opportunity costs); J. Gregory Sidak & Daniel F. Spulber, *The Tragedy of the Telecommons: Government Pricing of Unbundled Network Elements Under the Telecommunications Act of 1996*, 97 COLUM. L. REV. 1081, 1093–98 (1997) (arguing that the FCC's assessment and rejection of the ECPR was erroneous, and that prices for unbundled network elements should be set according to the market-determined efficient component-pricing rule (M-ECPR), by taking into account the incumbent's opportunity cost of providing the unbundled input). The classic definition of opportunity cost comes from Armen Alchian, who wrote that "the cost of an event is the highest-valued opportunity necessarily forsaken." Armen A. Alchian, *Cost*, *in* 3 INTERNATIONAL ENCYCLOPEDIA OF THE SOCIAL SCIENCES 404, 404 (1968).

8. *See* Jerry A. Hausman & J. Gregory Sidak, *A Consumer-Welfare Approach to the Mandatory Unbundling of Telecommunications Networks*, 109 YALE L.J. 417, 464–66 (1999) ("Regulators distort the apparent need for mandatory unbundling when they force an [incumbent local exchange carrier] to lease a network element at [total element long-run incremental cost], rather than at a price that incorporates the full option value conferred on the [competing local-exchange carrier]."); Jerry A. Hausman, *Valuing the Effect of Regulation on New Services in Telecommunications*, *in* BROOKINGS PAPERS ON ECONOMIC ACTIVITY: MICROECONOMICS 1997, at 1, 26–35 (Martin Neil Baily

Regulators instead required prices that were based on an engineering model of the forward-looking incremental costs of a hypothetical telecommunications network operator efficiently using the best technology currently available.[9] Network operators objected that this regime of hypothetical incremental-cost pricing denied them the opportunity to recoup their sunk investments in infrastructure.[10] Some of the same scholars who applauded this pricing regime are today proponents of limiting injunctive relief for patent infringement so as to reduce the royalty rate that will be negotiated between the owner of a valid patent and the party found to have infringed that patent.

It is unambiguous after the Supreme Court's 2004 decision in *Verizon Communications Inc. v. Law Offices of Curtis V. Trinko, LLP* that American antitrust law does not forbid a monopolist to charge as high a price for her product as she likes, provided that she did not unlawfully acquire the monopoly or does not take improper actions to maintain or extend that monopoly.[11] Consequently, it does not violate American antitrust law for the owner of a patent (which, of course, does not necessarily confer monopoly power in an antitrust sense)[12] to refuse to license his patent unless he receives the royalty he demands.[13] The Federal Trade Commission's 2006 decision in *In re Rambus, Inc.* does not alter that principle.[14] There, the patent holder was found to have monopolized the markets for four technologies in violation of § 2 of the Sherman Act[15] because it knowingly deceived its fellow members of a standard-setting organization (SSO), in violation of § 5 of the Federal Trade Commission Act,[16] so that they might unknowingly adopt the patent holder's proprietary technologies as standards.[17] And, of

et al. eds., 1998) (arguing that the FCC's pricing framework incorrectly assumes that no technological or economic uncertainty exists).

9. *Verizon Commc'ns*, 535 U.S. at 495.

10. *Id.* at 518.

11. Verizon Commc'ns Inc. v. Law Offices of Curtis V. Trinko, LLP, 540 U.S. 398, 407–08 (2004).

12. Ill. Tool Works, Inc. v. Indep. Ink, Inc., 547 U.S. 28, 43 n.4 (2006).

13. *Trinko*, 540 U.S. at 407 ("To safeguard the incentive to innovate, the possession of monopoly power will not be found unlawful unless it is accompanied by an element of anticompetitive *conduct*.").

14. *In re* Rambus, Inc., 2006-2 Trade Cas. (CCH) ¶ 75,364, at 105,476 (FTC July 31, 2006), *available at* http://www.ftc.gov/os/adjpro/d9302/060802commissionopinion.pdf (finding Rambus liable for monopolization).

15. 15 U.S.C. § 2 (Supp. IV 2006).

16. 15 U.S.C.A. § 45 (West 1997 & Supp. 2007).

17. *In re Rambus*, 2006-2 Trade Cas. (CCH) at 105,476.

course, fraudulent inducement of this sort would be actionable under contract law and tort law. But the benign owner of a patent that confers monopoly power is not obligated by antitrust law to refrain from exploiting its power over price.[18] Section 2 of the Sherman Act does not transform the owner of a valuable patent into a public utility—nor, for that matter, does any provision of patent law.

European competition law treats the benign monopolist less kindly. A monopolist can violate Article 82 of the Treaty Establishing the European Community[19] by charging an excessive price.[20] Consequently, Article 82 jurisprudence on excessive patent royalties may develop in Europe to resemble the determination of regulated rates for unbundled network elements, which are calculated on the basis of long-run incremental cost.[21] Any American firm filing patents in Europe, or selling patented inventions there, must manage its intellectual property portfolio with an understanding that Article 82 could be construed to regulate the acceptable level of patent royalties.

The concern here is that this process denies the patent holder the ability to achieve a royalty rate that compensates for his opportunity cost, which should include the real option value. As Part II.B.2 will discuss, this option value affords others in the market the chance to costlessly await the resolution of uncertainty over the profitability of any particular patented technology. If licensees can secure a royalty rate that is predicated on incremental cost, rather than the more accurate value that includes this option value, the court will have denied the patent holder the opportunity to exercise its lawful right to attempt to earn quasi rent and even monopoly rent. That result would conflict with antitrust law in the sense that the Court

18. *See Trinko*, 540 U.S. at 407 ("The mere possession of monopoly power, and the concomitant charging of monopoly prices, is not only not unlawful; it is an important element of the free-market system.").

19. Treaty Establishing the European Community, Dec. 29, 2006, 2006 O.J. (C 321E) 37, 74–75 [hereinafter EC Treaty].

20. *See* Case 27/76, United Brands Co. v. Comm'n, 1978 E.C.R. 207, ¶ 250, at 301 (stating that a price is excessive when it "has no reasonable relation to the economic value of the product supplied"); David S. Evans & A. Jorge Padilla, *Excessive Prices: Using Economics to Define Administrable Legal Rules*, 1 J. COMPETITION L. & ECON. 97, 98 (2005) ("[A] dominant firm violates Article 82(a) if it charges *unfairly* high prices to its customers."). Article 82 provides, among other things, that firms with a dominant position are prohibited from "directly or indirectly imposing unfair purchase or selling prices or other unfair trading conditions." EC Treaty art. 82(a).

21. *See supra* text accompanying note 9.

emphasized in *Trinko* that this opportunity to earn rents is critical to preserving competitive incentives for investment in innovation and product development.[22]

In this Article, I present an alternative perspective on patent holdup and royalty stacking. In Part I, I examine the theoretical models of Lemley and Shapiro in their work on the effect of injunctive relief on negotiated royalty rates. In their model, patent holders can engage in "holdup" by using the threat of an injunction, thus enabling the patentee to command a negotiated royalty that exceeds what Lemley and Shapiro consider to be the reasonable royalty rate.[23] The Supreme Court has accepted this proposition that holdup can occur. In *eBay Inc. v. MercExchange, L.L.C.*, the Court in 2006 addressed the legal standard that a plaintiff must meet to obtain permanent injunctive relief against a patent infringer,[24] and it held that, "[a]ccording to well-established principles of equity," the four-factor test commonly applied to general injunctive relief cases also applies to cases arising under the Patent Act.[25] Justice Anthony Kennedy, in a concurring opinion, observed that injunctive relief is a powerful bargaining tool for the patent holder in the manner that Lemley and Shapiro theorize.[26] The concerns over patent holdup are being seriously discussed in courts, as shown in the recent *Broadcom Corp. v. Qualcomm Inc.* opinion.[27]

Despite Lemley and Shapiro's insistence to the contrary, there is little evidence of the existence of the holdup and royalty stacking problems that concern them. The empirical work that exists on the matter concludes there is no royalty stacking problem in practice. Damien Geradin, Anne Layne-Farrar, and Jorge Padilla empirically analyzed the patents related to the third-generation (3G) cellular telephone technology—one in-

22. *Trinko*, 540 U.S. at 407 ("The opportunity to charge monopoly prices—at least for a short period—is what attracts 'business acumen' in the first place; it induces risk taking that produces innovation and economic growth." (quoting United States v. Grinnell Corp., 384 U.S. 563, 570–71 (1966))).

23. *See* Lemley & Shapiro, *supra* note 1, at 2008.

24. eBay Inc. v. MercExchange, L.L.C., 126 S. Ct. 1837, 1839 (2006).

25. *Id.* at 1839 ("These familiar principles apply with equal force to disputes arising under the Patent Act.").

26. *Id.* at 1842 (Kennedy, J., concurring) ("[A]n injunction, and the potentially serious sanctions arising from its violation, can be employed as a bargaining tool to charge exorbitant fees to companies that seek to buy licenses to practice the patent.").

27. Broadcom Corp. v. Qualcomm Inc., 501 F.3d 297, 301 (3d Cir. 2007) (acknowledging the inefficiencies produced by patent holdup).

dustry that Lemley and Shapiro explicitly offer as an example of holdup and royalty stacking[28]—and concluded that there is no evidence of royalty stacking among the more than sixty companies involved in the standard.[29] Similarly, Geradin's and Miguel Rato's general assessment of the literature in this area shows how Lemley and Shapiro's fear of holdup and royalty stacking is potentially misplaced.[30]

In Part II, I present a critique of the Lemley-Shapiro model of patent law. My critique focuses on several key aspects of the Lemley-Shapiro framework. First, I explain that the Lemley-Shapiro framework does not properly account for the relevant error costs associated with weakening the presumption of injunctive relief.[31] In particular, Lemley and Shapiro fail to consider how removing the presumption of injunctive relief could decrease dynamic efficiency.[32] Furthermore, even if their framework were correct, Lemley and Shapiro rely on biased parameters that preordain their result. This outcome follows for two reasons. First, because Lemley and Shapiro fail to account for the real option conferred on potential users of the patent when a patent holder makes sunk investments in new technologies or products, their hypothetical "reasonable royalty rate" is biased downwards.[33] Second, the Lemley-Shapiro model reaches its result not by deriving a general bargaining model, but by assigning all the bargaining power to the patent holder and claiming a general result.[34] Both factors bias Lemley and Shapiro's results in favor of the infringing party. Their oversight is easy to commit. In *eBay*, for example, Justice Kennedy essentially agreed with Lemley and Shapiro.[35] He described the problem of exorbitant royalty rates in the context that Lemley

28. *See* Lemley & Shapiro, *supra* note 1, at 2025–27 (discussing the royalty stacking problem in 3G cellular technology using empirical evidence).

29. *See* Damien Geradin, Anne Layne-Farrar & A. Jorge Padilla, Royalty Stacking in High Tech Industries: Testing the Theory 29–32 (May 31, 2007) (unpublished manuscript, available at http://ssrn.com/abstract=949599).

30. *See* 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 25 (Apr. 2006) (working paper, available at http://ssrn.com/abstract=946792).

31. *See infra* Part II.A.

32. *See infra* Part II.A.

33. *See infra* Part II.B.1.

34. *See infra* Part II.C.

35. *See* eBay Inc. v. MercExchange, L.L.C., 126 S. Ct. 1837, 1842 (2006) (Kennedy, J., concurring) (noting that injunctions "can be employed as a bargaining tool" allowing companies holding patents to charge high fees).

and Shapiro describe—where the value of the patented component is small in comparison to the value of the entire product.[36] This characterization is an overstatement, and potentially a significant one.

I. THE LEMLEY-SHAPIRO MODEL OF PATENT HOLDUP

In a series of papers, Lemley and Shapiro analyze the case of a patent holder and a potential infringer who is producing a product that incorporates the patented product or component.[37] Because the patent is only possibly valid and infringed, the potential infringer faces only the possibility of an injunction rather than the certainty of one.[38] Lemley and Shapiro argue that this injunctive relief, when combined with a patented component that accounts for only a small portion of the infringer's product, results in a negotiated royalty rate that exceeds a defined hypothetical benchmark.[39]

A. THE LEMLEY-SHAPIRO MODEL

Lemley and Shapiro present a theory of patent holdup that proceeds in essentially two parts. The first is an initial analytic discussion of a holdup problem whereby a patent holder can use the threat of obtaining an injunction to successfully negotiate royalty rates that exceed a defined hypothetical benchmark.[40] The second part discusses some empirical examples that, according to Lemley and Shapiro, show how the holdup problem is exacerbated when a product incorporates multiple patents, resulting in royalty stacking.[41]

1. Holdup

Lemley and Shapiro analyze a bargaining model where a patent holder and a downstream firm negotiate a royalty rate.[42]

36. *Id.*

37. *See* Lemley & Shapiro, *supra* note 1, at 1994–2010; Carl Shapiro, *Injunctions, Hold-Up, and Patent Royalties* 6 (Competition Policy Ctr., Working Paper No. CPC06-062, 2006), *available at* http://faculty.haas.berkeley.edu/shapiro/royalties.pdf.

38. *See* Lemley & Shapiro, *supra* note 1, at 1996 ("If the patent is ruled invalid or not infringed, the downstream firm . . . owes nothing to the patent holder . . . but if the patent is ruled valid and infringed, the downstream firm must pay reasonable royalties [and] the court enters an injunction . . . .").

39. *Id.* at 2001–02.

40. *Id.* at 2008–10.

41. *Id.* at 2010–11.

42. *Id.* at 1995–98.

The patent holder can threaten to seek an injunction at the time of bargaining and use this possibility to its advantage. A patent holder approaches a downstream firm that is already selling a product that incorporates a feature or component covered by the patent holder's patent.[43] The two parties engage in Nash bargaining, where the negotiated rate depends on each party's threat point.[44] Lemley and Shapiro calculate a hypothetical "benchmark" royalty[45] by considering the case of a surely valid patent and conclude that the hypothetical benchmark would be the product of the party's bargaining power, B,[46] and the marginal value added by the patented component, V.[47] The hypothetical benchmark royalty rate is therefore BV in the case of a surely valid patent.[48] When the patent is not surely valid, but instead is valid with only some probability θ, the hypothetical benchmark royalty is expressed as θBV.[49] Lemley and Shapiro regard the probability θ as a measure of patent strength.[50]

The "Litigate" strategy has the downstream firm litigating the infringement suit and redesigning the product only upon a loss; the second strategy, "Redesign and Litigate," has the downstream firm redesigning its product during the patent litigation and before the court enters judgment on the question of the patent's validity.[51]

The Litigate strategy is attractive to a downstream firm that faces either weak patents or high redesign costs relative to the lost profits that would follow a defeat in the litigation.[52] If the court upholds the validity of the patent, Lemley and Shapiro use the model to calculate the "percentage gap" or "royalty

43. *Id.* at 1995.

44. *Id.* at 1995–96.

45. *Id.* at 1999 ("[T]he royalty rate that would be reasonable and expected in the ideal patent system *without* any element of holdup.").

46. *Id.* at 1997–98 (assigning B as the "[b]argaining skill of the patent holder, as measured by the fraction of the combined gains from settling," instead of litigating).

47. *Id.* at 1996 (assigning V as the "[v]alue per unit of the patented feature to the downstream firm in comparison with the next best alternative technology").

48. *Id.* at 1999.

49. *Id.*

50. *Id.* at 1996 (describing the strength of the patent as "the probability that litigation will result in a finding that the patent is valid and infringed by the downstream firm's product").

51. *Id.* at 2000.

52. *Id.* at 2001.

overcharge" between the hypothetical benchmark royalty and the royalty that would result if a downstream firm were required to redesign its product after litigating.[53] It is important to discern the pejorative connotation of their choice of words: even a patent whose validity a court has confirmed can give rise to "overcharges."[54] Of course, in the United States there is no basis in either antitrust or patent law for denying a lawful monopolist the right to charge as high a price as he likes.[55] The grant of a patent is not conditioned on constraining the patent owner to charge infringes of the patent a royalty rate no higher than what a court deems to be reasonable.[56]

The overcharge in the Litigate scenario derived by Lemley and Shapiro depends on two factors—the need for the downstream firm to incur redesign costs, and the loss of a sales margin attributable to the injunction that follows the patent suit.[57] The second component can grow very large if the mark-up for the downstream product is high relative to the incremental value, *V*, of the patented input used in that product.[58] Lemley and Shapiro conclude that

> the negotiated royalty rate for a single patent tends to be greatly elevated above a reasonable benchmark level if the value of the patented feature is small relative to the total value associated with the product. The intuition is that the accused infringer will lose the full value of its product, not just the value of the patented component, if it is enjoined and has to redesign the product to avoid infringement.[59]

In contrast, a downstream firm prefers the Redesign and Litigate strategy if it faces a strong patent or when redesign costs are low relative to the loss in revenue that would follow a defeat in court.[60] If the patent is surely valid, Lemley and Shapiro reason that the negotiated royalty would be the first component of the two that comprised the negotiated royalty in the Litigate strategy above.[61] That is, the negotiated royalty would

53. *Id.* at 2001–02.

54. *Id.*

55. *See* Verizon Commc'ns Inc. v. Law Offices of Curtis V. Trinko, LLP, 540 U.S. 398, 407 (2004) (stating that monopolists may charge "monopoly prices" so long as they do not engage in anticompetitive conduct).

56. *See id.* at 407–08 (holding that the ability to charge "monopoly prices" increases the incentive to innovate, but "forced sharing" would decrease that incentive).

57. Lemley & Shapiro, *supra* note 1, at 2001.

58. *Id.*

59. *Id.* at 2001–02.

60. *Id.* at 2002.

61. *Id.*

be the amount of duplicative costs incurred by the downstream firm in redesigning its product using another input.[62] There is no second term in this case because the downstream product is never removed from (or delayed from entering) the market.[63] Of course, not all patents are surely valid. For patent strength $\theta < 1$, the negotiated royalty would be this same cost divided by θ.[64] The intuition is that the downstream firm will have wasted money on redesigning the product if the patent on the input is found to be invalid or if there was no infringement.[65] The downstream firm would therefore be willing to pay more than the value of the patented feature but less than the cost of redesigning the product.[66]

The scenarios discussed so far have assumed that the downstream firm learns of the patented feature only after committing itself to an initial product design.[67] Thereafter, the downstream firm must negotiate a royalty rate with the patent holder.[68] Lemley and Shapiro also consider the case where negotiations occur *before* the initial downstream product design.[69] This second scenario has far greater practical significance in light of the common existence in high technology industries of standard setting organizations in which member firms disclose patented technology relevant to a particular standard—such as mobile telephones—and agree to license that technology to other members of the SSO on "fair, reasonable, and nondiscriminatory"[70] (FRAND) rates.[71] I address this issue extensively in

62. *Id.*

63. *Id.*

64. *Id.*

65. This use of θ is confusing. The variable is the probability of patent validity. But the "no infringement" scenario would entail a legal conclusion regarding the defendant's actions toward a *valid* patent—such as the conclusion that the defendant's product acts outside the scope of the valid patent. The Lemley-Shapiro analysis depends on whether the patent can be enforced. But if Lemley and Shapiro are emphasizing lack of validity specifically, then it is inappropriate for them to let θ serve a larger purpose in their model. If one's objective is to drive the probability of an enforceable property right in an invention as low as possible, there are numerous policy levers that one might choose to manipulate. As discussed below, Lemley has made numerous recommendations to this effect, using other levers in patent law.

66. Lemley & Shapiro, *supra* note 1, at 2002.

67. *Id.* at 2003.

68. *Id.* at 2003–04.

69. *Id.* at 2004.

70. Geradin & Rato, *supra* note 30, at 7.

71. *See* Daniel G. Swanson & William J. Baumol, *Reasonable and Nondiscriminatory (RAND) Royalties, Standards Selection, and Control of Market*

the analysis of the Lemley-Shapiro policy recommendations below.

Taking as given that the downstream firm benefits from this predesign posture only insofar as it may possibly design around the patent, Lemley and Shapiro argue that the negotiated royalty rate is independent of the patent strength, θ: if negotiations over licensing fail, the downstream firm designs around the patent regardless, which involves losing any marginal value associated with the patented feature, and not only in the case where the patent is invalid.[72] Lemley and Shapiro show, counterintuitively, that the percentage overcharge in this case increases as the strength of the patent decreases.[73] That is, the more likely it is that the patent is invalid, the more likely it is that any resulting royalty payment made is actually an overcharge. "The intuition," write Lemley and Shapiro, "is that the accused infringer has chosen to give up without a fight, effectively agreeing to treat a possibly invalid patent as certainly valid, and so the chance that it would have invalidated the patent will not be reflected in the negotiated royalty."[74]

The bargaining model presented by Lemley and Shapiro therefore posits that, in a case where the patented feature adds little marginal value to the product as a whole, the negotiated royalty rate will be some large multiple of the hypothetical reasonable benchmark level.[75] Further, for stronger patents the downstream firm will likely choose to Redesign and Litigate, paying an inflated royalty rate (that is, a rate that exceeds the input's hypothetical benchmark royalty rate) because the downstream firm will incur redesign costs with certainty if negotiations fail.[76]

Power, 73 ANTITRUST L.J. 1, 5 (2005); Geradin et al., *supra* note 29, at 2–3.

72. Lemley & Shapiro, *supra* note 1, at 2004–05. This aspect of the model explicitly relies on the earlier Lemley-Shapiro analysis of probabilistic patents. *See* Mark A. Lemley & Carl Shapiro, *Probabilistic Patents*, 19 J. ECON. PERSP. 75, 95 (2005) (arguing that the scope of a patent right is uncertain).

73. Lemley & Shapiro, *supra* note 1, at 2005. The "overcharge" that Lemley and Shapiro discuss in this context is only an "overcharge" if one considers any deviation from the hypothetical benchmark that they have defined as an overcharge. In some sense *any* royalty is an overcharge because the marginal cost to the patent holder is zero.

74. *Id.*

75. *Id.* at 2001–02.

76. *Id.* at 2002.

2. Royalty Stacking

Lemley and Shapiro next address the implications of their model for royalty stacking, where many patents cover aspects of a particular product.[77] They discuss three issues that affect the negotiated royalties in the presence of stacking: rent splitting, shutdown, and Cournot complements.[78] The first is the point that, after each successive royalty agreement, the remaining margin to the downstream firm is smaller, such that future royalty agreements will have smaller gains to divide.[79] The second issue is that a downstream firm will not produce an unprofitable product, so the royalty rates will never be so extreme as to violate the ever-present break-even constraint.[80] The third issue—Cournot complements—arises here because each patent holder is "marking up" the royalty on the patent, which raises the downstream price and reduces demand for the product.[81] Such behavior can lead to reduced output, higher prices, and the resulting deadweight loss of allocative efficiency.[82]

A further complication is the inability to determine "reasonable royalties" in the case that litigation produces a final judgment. Lemley and Shapiro observe that the cases that actually go to judgment do so for a reason—the parties could not agree on a royalty rate in the first instance.[83] Further, negotiated royalty rates are poor proxies for what should be used in a litigation setting, as early agreements will reflect the probability that the patent is invalid. Once litigation reaches the "reasonable royalties" stage, the patent has been upheld in court and the royalty level should exceed any rate that the parties would have previously negotiated.[84]

Lemley and Shapiro explain that a separate complication in the determination of reasonable royalties is that the royalty should reflect only the value of the component covered by the

77. *Id.* at 2010.

78. *Id.* at 2010–11.

79. *Id.* at 2011–12.

80. *Id.* at 2012–13.

81. *Id.* at 2013 ("The Cournot Complements effect arises when multiple input owners each charge more than marginal cost for their input, thereby raising the price of the downstream product and reducing sales of that product.").

82. *Id.* at 2015–16.

83. *Id.* at 2019.

84. *Id.* at 2017.

patent and not the value of the product as a whole.[85] Despite Supreme Court precedent to the contrary,[86] court-ordered royalty rates, according to Lemley and Shapiro, are typically set with the total value of the product in mind. They cite reliance on industry licensing rates and informational constraints for this proposition.[87]

The empirical discussion in Lemley and Shapiro's article begins with examples of royalty stacking, including instances involving 3G cellular technology, Wi-Fi networks, DVD media, and RFID technology.[88] In particular, they argue that 3G technology and Wi-Fi epitomize the royalty stacking problem in "development of new technologies within a standard-setting organization."[89] In the case of 3G cellular technology, Lemley and Shapiro cite evidence that the new telephone technology implicates over 6800 patents, which can be reduced to still over 700 "patent families," where members of the standards institute at issue are calling for royalties per telephone in excess of the price of each telephone.[90]

The second empirical discussion in Lemley and Shapiro's work analyzes court-ordered royalty rates in cases between

85. *Id.* at 2020–21.

86. *Id.* (citing Seymour v. McCormick, 57 U.S. (16 How.) 480, 491 (1853)).

87. *See id.* at 2021–22.

88. *Id.* at 2025–29. All of these are newer technologies that incorporate many different patented components. 3G cellular technology allows the transmission of both voice and data over cellular networks. *See* Lee Garber, *Will 3G Be the Next Big Wireless Technology?*, COMPUTER, Jan. 2002, at 26. Wi-Fi is the term used to describe a particular technology for wireless networking using low power and an unlicensed spectrum. Randall Stross, *Wireless Internet for All, Without the Towers*, N.Y. TIMES, Feb. 4, 2007, § 3, at 3. DVD media, or digital video discs, enable the storage of large amounts of information (originally, primarily movies) on a single compact and portable disc. *See* Press Release, Toshiba Corp., DVD Format Unification (Dec. 8, 1995), *available at* http://www.toshiba.co.jp/about/press/1995_12/pr0802.htm. Radio frequency identification (RFID) technology has numerous applications in both payment systems and tracking technologies and involves a chip that emits a unique radio signal for identification purposes. *See* Jeremy Landt, Shrouds of Time, the History of RFID 3 (Oct. 1, 2001) (unpublished manuscript, available at http://www.transcore.com/pdf/AIM%20shrouds_of_time.pdf).

89. Lemley & Shapiro, *supra* note 1, at 2025.

90. *Id.* at 2026. Although they do not state so explicitly, Lemley and Shapiro are citing the price of the cell phone to the service provider and not the price of the phone to the end consumer. *See* Michael R. Franzinger, *Latent Dangers in a Patent Pool: The European Commission's Approval of the 3G Wireless Technology Licensing Agreements*, 91 CAL. L. REV. 1693, 1704 n.69 (2003). Furthermore, Lemley and Shapiro do not cite to any source for this statistic. *See* Geradin et al., *supra* note 29, at 22–23.

1982 and 2005.[91] They find an average royalty rate across all of the cases of 13.13% of the price of the downstream firm's infringing product.[92] Lemley and Shapiro consider this percentage to be evidence of the probabilistic nature of patents—that is, the sample is comprised of observations on royalty rates in cases where a patent is valid and infringed with certainty.[93] Lemley and Shapiro attempt to verify this proposition by analyzing each patent to determine whether it covered a single component or the entire downstream product.[94] They find that the court-ordered royalty rates for component inventions were approximately 10% of the price of the infringing product, and they describe this difference from the overall rate as "modest."[95] They describe this reduction in royalty rate as "equivalent to the conclusion that there are on average only 1.5 components in a multicomponent invention."[96] Because there are more components in the products of high technology industries, Lemley and Shapiro conclude that the current doctrines used to calculate reasonable royalties are not working. They also compare the average profit rate across all industries (8.3%) to the court-ordered royalty figures of 10%–15% and conclude that royalties, even for one patent, can be so large as to swallow all profits from a downstream product.[97]

Lemley and Shapiro base several policy recommendations on their empirical findings.[98] Because the holdup problem flows from the availability of an injunction, they argue that any policy proposal seeking to eliminate holdup will need to mitigate the effect of the injunction rather than merely modify the royalties due.[99] They propose that courts should deny (or at least delay) injunctive relief when the downstream product that would be enjoined contains many components.[100] In the alternative, Lemley and Shapiro propose that a court stay any permanent injunction to enable the infringing firm to redesign its product

91. Lemley & Shapiro, *supra* note 1, at 2030.
92. *Id.* at 2032.
93. *Id.* at 2033.
94. *Id.* at 2032.
95. *Id.* at 2034.
96. *Id.*
97. *Id.* at 2035.
98. *Id.*
99. *Id.* at 2036.
100. *Id.*

while paying reasonable royalties on the patented input rather than lose sales entirely.[101]

Their other recommendations include setting royalty rates with the next-best alternative design in mind, such that royalties should be smaller when the next-best alternative is almost as valuable to the downstream firm as the infringed design.[102] Of course, if the next-best alternative is a close substitute for the technology covered by the infringed patent, then it is hard to understand why the infringer's predicament has anything to do with holdup. Rather, his predicament follows directly from the consequences of his own choice.

B. CONDITIONS UNDER WHICH LEMLEY AND SHAPIRO CONCLUDE THAT INJUNCTIVE RELIEF IS NOT WARRANTED

Lemley and Shapiro's primary policy recommendation is to limit injunctive relief—by staying the force of any injunction—in cases where the patented component represents only a small share of the overall value of the infringer's product.[103] They would also impose prerequisites for injunctive relief: the patent holder must practice, or intend to practice, the patent in some way; and the infringing party must have developed the patented technology independently of the patent holder.[104]

1. The Input Covered by the Patent Represents a Small Share of Value of the Final Product

The standard case that Lemley and Shapiro consider is when the value of the patented invention is a small fraction of the value of the final product.[105] Indeed, one driving force behind the holdup outcome is that the infringing firm will lose revenues in the face of an injunction.[106] In the limit, as the value of the patented feature approaches zero, any royalty paid to

101. *Id.*

102. *Id.* at 2039.

103. *See id.* at 2035–39.

104. *Id.* at 2036–37. Lemley and Shapiro limit application of their analysis to situations where "the patent holder's predominant commercial interest in bringing a patent infringement case is to obtain licensing revenues" and do not apply their analysis where "the patent holder suffers significant lost profits as a result of the allegedly infringing activities of the downstream firm and seeks to use the patent to exclude a competitor from the market in order to preserve its profit margins." *Id.*

105. *Id.* at 2001–02.

106. *See id.*

the patent holder, according to Lemley and Shapiro, is an "overcharge based on holdup."[107]

The "preferred solution" of Lemley and Shapiro in holdup cases is to stay injunctive relief until the infringing party has an opportunity to design around the patented feature.[108] In cases where the patent is valid and infringed, the infringing party will now have the use of the patented feature for a "reasonable" time necessary to redesign the final product to remove the patented feature.[109] Lemley and Shapiro propose that this solution would eliminate holdup flowing from the disparity between the value of the final product and the value associated with the patented feature.[110] They also argue that staying an injunction would remove, or at least delay, a cost associated with the Redesign and Litigate strategy—namely, the cost of redesigning.[111] If a court finds the patent valid and infringed, the infringer will not need to incur redesign costs until after litigation. If the patent is invalid, the redesign costs will not have been wasted.[112] Lemley and Shapiro evidently ignore the possibility that the downstream firm can defend itself by preemptively filing for, or acquiring, adjacent patents that may succeed in invalidating or limiting the patent of the upstream patent holder who is suing for infringement. More generally, the downstream firm has an incentive ex ante to aggregate patents related to the patented inputs so as to (1) defend against possible infringement and (2) raise costs for competing downstream firms that are contemplating using an unpatented alternative to the patented input.

The proposed staying of permanent injunctions is primarily aimed at eliminating "patent trolls" that hold up potentially infringing firms by threatening to seek injunctive relief against a product that is "predominantly noninfringing."[113] Lemley and Shapiro argue that, because the goal of injunctive relief is to protect the patent holder's market and ensure a return on investment, injunctive relief should not be available when the pa-

107. *Id.* at 2003.
108. *Id.* at 2037–38.
109. *Id.* at 2038.
110. *Id.*
111. *See id.* at 2002 (discussing the "Redesign and Litigate" strategy).
112. *Id.* at 2038.
113. *Id.* at 2008.

tented item or feature is only a small piece of a much more complicated product.[114]

If it is settled that no injunction will be issued for the time that it takes an infringer to redesign its product, there is little incentive for an infringer to commence with redesign during the patent litigation.[115] That is, Lemley and Shapiro's policy recommendation essentially eliminates the Redesign and Litigate strategy because no firm would redesign at the outset of litigation, before uncertainty over validity is resolved, when it can costlessly wait until later to redesign.[116] Lemley and Shapiro "consider this a plus" because redesign costs will only be incurred when necessary, and the patent holder will receive a reasonable royalty for any infringing sales that take place during the stay of the injunction when redesign is occurring.[117]

By removing the patent holder's threat of injunctive relief, therefore, an infringing firm will not lose sales during any period of redesign, will not need to decide early during litigation whether to redesign regardless of the ultimate validity or invalidity of the patent, and, in the case of a valid and infringed patent, will only pay a reasonably royalty on its sales during the stay of injunctive relief.[118]

2. The Patent Holder Is a Nonpracticing Entity

Lemley and Shapiro would allow injunctive relief only when the patentee practices the patent in competition with the accused infringer.[119] They consider the goal of the injunctive relief sections of the patent law to be to ensure that parties who need injunctive relief to protect their markets or ensure a return on their investments can receive it. In contrast to the recommendation that injunctions be stayed "in holdup cases," Lemley and Shapiro "consider the presumptive right to injunctive relief to be an important part of the patent law," and they agree that, "[i]n most cases, there will be no question as to the patentee's entitlement to an injunction."[120] This statement significantly undercuts the force of any concern over holdup because "in most cases" there is no holdup at all.

114. *Id.* at 2038–39.
115. *Id.* at 2038.
116. *Id.*
117. *Id.*
118. *Id.*
119. *Id.* at 2035–36.
120. *Id.* at 2035.

The result that nonpracticing entities should not be entitled to injunctive relief actually flows by negative implication from Lemley and Shapiro's policy recommendations. They defend the right of injunctions for practicing entities, and by implication argue that nonpracticing "patent trolls" are prime candidates to be denied injunctive relief.[121] "Practicing" in this context includes selling the patented product, selling a different product in the same market, exclusively licensing the patent to someone in the market, or preparing to do any of these things through research and development or otherwise.[122]

3. Conditioning the Stay of Injunctive Relief on the Absence of Copying

Lemley and Shapiro argue that "[a]n additional prerequisite for denying an injunction should be that the defendant developed the technology independently rather than copying it from the plaintiff."[123] Denying a stay of injunctive relief when the infringer did not develop the technology or patented product independently is essentially a required check on abuse of the "stay injunctions during redesign" proposal. Lemley and Shapiro recognize that if would-be infringers know that no injunction will immediately issue, opportunistic firms will more likely steal patented technology.[124] The only cost of such theft, in a world without injunctive relief, would be a reasonable royalty rate with no loss in sales.

II. POTENTIAL BIASES AGAINST INJUNCTIVE RELIEF IN THE LEMLEY-SHAPIRO MODEL

Lemley and Shapiro propose limiting injunctive relief in holdup cases.[125] They define holdup as any instance where the infringer pays a royalty that exceeds the hypothetical benchmark of a reasonable royalty rate.[126] The holdup result in their model, therefore, depends entirely on the gap between the negotiated royalty rate and the hypothetical reasonable royalty rate, however calculated. Lemley and Shapiro further argue that the overcharge is actually even higher because of practical issues associated with court determinations of reasonable

121. *See id.* at 2035–36.
122. *See id.*
123. *Id.* at 2036–37.
124. *See id.* at 2036–37.
125. *See id.* at 1991.
126. *See id.*

royalties that inflate royalty calculations.[127] Their analysis addresses only factors that may tend to inflate royalties. It ignores several countervailing, and even stronger, considerations in favor of *higher* reasonable royalties.

In the following sections, I show that Lemley and Shapiro employ the wrong framework for determining the optimal rule for injunctive relief. Moreover, even within their flawed framework, Lemley and Shapiro establish a downwardly biased benchmark for the reasonable royalty rate. This conclusion follows both because their model ignores the real option created by the patent holder (and conferred on the infringer) when the patent holder opts to make sunk investment in an uncertain technology and because the Lemley-Shapiro model assigns all of the bargaining power, at the outset, to the patent holder. These assumptions skew the results of their model in favor of the infringing party.

A. THE LEMLEY-SHAPIRO FRAMEWORK FOR DETERMINING OPTIMAL INJUNCTIVE RELIEF FAILS TO BALANCE THE RELEVANT TYPE I AND TYPE II ERRORS CORRECTLY

The Lemley-Shapiro article has an odd starting point: why, as a matter of public policy, should we care about "the negotiations between a single patent owner and an alleged infringer"?[128] Usually, an economic analysis of a legal problem first explains the social objective (such as consumer welfare, the rate of innovation, or the sum of consumer and producer welfare).[129] Then, the analysis proceeds to show the conditions under which that objective is maximized, subject to whatever constraints exist.[130] In keeping with that traditional economic approach, I propose an alternative framework to the Lemley-Shapiro model.

There is a fundamental problem with using bargaining power as the starting point for analysis of patent holdup and royalty stacking. Will there be symmetry or asymmetry of invention and use across patent licensors and patent licensees? Do today's patent licensees expect to be tomorrow's patent licensors, and vice versa? If not, one will have the expectation

127. *See id.* at 2021.

128. *Id.* at 1993.

129. *See* RICHARD A. POSNER, ECONOMIC ANALYSIS OF LAW 24 (7th ed. 2007).

130. *See id.* (discussing how economic analyses can be used to create a more efficient system for achieving social objectives).

that he will disproportionately be paying or receiving patent royalties. In that case, one's recommendation for changes to patent law will be biased in one direction or the other. Lemley and Shapiro seem not to recognize this fundamental difficulty with their model. As explained more formally above, Lemley and Shapiro would remove injunctive relief whenever the voluntarily negotiated rate under the threat of injunction exceeds their subjective, hypothetical "reasonable royalty rate."[131] It is not clear that such a framework would advance the goal of social welfare maximization. Consider an alternative framework that is structured in a more traditional approach to balancing error costs.

With important caveats that they delineate, Lemley and Shapiro embrace the presumptive right to a permanent injunction.[132] In economics, this presumption implies that the "null hypothesis" is that injunctive relief is appropriate in most instances. Once the null hypothesis is established, the burden of proof falls on the accused infringer to establish that injunctive relief is not appropriate in a specific instance. With this null hypothesis, I define a "Type I error" (that is, rejecting the null hypothesis when it is true) as not granting injunctive relief when such relief is appropriate. I define a "Type II error" (that is, accepting the null hypothesis when it is false) as granting injunctive relief when such relief is not appropriate. The cost of a Type I error is the dynamic efficiency loss associated with less investment by patent holders who believe that they will not be adequately compensated for taking investment risks. Although those losses occur sometime in the future, they are nevertheless important, as all current welfare derives from previous innovation. The cost of a Type II error is the static welfare loss resulting from patent holdup. It could include Lemley and Shapiro's *C* variable (the downstream firm's cost to redesign its product to avoid infringing the patent claims), as well as higher royalty rates for producers that may be passed onto consumers, depending on the relative elasticities of demand and supply.

A standard approach to the balancing of these error costs is to set a maximum tolerable probability of a Type I error (the "power" of the test), and then design a set of rules such that Type II errors will be minimized.[133] When the relative size of the error costs is close to one, the power is typically set at 5%—

131. Lemley & Shapiro, *supra* note 1, at 1999.

132. *See id.* at 1991.

133. *See* WILLIAM H. GREENE, ECONOMETRIC ANALYSIS 156 (3d ed. 1997).

that is, whatever decision rule is chosen, it cannot generate Type I errors with a frequency greater than 5% of all trials. If the size of the Type II error is determined to be large relative to a Type I error, the power of the test can be increased—that is, there can be more tolerance of Type I errors.

An alternative approach, and one that is more amenable to economic analysis, is to choose a decision rule that minimizes the sum of the Type I and Type II error costs. For a given decision rule r, let C_I be the cost of a Type I error, $P_I(r)$ the probability of a Type I error, C_{II} the cost of a Type II error, and $P_{II}(r)$ the probability of a Type II error. For simplicity, assume that the error costs are independent of the decision rule.[134] The objective function can be written as:

$$[1]\ P_I(r)\ C_I + P_{II}(r)\ C_{II}$$

Taking the derivative of [1] with respect to the decision rule and setting it equal to zero yields:

$$[2]\ P_I'(r)\ C_I = -\ P'_{II}(r)\ C_{II}$$

Rearranging [2] yields:

$$[3]\ C_I / C_{II} = -\ P'_{II}(r) / P_I'(r)$$

The left-hand side of equation [3] is simply the ratio of the error costs. The right-hand side is the ratio of the marginal probabilities of committing a certain type of error given a slight change in the decision rule.

To put this abstract theory into focus, Lemley and Shapiro are advocating a slight change in the decision rule for injunctive relief. (Some might argue, however, that weakening the presumption of injunctive relief is a radical change that defies the marginal analysis here.) Thus, they are altering the right-hand side of equation [3]. The decision rule will in reality be multidimensional. However, the same logic applies. The decision rule can be regarded as a continuous variable that governs the number of cases that will be exempted from injunctive relief.

134. This assumption is not necessary for the analysis. In general, the probability of either type of error will not be a function of the error cost.

It is not clear, however, whether the relative marginal probabilities under the status quo are equal to the relative error costs. Stated differently, Lemley and Shapiro have failed to establish a market failure in the patent law. To make matters concrete, assume conservatively that the relative error costs are the same, so that equation [3] simplifies to

[3'] $P_{\mathrm{I}}'(r) = -P'_{\mathrm{II}}(r)$

Under this assumption, the optimal decision rule for injunctive relief is to equate the marginal probabilities of the two types of errors. Lemley and Shapiro make no effort to explain (1) that the current marginal probabilities are not aligned under the current presumption of injunctive relief or (2) how removing injunctive relief in component cases or nonpracticing entity cases would guarantee that the marginal probabilities of the errors would come into alignment.

To the extent that the error costs are not in perfect alignment, their evidentiary burden is raised further. In particular, Lemley and Shapiro need to demonstrate (1) that the current *error-cost-weighted* marginal probabilities are not aligned under the current presumption of injunctive relief; or (2) how removing injunctive relief in component cases or nonpracticing entity cases would guarantee that the *error-cost-weighted* marginal probabilities would come into alignment. But Lemley and Shapiro have made no attempt to estimate these error costs. The phrase "dynamic efficiency" cannot be found in their paper. They pay lip service to the idea in their conclusion by acknowledging that "[p]atents are important to innovation."[135] The word "invest" or "investment" appears only nine times in fifty-nine printed pages, and when it does, it always refers to the previous investments made *by the accused infringer*.[136] It appears that the incentives for future investment by patent holders simply do not enter the Lemley-Shapiro calculus. For patent holders, patents evidently fall from the sky like manna, without any sunk investments having been made in innovative activity.

Even with respect to the Type II error costs that do concern them, Lemley and Shapiro are remarkably vague as to the economic significance of those costs. With respect to the costs to

135. Lemley & Shapiro, *supra* note 1, at 2044.

136. *See id*. at 1991, 1993, 1997, 2009, 2010, 2012 (twice), 2015, 2024.

producers associated with allegedly inflated royalty payments, Lemley and Shapiro offer the following characterization:

> With the recent surge in patenting, especially in the information technology industry where royalty stacking is a serious concern, these overcharges [due to the threat of injunctive relief when such relief is not warranted], when aggregated, can lead to a very *significant* cost burden on producers. If these royalties accurately reflected the contributions made by the patent owners, the additional cost is one producers should be made to bear in order to encourage innovation. However, by focusing above on the gap between the negotiated royalty and the benchmark level, we have already shown that much of this cost burden *is not* justified based on the actual contributions of the patent holders who earn these royalties.[137]

Clearly, these costs are "significant" in the estimation of Lemley and Shapiro.[138] But to have a credible case for removing the presumption of injunctive relief for patent infringement, one must quantify those costs relative to the costs of a Type I error. With respect to the other Type II costs—namely, redesign costs—Lemley and Shapiro are equally vague, suggesting only that these efforts are "extremely costly."[139] Because Lemley and Shapiro have failed to account for the key components of a standard economic approach to reforming legal rules, their framework is woefully incomplete.

B. NOTWITHSTANDING THE DEFICIENCIES IN THE FRAMEWORK, THE PARAMETERS THAT INFORM THE FRAMEWORK ARE BIASED DOWNWARD

Suppose for sake of argument that the Lemley-Shapiro framework is correct. Still, in implementing their framework, Lemley and Shapiro make assumptions that systematically inflate the negotiated royalty rates while simultaneously deflating the hypothetical reasonable benchmark royalty rate. The first source of this bias is the fact that Lemley and Shapiro ignore the real option provided by a patent holder who has made a sunk investment in technology that may or may not prove productive and profitable. The real option is valuable to potential infringers.

1. A Primer on the Option Value of Involuntary Exchange

Relative to the conclusions of Lemley and Shapiro, both real-options analysis and the literature on access pricing would

137. *Id*. at 2013 (first emphasis added).
138. *See id*.
139. *Id.* at 2016.

likely give quite different answers about the "unreasonableness" of the royalties being examined. With Gregory Leonard and Jerry Hausman, I have shown that, as interpreted by the Federal Circuit after *Grain Processing Corp. v. American Maize-Products Co.*,[140] the lost-profits measure of patent damages undercompensates the patent holder and grants the would-be infringer a free option that reduces his incentive to seek a license from the patent holder.[141] In other words, the lost-profits approach is, in practice, incorrectly low. Lemley and Shapiro are at the opposite pole: they believe that the lesser statutory right to reasonable royalties *overcompensates* the patent holder. Their analysis is flawed, however. It ignores the patent holder's opportunity cost and the value of the free option held by the infringer under a regime in which injunctions are not issued.

Patent infringement is the unauthorized use, without compensation, of valuable information created by someone else.[142] Moreover, one can characterize patent infringement as a real option to exploit another party's investment in innovation. The infringed patent embodies a kind of selection bias. It identifies not only the technologies that the infringer can profitably pursue, but also the technologies that have been revealed—through another party's trial and error—to be unsuccessful and thus should be avoided. The distortion caused by the infringer is exacerbated if a large portion of the assets required to create and exploit the patented invention is sunk.

Stated differently, because a person cannot redeploy the sunk investment that is required to discover a patented invention, it pays for him to "wait and see" how well other investments in that industry have performed before committing himself to investing his own capital.[143] Conversely, the would-be infringer can wait to see whether a particular patented technology belonging to another is worth using. The option value of

140. Grain Processing Corp. v. Am. Maize-Prods. Co., 185 F.3d 1341, 1356 (Fed. Cir. 1999) (holding that an infringer may claim that it would have adopted noninfringing technology despite the fact that the infringer had never done so).

141. *See generally* Jerry A. Hausman, Gregory K. Leonard & J. Gregory Sidak, *Patent Damages and Real Options: How Judicial Characterization of Noninfringing Alternatives Reduces Incentives to Innovate*, 22 BERKELEY TECH. L.J. 825 (2007) (discussing *Grain Processing Corp.*, 185 F.3d at 1341).

142. BLACK'S LAW DICTIONARY (7th ed. 1999).

143. For an application of this real-option analysis to legal and regulatory rules, see Hausman & Sidak, *supra* note 8 and Hausman, *supra* note 8, at 13–24.

infringement—involuntary exchange—becomes especially large in Schumpeterian industries, where different competing technologies make it possible that one firm will leapfrog others. In such an industry, the decision to invest today is especially risky, because it may commit a firm to a particular technology that may reveal itself later to be inferior. The imitator, therefore, enjoys a valuable "second mover" advantage, for he can shift the risk of sunk investment in a new technology onto the innovator.[144]

In other words, for the patent infringer the option value of involuntary exchange encompasses the ability to concentrate on infringing only the fruitful results of someone else's risky investment. Private investors will fund inventive activity only if they have a reasonable expectation that the company making that investment will recover the cost of its investment, including a competitive (risk-adjusted) return on capital. But "[s]unk investment is not a one-shot deal"; instead, "sunk investment is made continuously over time," implying a continuously varying investment-return expectation.[145] Therefore, as soon as the capital markets understand that a new patent regime will jeopardize a firm's recovery of its sunk costs, they will demand a higher return. As the cost of capital rises to compensate for this new risk, incremental sunk investment in risky innovation will be more costly for its owner, and the likelihood that such innovation will be pursued to its originally intended scale will diminish.

Economists have endeavored to measure the value of the option to wait before making a sunk investment. Avinash Dixit and Robert Pindyck have estimated that the markup on the cost of capital that is necessary to account for the sunk nature of investment varies from investment to investment, but is often at least 200%.[146] Stated differently, any project entailing significant sunk costs that yielded an expected return of between 100% and 200% of the cost of capital would no longer be justified.[147] This analysis is applicable to patent infringement—or to any form of involuntary exchange, for that matter. The in-

144. *See, e.g.*, F. Scott Kieff, *Property Rights and Property Rules for Commercializing Inventions*, 85 MINN. L. REV. 697, 708–09 (2001) (noting the frequently enjoyed competitive advantages of second movers).

145. J. Gregory Sidak, *A Consumer-Welfare Approach to Network Neutrality Regulation of the Internet*, 2 J. COMPETITION L. & ECON. 349, 357 (2006).

146. *See* AVINASH K. DIXIT & ROBERT S. PINDYCK, INVESTMENT UNDER UNCERTAINTY 153 (1994).

147. *See id.*

fringement of a patent truncates the innovator's returns in the "good state" of the world. That truncation of positive returns is especially harmful when one considers that the sunk nature of investment in innovation raises the hurdle rate for investments. Because a firm cannot recover the resources invested in a failed sunk-cost investment and shift them to an alternative project, that risk will create a disincentive for the firm to invest in innovative activities, in the absence of adequate patent protection.[148]

The Dixit-Pindyck model explains the behavior of innovative firms in high-technology industries.[149] Such firms face incentives, in addition to those related to the sunkeness of the investment, for delaying deployment of innovative processes and products.[150] These incentives include the rapidity of technological change and the declining costs across cumulative outputs that inhere in many industries (such as those associated with computer hardware and software technologies). In the face of rapid technological change, a firm has a strong incentive, in addition to the incentive arising from the sunkeness of the investment, to delay investment as long as competitive forces will permit.

A simple example illustrates the point. The traditional view in microeconomic theory was that one should invest in any project that has a positive net present value of cash flows.[151] Real option theory, however, shows that it may be better to wait if possible until some uncertainty is resolved and cost reduction can be achieved.[152] That reduction in uncertainty is precisely the advantage that the patent infringer enjoys.[153] Assume initially, however, that the process of innovation is random across firms; firms do not select ex ante to be innovators or infringers of proprietary intellectual property. Consider, for example, a firm that traditionally builds routers for data networks. The firm must decide whether to develop a new dense-wave multiplexing technology for routers that costs, say, $1 billion today but has an uncertain return tomorrow. Suppose that, if the demand for the new routers is high, the firm will make $4 billion in profit. If, on the other hand, there is a bad outcome

148. *See* Hausman & Sidak, *supra* note 8, at 462–63.
149. DIXIT & PINDYCK, *supra* note 146, at 3.
150. *See id.* at 3, 135.
151. *Id.* at 4.
152. *Id.* at 6–7.
153. *See id.*

and the demand for the new routers is low, then the new technology will be unproductive, and the firm will gain nothing from owning it. If the probability of each outcome is 0.5, then the expected net cash flow of investing in the development of the new technology is, ignoring discounting, calculated as follows: (0.5 x $4 billion) + (0.5 x $0) − $1 billion = $1 billion.

Because the project has a positive expected net cash flow, one might think it optimal for the firm to take the role of the innovator—that is, make the investment today to develop the new technology. But that decision is not privately optimal for the firm. If the firm can delay making the investment, it can reduce the risk of bad outcomes by observing the experience of others and capturing the gains associated with deploying the superior technology later. The value of waiting is that the firm preserves the option *not* to make the investment of $1 billion if the bad state of the world occurs. To continue with the previous numerical example, the expected net cash flow of investing in the new technology *after* the market has witnessed its commercial success is, again ignoring discounting, calculated as follows: (1.0 x $4 billion) + (0.0 x $0) − $1 billion = $3 billion. In other words, the firm may decide that it is more profitable to pursue a strategy of being an imitator of new technology rather than an innovator. By waiting, the firm would increase its expected return. If the firm invests in developing new technology today, it sacrifices an option to invest tomorrow in imitating that new technology.

The choice facing the patent infringer is even more favorable than the choice facing the imitator because the infringer avoids making the $1 billion sunk investment to develop the patented invention. Hence, the value to the infringer of waiting to market a product containing the infringed patent is, again ignoring discounting, calculated as follows: (1.0 x $4 billion) + (0.0 x $0) − $0 = $4 billion. Of course, this calculation does not incorporate the expected value of any damages that the infringer subsequently may be ordered to pay the innovator who owns the patent. But what if the infringer chooses not to wait to market a product? After all, he does not face the choice of whether or not to make a sunk investment. If the patent infringer markets a product when there is still uncertainty about the innovator's new technology, his expected net cash flow is, ignoring discounting, calculated as follows: (0.5 x $4 billion) + (0.5 x $0) − $0 = $2 billion. In this numerical example, patent

infringement is still more attractive than risky investment in innovative activity.

2. Implications of Option Value in the Lemley-Shapiro Framework

In the context of the Lemley-Shapiro framework, the option value of infringement necessarily means that the calculation of the reasonable royalty is biased downwards, and perhaps significantly so. In particular, the hypothetical benchmark royalty that they propose is almost entirely based on the variable *V*, the value per unit of the patented feature to the infringing firm.[154] They explain that when *V* is equal to $1, the value of the patented feature enhances the value of one unit of the product, for consumers, by $1.[155] Although this definition of *V* is certainly part of what a licensee or would-be infringer derives from the use of the technology, it completely omits the real option value, to the infringer, of waiting until uncertainty is resolved over the patented product or feature before making any irreversible move in the market.

Lemley and Shapiro defend *V* as the appropriate measure of the value of the patented product to the infringer, but only in the face of other aspects of the downstream product and not in terms of other value received by a licensee or infringer.[156] This other value is the option value of involuntary exchange. In light of this option value to the infringer, one begins to see how the hypothetical benchmark royalty rate is in fact biased downwards. Indeed, this insight provides a much better explanation for the result in Lemley and Shapiro's worst-case scenario, where *V* approaches zero yet still constitutes a significant hold-up.[157] In those cases, where *V* equals zero, the Lemley-Shapiro model would find that the hypothetical reasonable benchmark royalty rate is zero—the patent adds *no* value to the product. Value added to the product, however, is only part of the story. The infringer was able to wait on the sidelines, invest nothing, and await the resolution of uncertainty over the patented fea-

154. *See* Lemley & Shapiro, *supra* note 1, at 1999.

155. *Id.* at 1996.

156. *See id.* at 2040 (noting, for example, that it is important "that the fact finder has the information necessary to assess the contribution of a component invention in the context of the value of the entire product").

157. *See id.* at 1999–2000.

ture. That is, she exercised a valuable option that was, at least before the payment of any royalties, a free option.[158]

Lemley and Shapiro concede that in many cases holdup is not a concern, largely because many patents ultimately have no value at all.[159] That is, those cases involve issued patents that did not ultimately contribute to a profitable product. But those patents were not necessarily valueless at the time that they were issued. As the analysis here shows, the firm taking the initiative to develop the particular technology and invest in research and development is taking a risk. Potential licensees and would-be infringers sit on the sidelines with a free option to take advantage of any profitable patents that arise. Lemley and Shapiro would protest in precisely those cases where infringers are exercising the option of involuntary exchange. That option is only exercised when it is profitable to do so. But the fact that it is profitable to those parties exercising the option shows precisely how the hypothetical reasonable benchmark royalty proposed by Lemley and Shapiro is biased downward.

Any discussion of the reasonable royalty rate in light of the option value of involuntary exchange would be incomplete without analyzing how the option value enters the royalty calculation. Unfortunately, though it is straightforward to see why the option value must be included in the reasonable royalty rate, providing for a systematic way to include it in the calculation is more difficult.[160] A discussion of when we expect the option value to be extremely high, however, provides an even more satisfying explanation for the concerns of Lemley and Shapiro.

158. An additional case not considered by Lemley and Shapiro is when the patented feature adds no value to the consumer but makes it significantly less costly to produce the good. In this sense the focus of the hypothetical benchmark calculation in the Lemley-Shapiro model is incorrect from the outset. Focusing only on value to consumers ignores the other valuable aspects of the patent feature, including cost savings and the value of the real option created.

159. *Cf.* Lemley & Shapiro, *supra* note 1, at 2036 (acknowledging that "some injunctions will not lead to a risk of holdup").

160. To my knowledge, the option-value approach to solving the optimal royalty rate has not been developed in a formal model. Two other methods that economists have proposed are an ex ante auction based on the ECPR, *see generally* Swanson & Baumol, *supra* note 71, and the Shapley value in cooperative game theory, *see generally* Anne Layne-Farrar, A. Jorge Padilla & Richard Schmalensee, *Pricing Patents for Licensing in Standard Setting Organizations: Making Sense of FRAND Commitments*, 74 ANTITRUST L.J. 671, 693 (2007).

Unlike the concerns in the Lemley-Shapiro model over the strength of the patent, the relevant variable in the context of the real option is whether there is uncertainty, and how much, over the profitability of the technology. For example, the value of the option is highest when there is a very low probability that the technology will be successful coupled with extremely high profits in the case of success. That is, would-be infringers realize the most value when taking advantage of the real option in high-risk, high-reward industries. When would we expect to see such a gap between risk and reward? Such a large gap between probability of success and profitability is most likely to exist precisely in the high technology, complex component products cases that evidently worry Lemley and Shapiro the most. In other words, not only does the existence of the real option value demonstrate why the reasonable royalty rate is biased downwards, it is also especially relevant to the particular industries that are the focus of Lemley and Shapiro's concerns.

Lemley and Shapiro focus only on one-half of the uncertainty in the world of patents. They focus on the strength of the patent and the likelihood that the patent will stand up in court. However, by ignoring the real option presented to licensees and infringers in the face of the most important uncertainty—the uncertainty *over profitability of the technology*—Lemley and Shapiro neglect to capture an important component, perhaps the most important component, of the reasonable royalty calculation.

C. IMPROPER ACCOUNTING FOR BARGAINING POWER AND INFORMATION SETS

The hypothetical benchmark royalty calculated by Lemley and Shapiro at the outset of their model is θBV.[161] They calculate this royalty by starting with the value of the patented feature, V, and discounting that value by the probability that the patent is valid and infringed, θ.[162] A final adjustment to the hypothetical benchmark is made by accounting for bargaining power of the parties, through B.[163] It is noteworthy that at no point in the analysis do Lemley and Shapiro provide any formal

161. Lemley & Shapiro, *supra* note 1, at 1999; *see also supra* Part I.A.1 (discussing the Lemley-Shapiro model for holdup).

162. Lemley & Shapiro, *supra* note 1, at 1999.

163. *Id.*

modeling with respect to the bargaining power of the parties.[164] Such modeling is very important, because the process of negotiating royalties depends integrally on the relative bargaining power of the parties to the negotiation. Although Lemley and Shapiro do not formally describe their model as one of bargaining, that is essentially what the analysis in their model is doing.

This conclusion follows directly from the negotiated royalty rates derived by Lemley and Shapiro in each case that they consider. Though the hypothetical benchmark royalty rate first considered and discussed includes the bargaining variable *B*, neither of the derived royalty rates for the specific strategies available to the infringer includes the bargaining power component. That is, neither the Litigate strategy[165] nor the Redesign and Litigate strategy[166] varies with the bargaining power of the parties. It is important to note that Lemley and Shapiro are calculating the percentage overcharge rather than the nominal level of the royalty overcharge;[167] it is still the case, however, that their derived overcharge is an expression that is independent of the bargaining power of the parties. What that fact means, of course, is that the derived values have implicitly *assumed* bargaining power for both the infringer and, therefore, the patent holder.

Given that the derived values for the negotiated royalty overcharge include the full cost of redesign and, for the Litigate strategy, the unadjusted cost of lost sales flowing from the period of injunction,[168] the assumption implicit in the Lemley-Shapiro derivation is that the patent holder has all of the bargaining power. That assumption is not necessarily improper, but it is an assumption nonetheless—and it provides a better characterization of what is precisely going on in the model. The Lemley and Shapiro model derives negotiated royalty rates that flow from an environment in which all bargaining power rests with the patent holder.

An issue related to this point about bargaining power—indeed, a factor that will certainly enter any formal model of bargaining—is the information set available to each of the par-

164. *See, e.g.*, *id.* at 1998 ("[T]he model will produce similar results with any value of *B*.").

165. *Id.* at 2001.

166. *Id.* at 2002.

167. *Id.* at 2001.

168. *Id.* at 2001–02.

ties to the negotiation. Each party knows its own costs and potential gains from the patented technology, or at least has some set of beliefs over what those costs and gains from use of the technology might be. The Lemley-Shapiro negotiated royalties assume that the patent holder knows with certainty all the variables relevant to the *infringer's* business.[169] That is, Lemley and Shapiro assume that the patent holder knows, with certainty, the infringer's profit margin (*M*), valuation of the patented feature (*V*), cost of redesign (*C*), and percentage of lost sales during redesign (*L*). Given that it is unlikely that even the infringer herself knows these variables, the assumption that the patent holder knows them lacks plausibility.

If the patent holder lacks this information, or if the patent holder has only an imperfect expectation of what the benefits to the infringer are and what the costs of the injunction to the infringer might be, then the negotiated royalty (and hence any royalty overcharge) will necessarily be lower than the royalty that Lemley and Shapiro calculate. This proposition follows because in any case where the negotiated rate in the presence of imperfect information would be higher than the full information rate, the infringer would improve her outcome by fully revealing her position to the patent holder. As a result, when one considers that the full information case considered by Lemley and Shapiro is surely the exception rather than the rule, the overcharge calculated in their model cannot be taken as the appropriate measure of the negotiated rate in the real world, where uncertainty rules.

These arguments are consistent with the findings of others addressing royalty stacking issues in high technology industries. For example, because each licensee will have different information *vis-à-vis* the patent holder, there is no reason to expect, as the Lemley-Shapiro model does, that licensing outcomes will be symmetric or identical across all licensees.[170] Further, given uncertainty over the value of *V*, the ability of the patent holder to fully appropriate the economic rents flowing from the invention should not be limited, as it is in the Lemley-Shapiro framework.[171]

169. *See, e.g.*, *id.* at 2001.
170. *See* Geradin et al., *supra* note 29, at 39.
171. *See id.*

D. OVERLOOKING THE SIGNIFICANCE OF SUBSTITUTING COMPLEMENTS

A further assumption running throughout the Lemley-Shapiro analysis is that the patented component is both unique and required for the production of the final product. That is, the holdup result derived in their model depends on the unavailability of substitutes for the patented component. Holdup in the Lemley-Shapiro model occurs only because the downstream firm has nowhere else to turn when the patent holder alleges infringement. However, if there are substitutes for the patented component, the holdup result will not occur.

In fact, only a few substitutes are needed for the holdup result to disappear. Guiseppe Dari-Mattiacci and Francesco Parisi, in a more general model of imperfect competition, show that the presence of even a *single* substitute for any patented component is sufficient to prevent the holdup outcome.[172] More importantly, Dari-Mattiacci and Parisi show that, even if there are many complementary inputs (or many patents covering the downstream product in the Lemley-Shapiro framework), the presence of a substitute for each of the inputs will eliminate the holdup problem.[173] This result follows because, if any one patent holder faces competition from another technology or product to which the downstream can turn in the face of potential holdup, then competition between the two input suppliers (patent holders) will eliminate any incentive to attempt to hold up the downstream firm. Lemley and Shapiro offer no response to this powerful insight.

E. AS A RESULT OF THESE ERRORS, THE SET OF CASES IN WHICH THE LEMLEY-SHAPIRO MODEL WOULD TOLERATE INJUNCTIVE RELIEF IS TOO SMALL

Lemley and Shapiro have erected a framework that operates independently of standard decision-theoretic principles,

172. *See* Giuseppe Dari-Mattiacci & Francesco Parisi, *Substituting Complements*, 2 J. COMPETITION L. & ECON. 333, 340 (2006). They write in a more general context than the specific two-party bargaining context considered by Lemley and Shapiro, but their result is nevertheless important in terms of assessing the plausibility of the Lemley-Shapiro model.

173. *See id.* at 337 ("It is important to note that the legal problems to which the complementary oligopoly and anticommons theories have been applied have the common characteristic of the uniqueness of the complements. Fragmented owners face an anticommons problem to the extent that the complementary rights that they seek to acquire cannot easily be substituted with other rights.").

and they have parameterized the framework in such a way that its results are inherently biased against patent holders. Moreover, they have ignored the extent to which substituting complements and the market for corporate control mitigate any problems of holdup and royalty stacking.

The Lemley-Shapiro framework is incomplete because it virtually ignores dynamic efficiency effects, or investment incentives, and does not even attempt to find the correct balance between the relative error costs with the marginal probabilities of realizing those error costs. The Lemley-Shapiro model is also incorrectly parameterized. It ignores the real option, which confers value on the infringer, of being the second mover in the particular market for the product that incorporates the patent. If the Lemley-Shapiro model properly accounted for the value of the real option, the level of the reasonable royalty—the hypothetical benchmark—would properly be much higher.

The implication of these multiple shortcomings is that Lemley and Shapiro systematically overstate the severity of the royalty holdup problem. This conclusion—that Lemley and Shapiro's theory is overblown—is further supported by the lack of empirical evidence supporting their claims.[174] Although Lemley and Shapiro attempt to provide some support through various case studies, there is no conclusive evidence that patent holdup and royalty stacking are occurring.[175]

Finally, the solution proposed by Lemley and Shapiro—staying injunctive relief—is not calculated to maximize any objective measure of welfare. Rather, it is the remedy prescribed for a problem whose existence and severity are preordained by the assumptions of the Lemley-Shapiro model.

CONCLUSION

The Lemley-Shapiro model of patent holdup and royalty stacking, and its accompanying policy recommendations, propose a revolutionary shift in the patent system. However, closer analysis reveals that the Lemley-Shapiro model is not supported by theory and that their recommendations, taken together, create more problems than they would solve. In particular, the Lemley-Shapiro framework does not properly account for the relevant error costs associated with weakening the presumption of injunctive relief. Consequently, it fails to consider

174. *See* Geradin & Rato, *supra* note 30, at 21.
175. *Id.* at 24–25.

how removing the presumption of injunctive relief would decrease dynamic efficiency. Lemley and Shapiro seek to exempt certain cases from injunctive relief, but their prescription does not offer a limiting principle. As a result, the characteristics of the cases allegedly deserving of such exemption are arbitrary. Further, Lemley and Shapiro rely on parameters that are biased in several ways. First, their hypothetical benchmark royalty rate does not account for the real option generated when a patent holder who has made sunk investments to create an invention must license its use at less than the price that would emerge from voluntary exchange. Second, their model begs the question by assigning all the bargaining power to the patent holder at the outset and then claiming a general result. Both factors bias the Lemley-Shapiro results in favor of the infringing party.