Preventing Patent Hold up: An Economic Assessment of Ex Ante Licensing Negotiations in Standard Setting

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Abstract

New rules and procedures to prevent patent hold up and other such opportunistic licensing within standard setting contexts have received considerable attention in the academic literature. One such proposal would be to allow standard setting members to jointly negotiate patent licensing terms. Adding some support to this proposal, the US Department of Justice and the Federal Trade Commission announced in their 2007 Report, Antitrust Enforcement and Intellectual Property Rights: Promoting Innovation and Competition, that they will review joint negotiation policies at standard setting bodies under a rule of reason, rather than as per se illegal. In this paper we provide an economic evaluation of joint licensing negotiations in standard setting contexts. We find that joint negotiations are difficult to support even in light of the need to prevent patent hold up. Instead, other more moderate policy solutions that take advantage of existing institutional features within standard setting bodies have a greater likelihood of preventing hold up without running the risk of anticompetitive consequences of their own.

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1. Introduction

In antitrust circles, a great deal of attention has been focused on the problem of opportunistic patent licensing within standard setting. In *In re Union Oil Co. of Cal.*, the US Federal Trade Commission’s concern was that Unocal Corporation had illegally obtained monopoly power by failing to inform relevant parties that it held patents over the reformulated gasoline that the California Air Resources Board (CARB) was adopting in regulation. Absent that deception, the FTC argued, CARB would never have enacted the reformulated gasoline regulatory standard that required Unocal’s patents. Similar concerns are behind more recent cases involving Rambus, which also entail allegations of anticompetitive deception through a failure to disclose patents, this time to JEDEC, the cooperative standard setting organization (SSO) developing computer DRAM standards.

Non-disclosure of the sort in *Unocal* and *Rambus*, while the most prevalent charge in the handful of standard setting antitrust cases filed thus far, is not the only source of concern over opportunistic licensing. A second tranche of cases has involved allegations of “unreasonable” licensing terms. So, for example, in *Broadcom Corp. v. Qualcomm Inc.*, Broadcom alleged that Qualcomm obtained monopoly power by promising to ETSI (the European Telecommunications Standards Institute) that it would license its patents relevant for the 3G mobile telecom standard on Fair, Reasonable, and Non-Discriminatory (FRAND) terms—a commitment that Broadcom claims Qualcomm made in bad faith and has since reneged on. Taking the FRAND promise even farther, the FTC recently settled a complaint against Negotiated Data Solutions for licensing its patents on terms that did not match the original terms disclosed to the IEEE (the Institute of

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3 Multiple cases are at issue here. See, *Rambus*, supra note 2. The US Court of Appeals for the DC Circuit ruled in April 2008 that the Commission’s orders be “set aside”, remanding the case for further proceedings that are “consistent” with the DC Circuit opinion; see, *Rambus Inc. v. F.T.C.*, No. 07-1124 (D.D.C. App. Ct. 2008). Private suits were also brought against Rambus by JEDEC members, but Rambus has won a significant victory here as well, with the District Court of San Jose ruling that the firm did not behave anticompetitively; see Consolidated Rambus Litigation, Hynix Semiconductor Inc., Nanya Tech. Inc. & Micron Tech. Inc. v. Rambus Inc., Case Nos. C-00-20905-RMW, C-05-00334-RMW & C-06-00244-RMW (N.D. Cal. March 26, 2008) (special verdict form).
4 *Broadcom Corp. v. Qualcomm Inc.*, No. 05-3350 (D.N.J. filed Aug. 31, 2006) (complaint).
Electrical and Electronics Engineers) for their Ethernet standard.\(^5\) The FTC grounded its complaint in the same line of deception-as-a-competition-violation logic as developed in *Unocal* and *Rambus*, although in the N-Data case the patents were fully disclosed before the standard was finalized.\(^6\)

At the root of the previous disputes is the problem of opportunistic licensing. That is, the concern that patent holders for the specific technologies included in a standard will be able to exploit the cost of switching to a different technological solution after a standard is defined. Under hold up, the costs involved in defining a new standard around different technologies or the costs of shifting capital investments for implementing one technology as opposed to another are held hostage, enabling patent holders to charge more than the value of their patented technologies.

In light of these antitrust concerns, several solutions have been proposed or attempted for eliminating opportunistic licensing in standard setting contexts, all of which strive to capitalize on potential ex ante competition over technologies vying for inclusion in a standard. Moving licensing discussions ex ante, before the technology path for a standard is frozen or before significant capital outlays are required for implementing a standard, offers a means of capturing competition over technologies and thereby reducing the risk of patent hold up and “non-FRAND” licensing. Although ex ante negotiation appears to have gained broad support as a solution to patent hold up, an important question remains: how best to put such negotiations into practice.

One proposal developed by Daniel Swanson and William Baumol has captured considerable attention.\(^7\) Their proposal consists of giving a patent holder a reward for his patented technology equivalent to what he could have obtained through an ex ante auction of a license for the downstream implementation of his invention. In other words, the licensing terms would be defined by the most that the patent could have commanded in an auction held while the standard was still under development, before the specific technologies have been settled upon. The auction


\(^6\) Note that the original licensing terms were disclosed eight years before Negotiated Data attempted to alter them and were offered by a separate entity from whom Negotiated Data later obtained the patents. See, N-Data, *supra* note 5 (dissenting statement of Chairman Majoras), available at http://www.ftc.gov/os/caselist/0510094/080122majoras.pdf.

approach would compensate an innovator for his contribution to an SSO over what the next best alternative technology could generate. Thus, the patent holder would receive the value of the incremental improvement that his patent offered to the standard compared to the closest rival.

While the auction concept has already been used as an antitrust reference point in the FTC Rambus matter, actually running an ex ante auction poses a number of problems. Most fundamentally, there is no guarantee that the terms set by an ex ante auction would ensure optimal investment in innovation and properly balance the needs of both licensors and licensees. Equally important, a number of practical auction design challenges likely rule out this method for anything other than ex post thought experiments like the one employed by the FTC.

A second option for curbing patent hold up is one that two SSOs, VITA and IEEE, are experimenting with: ex ante disclosure of licensing terms. VITA has the more stringent of the two new policies, both of which obtained U.S. Department of Justice business letter clearance before going into effect. VITA’s policy mandates the disclosure of all IP holders’ maximum rates and most restrictive licensing terms. Putting teeth behind the mandate, the policy states that any VITA member that fails to disclose either patents or maximum rates would have to license any patents deemed essential for the standard on a royalty free basis. In other words, disclose it or lose it.

IEEE’s new policy is far less demanding than VITA’s. The policy shift that IEEE instituted consists of giving members more opportunities to voluntarily disclose their desired licensing terms and conditions. In particular, IEEE’s IP disclosure guidelines now include several additional items members “may” list in any Letter of Assurance (an LOA is the IEEE’s official disclosure document), namely “(i) a not-to-exceed license fee or rate commitment, (ii) a sample license agreement, or (iii) one or more material licensing terms”. These additional term disclosures are simply encouraged, however, and IEEE has instituted no sticks of the disclose-it-or-lose-it variety to push members in the direction of licensing term publication. In fact, at the time of this writing, well over a year after enacting the new policy, only one of the LOAs publicly

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11 Id.
posted on IEEE’s website has included any licensing terms. At this point, then, the voluntary approach appears tantamount to business as usual, with little ex ante disclosure of licensing terms being volunteered.

It is interesting to note that both VITA and IEEE strictly prohibit joint negotiations. So, for example, even though the VITA policy dramatically increases information disclosure over the status quo at the vast majority of SSOs, it also consciously draws the line at group dialogue. Section 10.3.4 of the VITA policy explicitly states “The negotiation or discussion of license terms among WG [working group] Members or with third parties is prohibited at all […] meetings”. Likewise, the IEEE policy states “Copies of an Accepted LOA may be provided to the working group, but shall not be discussed, at any standards working group meeting”.

This brings us to a third proposal in the literature for preventing patent hold up via ex ante licensing: allowing SSO members to jointly negotiate licensing terms with patent holders prior to settling a standard. As is evident in the VITA and IEEE policies quoted above, joint negotiations of any prices are typically shunned for antitrust reasons. Challenging that view, Robert Skitol argues that “buying collaborations [within standard setting] … warrant more permissive rule of reason treatment because they entail integration efficiencies, can protect against anticompetitive uses of seller market power, reduce costs for downstream consumers, and can thus be procompetitive in their net impact.” And indeed, the U.S. antitrust agencies agreed with this logic in early 2007 when the DOJ and FTC issued a report that suggested such “buyer collaborations” henceforth would be viewed under a rule of reason. The report concluded that in the context of standard setting organizations, joint negotiations should not be deemed as per se illegal because of their potential for procompetitive effects. In particular, the agencies wrote that

In most cases, it is likely that the Agencies would find that joint ex ante activity

13 VMEbus International Trade Association, supra note 9.
14 Institute of Electrical and Electronics Engineers, supra note 10.
undertaken by an SSO or its members to establish licensing terms as part of the standard-setting process is likely to confer substantial procompetitive benefits by avoiding hold up that could occur after a standard is set, and this would be an important element of a rule of reason analysis. Ex ante licensing discussions may lead to price competition, in effect allowing for broader competition among alternative technologies vying for inclusion in the standard.\textsuperscript{17}

Each of these three proposals—auctions, ex ante licensing term disclosure, and joint negotiations—has its advantages and disadvantages. We would like to point out, however, that the list is incomplete. A fourth option for putting the ex ante concept into practice—one not yet discussed to any extent in the literature—would be for SSOs to encourage bilateral licensing negotiations ex ante, along with the typical IP disclosure and FRAND licensing commitments. This alternative would simply take the current process of confidential licensor-licensee negotiations and shift it forward in time, to a point before a standard’s technology path is frozen and technological alternatives might still exist and compete with one another. To put this proposal into practice, SSOs would simply add one more commitment to the list of promises already sought from members, namely the commitment to engage in good faith licensing negotiations with as many parties as practicable before the standard is finalized. Rather than limiting this pledge to patent holders, as with disclosure and FRAND, the ex ante licensing negotiation promise would be applied to all SSO members to ensure that firms hoping to implement the standard also act in good faith to seek licenses from those patent holders they believe to be the most relevant.

Given that ex ante auctions have already been closely examined and that more time is needed before the efficacy of the licensing term disclosure policies instituted by VITA and IEEE can be determined, in this article we focus on the third and fourth options for preventing patent hold up. Specifically, we consider whether either ex ante joint negotiations or ex ante bilateral negotiations offer a viable route to achieving the competitive ideal. Taking the Swanson-Baumol proposal to define the benchmark for a reasonable royalty as the ex ante incremental contribution over the next best alternative (i.e., the amount obtainable in a hypothetical ex ante auction), we evaluate the two ex ante negotiation approaches by assessing the extent to which they could be expected to lead to outcomes that diverge from this benchmark.

We find that while each ex ante approach has its shortcomings, bilateral negotiations are more likely to meet the pro-competitive objectives envisioned in the ex ante licensing proposals. In

\textsuperscript{17} Id. at 52.
particular, as recognized in the DOJ-FTC 2007 report, joint ex ante negotiation might entice collusion in final markets: “multilateral licensing negotiations certainly may offer an opportunity for SSO members to reach naked price-fixing agreements that lack plausible and cognizable justifications”.\(^\text{18}\) Moreover, joint ex ante negotiations might deny technology owners a fair return to innovation in cases where ex ante no viable alternatives exist, so that the adoption of the standard does not imply any increase in market power. As the DOJ-FTC 2007 report observed on this front,

…such [joint] negotiations might be unreasonable if there were no viable alternatives to a particular patented technology that is incorporated into the standard, the IP holder's market power was not enhanced by the standard, and all potential licensees refuse to license that particular patented technology except on agreed-upon licensing terms. In such circumstances, the ex ante negotiation among potential licensees does not preserve competition among technologies that existed during the development of the standard but may instead simply eliminate competition among the potential licensees for the patented technology.\(^\text{19}\)

Bilateral ex ante negotiations can pose problems of their own, in either direction. Under certain circumstances (which we explain below) bilateral licensing can enable a patent holder to charge royalties in excess of the reasonable benchmark, even when determined ex ante. Under certain other circumstances, bilateral licensing can result in the same kind of under-compensation for patent holders as joint negotiations would tend to do. Nonetheless, weighing the likelihood of these circumstances arising in practice we find that bilateral ex ante negotiations pose less of a risk than joint negotiations and are more likely to meet the reasonable ex ante benchmark.

While neither bilateral nor joint ex ante negotiations are perfect, ex ante bilateral negotiations emerge as the approach most likely to appropriately balance the needs of both patent holders and licensees. On the one hand, technology owners should be sufficiently rewarded to provide adequate incentives to undertake risky investments in research and development. On the other hand, excessive licensing rewards obtained ex ante generate similar costs to those incurred under ex post hold up and can therefore give rise to higher consumer prices. The balance must be just right to satisfy both parties’ needs, maintaining investments in R&D but still resulting in moderate prices in the downstream market. The rate achieving that balance is the “first best” royalty rate, in the language of economics. Bilateral negotiations can fail to reach the first best rate by leading to excessive rewards to innovators under some circumstances or by “under-

\(^{\text{18}}\) Id. at 51.
\(^{\text{19}}\) Id. at 53.
rewarding” innovators in other circumstances. We find that joint negotiations, however, would systematically lead to inefficiently low rewards, below the first best. We show that the potential for excessive rewards in the case of ex ante bilateral negotiations is reduced or even eliminated altogether once we account for some factors that are common in cooperative standardization.

We conclude that, rather than experimenting with joint negotiation procedures under the agencies’ more lenient rule of reason regime, SSOs should first explore shoring up their current IP policies of disclosure and FRAND licensing with a few more moderate additions. First, SSOs can consider how technologies are selected for inclusion in their standards. We find that majority requirements for a technology to be included in a standard can provide greater leverage for licensees in ex ante bilateral negotiations and thus can lower the odds of patent hold up. Second, SSOs can consider policies that would encourage bilateral ex ante negotiations as a means of pushing licensing earlier in the standardization process, when competition among technologies can act to hold royalty rates down. Third, antitrust authorities can consider signaling greater enforcement of the non-discrimination element of the FRAND commitment made to SSOs in the same fashion as they offered the green light for experimentation with joint negotiations by announcing that such policies will be evaluated under a rule of reason. While defining what is and what is not discriminatory pricing in the context of differentiated licensees may not be easy, it seems far more tractable than defining what is and what is not fair or reasonable under a FRAND commitment.20 The fair and reasonable assessment requires a but-for benchmark that is likely difficult to estimate but the non-discriminatory assessment simply entails a comparison of existing licensing terms against one another.

We begin in Section 2 with some key definitions. First, we clarify patent hold up. Second, we provide a brief summary of the Swanson-Baumol ex ante benchmark for reasonable royalties. Section 3 then explores joint negotiations, considering when such an approach could be expected to achieve the ex ante benchmark and when it could be expected instead to have anticompetitive effects. Next we consider ex ante bilateral negotiations in Section 4, making the same comparison to the reasonable benchmark and considering the potential for anticompetitive effects. We offer conclusions and policy implications in Section 5.

2. Key Definitions: Hold up and Reasonable Royalties

Before we turn to a reasonable ex ante benchmark or an assessment of proposals against that benchmark, let us define the hold up problem more precisely. Hold up typically occurs when two parties contract on the provision of a good and one of the parties (typically the buyer) needs to make a specific investment ex ante before the price is negotiated.\textsuperscript{21} After that specific investment is made, that is ex post, the other party can have increased bargaining power and it may therefore choose a price that does not reward the sunk investment and thus would have destroyed the incentives to invest in the first place had the price been known ex ante.

Consider a simplified scenario in which just one firm comprises an SSO. Within this SSO, two technologies are vying for inclusion in the standard. Suppose that no licensing occurs during the development phase, but rather occurs only after the SSO members have voted on which technology to include in the standard. Whereas one technology is publicly available, the superior one is controlled by a patent holder. The patent holder does not compete in the downstream market with the prospective licensee. The patented technology offers better cost-savings and implies production costs of $c_1$ for the firm implementing the standard. The other technology is freely available but implies higher production costs, $c_0 > c_1$. The incremental contribution of the patented technology to the standard is therefore the production cost savings over the free technology, $c_0 - c_1$. The licensee, therefore, will value the patented technology at $v_1 = c_0 - c_1 > 0$ per unit of production. Since the alternative technology is freely available, it forms the baseline and it is valued at $v_0 = 0$. The licensee charges an exogenous price $p$ in the marketplace, so that if technology 1 is chosen, we have $p = c_1 + m_1$ with $m_1$ representing the implementers’ markup, as opposed to a markup $m_0 = p - c_0$ if the alternative technology is chosen.

If the two firms establish licensing terms ex ante, when the patent holder faces real competition, the negotiated royalty rate will be at most $r = v_1$. That is, the patent holder can charge no more than the value it brings to the standard or the licensee will choose to license the competing technology. Whether the royalty that emerges from the negotiation process approaches $v_1$ or not depends on the relative bargaining strength of the patent holder as compared to the licensee. Set the patent holder’s bargaining power at $\beta$ (and the licensee’s power to $1 - \beta$), where

$0 \leq \beta \leq 1$. With ex ante negotiations, when the patent holder faces competition, the royalty rate will be $r = \beta v_1$. In the special case of the patent holder having all of the bargaining power ($\beta = 1$), then $r = v_1$. Under this general framework, licensee profits will be $\pi = p - (c_1 + \beta v_1)$, which will equal $\pi = m_1 - \beta v_1$ after substituting for $p = c_1 + m_1$. That is, the licensee’s profits are equal to its markup less the licensing fee.

If licensing negotiations take place ex post, the patent holder can exploit the switching costs of moving to a different standard after the technology is selected.\(^{22}\) We can illustrate patent hold up in a number of ways. For example, if the patent holder holds all of the bargaining power, it might set the royalty rate so as to appropriate all the licensee’s markup above production costs, in addition to the value the patent contributes to the standard. In this case the hold up royalty rate $r'$ would be set as $r' = p - c_1$, so that the licensee’s profits would be zero. Compared to the ex-ante negotiation process, the royalty increases by $r' - r = p - c_0 > 0$.\(^{23}\) It is important to emphasize that if ex ante the licensee expects a rate $r' > v_1$, it will choose not to accept the technology into the standard; there must be some element of deception or surprise for hold up to work.

With this more precise understanding of patent hold up in mind, turn next to the benchmark rate that Swanson and Baumol propose. In order to define a reasonable royalty, Swanson and Baumol present a very simple model of patent licensing within an SSO similar to that developed above. They envision an auction where a single potential licensee bids a royalty that it is willing to pay to be the only user of the technology. The incremental contribution of the patented technology to the standard is again the production cost savings over the alternative technology, $c_0 - c_1$. The licensee therefore values the patented technology at $v_1 = c_0 - c_1 > 0$ per unit of production. For the reasons discussed earlier, this hypothetical ex ante auction will never yield a royalty rate higher than $v_1$, since the licensee would otherwise face a licensing cost in excess of the production cost savings from using the technology. Paying such a royalty would not make business sense, and so the licensee would instead opt for the alternative technology. In this latter case, the patented technology would not be chosen for the standard and, without any licensing

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\(^{22}\) Note that hold up is not automatic even when negotiations occur ex post. It might be optimal for a patent holder to charge a lower royalty in situations with repeat-play reputation effects or when the reduction in downstream sales is so large that it compensates for the higher per unit margin.

\(^{23}\) Another way to think of hold up is in terms of a switching cost $s$ that the licensee might face to move from the standard based on technology $v_1$ back to one of the rival technologies that competed with $v_1$ prior to the vote. If the cost of switching is $s$, the hold up royalty rate would be set to $r' = v_1 + s$. 
options outside of the standard, the patent holder would receive no royalty earnings at all.

The royalty rate \( r = v_1 \) is the ex ante reasonable benchmark proposed by Swanson and Baumol, and it has a number of desirable properties. It is equal to the incremental value of the best technology option as compared to the next best alternative. The closer the available alternatives, the smaller is \( v_1 \); the greater the incremental contribution of the best option (i.e., the more pioneering the technology is), the higher is \( v_1 \). This royalty therefore captures the competition between the available technologies vying for inclusion in the standard. It rewards better innovations with higher earnings and penalizes me-too technologies with lower (or even zero) earnings. As such, \( r = v_1 \) presents a yardstick against which to gauge the reasonableness of other royalty rates.

It is important to point out, though, that by proposing an auction the Swanson-Baumol ex ante benchmark makes an implicit assumption about bargaining power, namely that \( \beta = 1 \). In other words, the outcome of an ex ante negotiation would coincide with this benchmark only if the patent holder has all of the bargaining power and can thus obtain the full incremental value contribution it makes to the standard.

Note that the benchmark rate \( r = v_1 \) may not match the first best royalty rate described in the introduction—the rate which perfectly balances the need for incentives to innovate against the need to offer products implementing the innovation to consumers at reasonable prices. For example, if spillovers in innovation exist, the social optimum would call for more firms investing in R&D than would naturally occur. As a result, larger rewards (i.e. larger royalties) would be necessary to lure entry into innovation efforts. Moreover, if ex ante competition between technologies is particularly fierce, \( v_1 \) could equal zero, which surely would not represent the value of the chosen technology, even if it did capture the incremental value of the chosen technology over the next best alternative. As a result, the \( r = v_1 \) ex ante benchmark can fall below the first best royalty. The two rates may be equal in many cases, but in some circumstances the ex ante benchmark may be too low to offer adequate incentives to innovate.\(^{24}\) Nevertheless, the incremental value benchmark \( r = v_1 \) offers a reasonable starting point for the analysis—especially considering that no one really knows what the first best rate is or how to even approximate it.\(^{25}\)

\(^{24}\) Of course when bargaining power is split so that \( \beta < 1 \), then the royalty rate resulting from an ex ante negotiation will be even lower.

In the remainder of the paper, we discuss circumstances in which hold up can occur within an SSO and how different kinds of ex ante negotiations stack up in relation to the Swanson-Baumol benchmark. Moving away from the overly simplistic hypothetical auction setting described above, with just one licensee and one patent holder, we must recognize that any technology owner that wants his invention included in a standard must gather support from a sufficient number of SSO members in order to win the SSO vote. The rules governing these votes matter, as we show below. And just as competition among technologies helps to keep royalty rates reasonable for buyers, competition among licensees helps to keep the royalty rates reasonable for innovation incentives.

3. Joint Ex Ante Negotiations

We begin our evaluation by discussing how royalty rates would be determined when all buyers negotiate together ex ante with the patent holder. We consider, therefore, a case of full coordination among buyers in the pursuit of their best licensing deal. We continue our discussion in the context of the stylized model presented in Section 2 and we illustrate it using a very simple example. Assume that there are three potential licensees—firms A, B and C—that do not compete downstream and that each one sells only one unit of the good. Because the patent holder has a technology superior to the other available alternatives, the parties have incentives to negotiate a licensing deal.

What happens if negotiations fail? The three implementers simply select an alternative technology for the standard. For simplicity, we set that alternative here to a freely available technology. Thus in the notation from above, licensees A, B and C use the alternative technology at royalty $r = v_0$ and obtain a production cost of $c_0$. As is often the case in high technology industries, if the patent holder does not succeed in getting his technology included in the standard, we assume that his outside licensing options are limited or non-existent. Thus, the

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26 We make this simplifying assumption for expositional reasons as it results in straightforward and easy to follow equations. Our conclusions do not hinge on it.
27 This assumption makes the comparison more stark, but it does not alter the fundamental findings. As long as the technically inferior alternatives cost less than the patented technology under consideration, the qualitative results of the model are unchanged.
28 An increased market is in fact one of the key motivations for incurring the costs and hassles of participating in cooperative standard setting efforts. See e.g., Mark Rysman and Tim Simcoe, Patents and Performance of Voluntary Standard Setting Organizations, 54 MGMT. SCI. 1920 (2008).
patent holder earns lower profits than had he been able to license within the standard. For simplicity, assume that the patent holder earns zero profits if his patent is not chosen for the standard.

If, however, the three firms reach an agreement with the patent holder then the incremental aggregate benefits (in relation to the next best alternative) equal \(3v_1 = 3(c_0 - c_1)\). Of course, there is no rule as to how the aggregate benefits are split between the patent holder and the three licensees. The negotiation of the royalty rate \(r\) achieves that end, such that the patent holder obtains profits of \(3r\) while each licensee enjoys a net return of \(v_1 - r\).

How, then, is the surplus actually split? What is the royalty rate \(r\) under joint negotiations? As before, set the patent holder’s bargaining power to \(0 \leq \beta \leq 1\). The licensees, then, have bargaining power \(1 - \beta\) as a group. For simplicity, assume the three licensees are identical partners and therefore split their portion of the aggregate surplus equally amongst themselves. The royalty rate is therefore set at \(r = \beta v_1\). Profits from the licensing deal are \(3\beta v_1\) for the patent holder and \((1-\beta)v_1\) for each of the licensees.

Bargaining power \(\beta\) can hinge on any number of factors, including firm size (market share), the availability of outside licensing options, risk preferences (which influence negotiation threat points), and even individual negotiation skills.\(^{29}\) If \(\beta = 0\), the patent holder has no bargaining power at all and obtains profits of 0. If \(\beta = 1\) the patent holder can appropriate the entire license surplus (the incremental value contributed to the standard), which is equivalent to the reasonable royalty benchmark defined in the previous section. It is therefore apparent that the reasonable ex ante benchmark \(r = v_1\) forms the upper bound of the possible royalty rates under joint negotiations, and is in fact only achievable in the unlikely event the patent holder has all of the bargaining power.

The general conclusion we draw from this analysis is that with joint ex ante negotiations the patent holder will in general be under-rewarded in the sense that the negotiated royalty rate is likely to fall short of the ex ante benchmark. The case where \(\beta = 1\) is unlikely to occur under joint

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\(^{29}\) Although economists often distinguish bargaining power per se and the effects of other elements such as outside options, for the purpose of this paper it is enough to observe that the many factors operate by shifting the surplus from the negotiation in the same direction. ABHINAY MUTHOO, BARGAINING THEORY WITH APPLICATIONS (1999), for a general treatment of the Nash Bargaining solution and a discussion of applications that endogenize bargaining power. For a more general discussion of bargaining power, although in the context of banking, see Hirofumi Uchida, Empirical Determinants of Bargaining Power (2006) (Working Paper), available at http://ssrn.com/abstract=954534.
ex ante negotiations for a number of reasons: the patent holder may need to participate in the
standard setting body to remain viably competitive in the industry; or the members of the
standard setting body may represent all of the key industry players in the industry anyway, so that
dropping out of the standard would not improve the patent holder’s negotiating position. As a
result, in most cases joint negotiations will lead to $r < v_1$ because $\beta$ will be less than 1. Most
commonly then, joint negotiations will under-compensate patent holders in relation to the ex ante
benchmark.

4. Bilateral Ex Ante Negotiations

Joint negotiations are, of course, not the only means by which to capture ex ante
competition, as already discussed in section 1. The academic debate has largely ignored the fact
that standards are agreed through a voting process and that ex ante bilateral negotiations, useful to
gather support from potential licensees, could constrain the potentially opportunistic ex post
behavior of patent holders. This approach is similar to the common practice of two-way
confidential negotiations, except that negotiations take place ex ante, prior to the standard’s
technology choices.\(^{30}\)

The goal of this section is to determine under which conditions bilateral negotiations, if
completed ex ante, would solve the problem of opportunistic licensing. To answer that question,
we discuss the possible outcomes of ex ante bilateral negotiations under several different
scenarios: (a) when unanimity within the SSO is required before a technology is selected, (b)
when unanimity is not required but some SSO members are pivotal and (c) when negotiations
take place under non-discriminatory commitments. Finally, to provide a complete picture, we
describe the unrealistic situation under which ex post opportunism can be reproduced in ex ante
negotiations as well. The extreme assumptions that need to concur in this case reflect the power
of ex ante negotiations to curtail the holdup risk.

\(^{30}\) Ex ante bilateral negotiations do in fact take place now. The proposal here is to increase their occurrence
through official sanctioning.
4.1 Full Consensus

In general, defining a cooperative standard is a consensus-building process. As our first scenario, then, consider an SSO that has a full unanimity rule: all SSO members must agree before any technology is included in the standard. In this case, each member has one vote and all votes are equal. Any technology owner that wants an invention to be included in the standard must gather support from all of the other SSO members in order to win the vote. In the context of our simple model, the three implementers A, B, and C constitute the other SSO members, each with an equal vote, and all three must support the patented technology for it to be included in the standard.

Once the patent holder’s technology has the support of the members, the actual license can be negotiated either ex ante or ex post. In this scenario, ex ante licensing negotiations—and possibly the favorable terms that they might entail for those who sign early—are a useful lure to convince firms to support the technology during the standard vote. The downstream implementers anticipate that if they do not reach an agreement with the patent holder ex ante for a technology that is eventually included in the standard, they will need to reach an agreement ex post, when the bargaining position of the technology owner could be greatly improved. The potential licensees therefore have strong incentives to seek out early licenses for technologies they intend to support (or not oppose) for inclusion in the final standard.

What does the final license look like? For discussion purposes assume that the patent holder meets with the three firms in sequence. While artificial, this standard approach in game theory helps to clarify possible outcomes, and generally results in rational solutions. Prospective licensees decide to support a technology depending on their expectations of whether other potential licensees will reach an agreement or not and, if so, the ensuing royalty rate outcome. Because firms A and B will anticipate the outcome of the negotiation with firm C, we start with

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32 If negotiation costs are low, potential licensees have incentives to license all potentially included technologies and structure those licenses such that no payments are due unless the technology is in fact included in the standard. When standards are complex and include numerous components, complete ex ante licensing may be difficult, but key players could nonetheless be targeted.
33 Note that we are not assuming strict sequentiality here. Licensing negotiations can start, stop, and resume. We simply look at the negotiations in order for expository reasons. Below we explain how strictly sequential negotiations can be used to enhance a patent holder’s bargaining position.
34 MARTIN OSBORNE, **AN INTRODUCTION TO GAME THEORY** (2004).
this last negotiation. Two outcomes are possible before the patent holder engages in negotiations with firm C:

1. The patent holder has not obtained support from firm A, firm B, or both. In that case, the negotiation with C is irrelevant as the technology will not be accepted by the SSO because a full consensus is required.

2. The patent holder has obtained support from both firms A and B. In that case, firm C is pivotal in the decision because the alternative technology will be implemented if C rejects the offer, whereas if C accepts the offer then the patented technology will be chosen by the SSO. Given that the private benefit to firm C of accepting is $v_1$, firm C will accept the patent holder’s offer only if the royalty rate is less than or equal to the benefit: $r_C \leq v_1$. In this case licensee C can withhold support: unless the patent holder shares a portion of the incremental value of the patent’s contribution to the standard, firm C will not support the patent for inclusion. Thus, $r_C = \beta v_1 \leq v_1$.

With firm C’s acceptance point determined, we can now turn to the negotiation between the patent holder and firm B. Both parties anticipate the outcome of the future negotiation with firm C. They both know that the patent holder will always offer a license that is acceptable for firm C in order to get the patented technology accepted in the standard. As a result, two possibilities are relevant, depending on whether firm A has already accepted or not.

1. If firm A has not accepted the offer from the patent holder, negotiations with firm B are irrelevant as the patented technology cannot gain the necessary consensus.

2. If firm A has accepted the offer of the patent holder, firm B knows that it is now pivotal in the negotiation. Analogous to firm C’s decision, firm B will only accept the license if the royalty is set as $r_B = \beta v_1 \leq v_1$.

With the other two licensees determined, we now turn to the negotiation between firm A and the patent holder. Similar to the above reasoning, firm A will accept any licensing agreement such that $r_A = \beta v_1 \leq v_1$.

The general outcome is that with full consensus voting, all SSO members understand that they can be pivotal to any technology decision. This result does not hinge on any sequential negotiation process, as employed above for expositional purposes. The intuition here is that every single vote counts—firm A does not need to know the outcome of negotiations with firms B and C in order to know that its vote is required for the patent holder’s technology to be accepted.35 As a result, under full consensus voting licensees will hold non-zero bargaining power ex ante, so that licensing terms will fall below the ex ante benchmark of $r = v_1$. Any higher rate and the

35 This is, in fact, the classic hold out problem in right-of-way disputes. See e.g., Patricia Munch, *An Economic Analysis of Eminent Domain* 84 J. POL. ECON. 473 (1976).
licensees within the SSO will not support the technology and it will not be included in the standard. In other words, all SSO members are “pivotal” in that the patent holder must have the support of each and every member in order to earn any licensing fees through the standard. Just as with joint negotiations, consensus rules make all players pivotal so that the patent holder must share the contributed value of the patent with licensees and accept a royalty rate less than the ex ante benchmark. However, in as much as joint ex ante negotiations entail a risk of downstream collusion among licensees, individual negotiations in consensus SSOs will be deemed a superior mechanism from a social welfare standpoint.

4.2 Pivotal Licensees

The discussion thus far highlights a crucial element in the hold up equation: the presence of pivotal players. Under the ex post hold up scenario it is the patent holder who is pivotal; the patent holder has a superior technology and can credibly threaten to withhold the patent if the licensee does not share its revenues above and beyond the value contributed by the patent. Under ex ante joint negotiations, it is the licensees as a group that is pivotal: the group can credibly threaten to support an inferior alternative technology for the standard in order to pressure the patent holder to accept less than the incremental value of its patent. Likewise, under full consensus rules each licensee is pivotal, so that again the patent holder must choose between the (likely inferior) outside option or royalty earnings that may compensate it less than the full value of its patented technology.

We do not, however, need joint negotiations or a full consensus in order to have pivotal licensees. While consensus building is always important within SSOs, they do not all require 100% support for a technology to be included in a standard. Just how much support is required depends on the SSO’s voting rules and on the voting power of the particular patent holder as compared to other members of the SSO. For instance, some SSOs apportion votes based on revenue categories. Without unanimity, a technology owner needs the support of either the necessary threshold proportion of SSO members or at a minimum the most powerful SSO members for its patented invention to be included in the standard. This is a particularly important point to understand, as the vast majority of SSOs are comprised of far more technology users than

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technology suppliers. That is, patent holders are commonly in the minority and must gain support from at least some potential licensees for their patented technology to be considered in standard development.

When an SSO apportions votes according to sales, certain firms will be pivotal simply by virtue of their relatively large voting rights. Similarly, when an SSO has majority vote rules, some group of firms will become pivotal as the patent holder needs their support to be included in the standard. These pivotal firms will have non-zero bargaining power because they can block the patented technology’s acceptance into the standard. As a result, the pivotal licensees will never accept licensing terms above the ex ante benchmark, and \( r \leq v_1 \). As explained earlier, the ex ante royalty rate for any pivotal player will be \( r = \beta v_1 \).

4.3 Non-Discrimination Commitments

If pivotal players always pay, at most, the benchmark ex ante rate and in fact tend to pay rates less than that due to their relative bargaining power, what happens to the non-pivotal licensees? Without joint negotiations or full consensus to make all licensees pivotal, would the non-pivotal firms be subject to patent hold up? In most cases no. This follows because most SSOs request FRAND promises from their members. While the “FR” portion of the FRAND commitment has received the most attention in the literature, it is the “ND” portion that emerges as crucial here because it requires license terms to be identical for all similarly situated firms.

So, for example, the three identical licensees in our simplified model would all be entitled to the same terms under a FRAND promise. If a pivotal firm, say firm A, obtains a royalty \( r_A = \beta v_1 \), the patent holder would have to offer \( r_B = r_C = \beta v_1 \) as well in order to comply with its FRAND promise to the SSO. Even if firm A were the only firm to take a license ex ante, the patent holder could be bound to \( r = \beta v_1 \) ex post in order not to discriminate against firms B and C. With non-discrimination clauses, firms would pay at most the ex ante reasonable royalty benchmark and no hold up would arise as long as at least one licensee entered into a reasonable agreement ex ante.

Non-discrimination commitments do not require identical terms for all parties, but rather identical terms for all similarly situated parties. Here, all licensees are assumed to be identical and so would have to receive identical licenses. Non-discrimination commitments could nonetheless be equally effective in the real world because the only differences tolerated under such rules are those justified by the differing circumstances. Ex post opportunism would not qualify as a justification. So, differences between ex ante and ex post licensees can only be justified by genuine differences in conditions, such as the additional risk that ex ante licensees might face regarding the success of an unproven technology.

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lower royalty rate obtained by one of the licensees would spill over to all other similarly situated firms.\(^{38}\)

More interestingly, it turns out that a FRAND commitment can eliminate the holdup risk even if no pivotal players exist.\(^{39}\) The reason is that non-discrimination clauses align the incentives of the different licensees. That is, since licensees benefit from the best royalty offered to all the others, some of them can withhold their support ex ante in order to make the remaining one pivotal in the negotiation to extract a better deal from the patent holder. To see this point, we can go back to the original example with an SSO comprised of three firms, and the case where all bargaining power is in the hands of the patent holder (\(\beta = 1\)). Firm A will not accept a royalty larger than \(v_1\) because by rejecting, firm B and/or C would become pivotal, who, in the negotiation with the patent holder would only accept a royalty below \(v_1\), the same as firm A would get under non-discrimination.

4.4 Worst Case: Discriminatory Bargaining

What if neither of the previous conditions is satisfied? As a final case, we consider the worst scenario for ex ante bilateral negotiation, one in which patent hold up might emerge even ex ante. In particular, we assume strictly sequential negotiations with no full consensus and with no FRAND commitment possible (although we still maintain the IP disclosure policy). This is an extremely artificial set of assumptions meant to highlight the worst that ex ante bilateral negotiations could bring. In a purely sequential negotiation, the patent holder approaches each potential licensee in sequential order for a one-shot, no return negotiation, which prevents any licensee firm from becoming pivotal in equilibrium and thus allows the patent holder to license opportunistically even ex ante. The outcome of these successive negotiations coupled with the absence of any non-discrimination commitment therefore allows the patent holder to reproduce ex ante what it could have obtained ex post—that is, patent hold up. We offer this case as a contrast to the more likely scenarios developed above.

\(^{38}\) Another route to achieving the same end would be the presence of “most favored nation” (MFN) clauses in the license contract. A MFN clause entitles a licensee to any more favorable terms that the patent holder negotiates later with other licensees (although these clauses generally do not allow cherry picking of terms but instead require the bundle of terms in the later license be accepted in their entirety).

\(^{39}\) As in the benchmark case, this result generalizes to an arbitrary number of firms or asymmetries in the voting power of possible buyers. See the appendix for details.
Sequential bargaining has been used in other contexts to illustrate “naked exclusion”. In its original context of vertical relations, it is used to study the exclusive agreements that a market incumbent, the producer of some intermediate good, can reach with its downstream buyers in order to prevent the entry of more efficient upstream competitors. In that context, as in ours, the decisions of different buyers are related. If buyers are able to coordinate to reject the terms the upstream incumbent offers, the boycott could trigger the entry of a more efficient producer and thus more competition facing the upstream incumbent with a lower price for the input as a result. However, if the upstream incumbent can negotiate with each buyer sequentially it can improve its negotiating position when facing the first firms in the sequence by using the threat of reaching entry-preventing agreements with buyers in later negotiation rounds.

Similarly, in the standard setting context purely sequential negotiation could prevent tacit coordination among licensees and, as a result, could maximize profits for the patent holder. This outcome is due to the fact that ex ante the patent holder only needs to reach an agreement with the threshold proportion of licensees necessary for the patented technology to be included in the standard. Once this proportion has been reached through offers of \( r = \beta v_1 \), in further ex ante negotiations the patent holder could charge the same royalty as in an ex post agreement \( (r') \), when it benefited from the created market power due to inclusion in the standard. Because we assume for the moment that the patent holder is not bound by a FRAND commitment, it can earn hold up royalties from at least a portion of the licensees.

To see why this conclusion would hold under this set of assumptions, let’s return to the simple model with the three potential licensees. The patent holder negotiates with each of the three firms in a strict, no-return sequence, from A to B to C. Assume that support from two of the three firms is needed for the patented technology to be included in the standard. The patent holder first approaches firm A and offers an agreement for the patent to be licensed at royalty \( r_A \). If firm A accepts, it will obtain a return \( m_1 - r_A \). That is, the private benefit for firm A equals the margin obtained from selling the product net of the price paid for the license. If firm A rejects the offer two things can occur: either the technology does not obtain the necessary support and an alternative technology is chosen for the standard or both of the other two firms accept the patent holder's offer and the patented technology is selected for the standard, implying that firm A must

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40 This concept has become popular in the economics of antitrust, starting with papers such as Eric B. Rasmusen, Mark J. Ramseyer & John S. Wiley Jr., *Naked Exclusion*, 81 AM. ECON. REV. 1137 (1991), and Llya R. Segal & Michael D. Whinston, *Naked Exclusion: Comment*, 90 AM. ECON. REV. 296 (2000).
enter into ex post negotiations with the patent holder. If firm A is faced with ex post negotiation, the patent holder would be able to charge $r' > \beta v_1$.

We again start with the last negotiation, with firm C. There are three possible outcomes for the patent holder going into negotiation with C:

1. The patent holder has not obtained the necessary support from either firm A or B. In that case, the negotiation with C is irrelevant as the patent holder cannot reach the two-thirds majority needed for inclusion in the standard and thus the patented technology will not be accepted by the SSO.

2. The patent holder has obtained support from only one of the firms, A or B. In that case, firm C becomes pivotal in the decision because if C rejects the patent holder’s offer the alternative technology will be included in the standard. If C accepts the offer, the SSO will include the patented technology. Hence, in this case firm C will only accept the patent holder’s offer if the royalty rate, $r_C$, is set equal to or below the share that firm C, according to its bargaining power, could appropriate from the incremental benefit of using the patented technology: $r_C = \beta v_1$.

3. The final possibility is that both firms A and B have accepted the patent holder’s offer. As a result, firm C is irrelevant for the standard to be implemented since the two-thirds majority has already been achieved. In this case, the patent holder has no incentive to reach an ex ante licensing agreement with firm C unless that agreement produces a return as high as an ex post agreement would grant. Since ex post there is no costless alternative to the patented technology, firm C would have to accept the hold up license $r'_C$. Hence, once the majority is reached the patent holder will offer ex ante $r_C = r'_C$.

Consider next the negotiation between the patent holder and firm B. Both parties can anticipate the outcome of the future negotiation with firm C. They both know that the patent holder will always be able to offer a license that is acceptable for firm C. As a result, two possibilities are relevant, depending on whether firm A has already accepted or not.

1. If firm A has not accepted the patent holder’s offer, firm B knows that it is now pivotal in the negotiation given the necessary two-thirds majority. Therefore, firm B will only accept the license if the royalty is at most equivalent to what it would obtain under the alternative technology, that is, $v_1$. Therefore, $r_B = \beta v_1$.

2. If firm A has accepted the patent holder’s offer, firm B anticipates that if it rejects the offer, the standard will be implemented anyway since the patent holder can set $r_C$ to ensure that firm C accepts. Hence, in this case firm B will be willing to pay ex ante the same amount it would have to pay ex post: $r_B = r'_B$.

We finally come to the first negotiation, between firm A and the patent holder. From the previous discussion we can deduce that if firm A declines the patent holder’s offer, the patent holder can set royalties such that both firms B and C will accept. As a result, the standard will be accepted regardless of firm A’s decision. In other words, firm A cannot be pivotal. As before, firm
A will accept any licensing agreement that it would have obtained ex post, so \( r_A = r'_A \). Because A accepts, firm B and C will also accept and they will all pay the ex post holdup royalty rate \((r'_A, r'_B, r'_C)\).

Just as in the other cases discussed above, the negotiation power of each potential licensee hinges on the possibility of being pivotal in the decision. Each licensee will obtain better licensing terms the more necessary is his acceptance for the standard to be implemented. If the patent holder expects to reach the necessary majority by negotiating with another party, it will only offer the current party ex ante terms equivalent to the higher ex post terms.

Note, however, that this worst case scenario result only emerges after we drop a number of reasonable assumptions that match the typical SSO IP policy and standard setting process. First, the negotiation process in this example is strictly sequential, with no firm revisited for a second round until after the standard is set. In reality, licensing negotiations are likely to be a combination of sequential and simultaneous. A patent holder may be engaged in negotiations with several potential licensees at any given time, but these negotiations tend to take time—months or even years. Nor are negotiations one-shot deals; firms can and do stop talks only to resume them later. While patent holders can attempt to play one licensee off of another in building a base of support, pure sequentiality cannot be used to prevent any licensee from becoming pivotal. This alone is enough to eliminate the finding of hold up royalty rates for all licensees even when contracts are signed ex ante. Second, in this one extreme case we have assumed no FRAND promise exists. This too is counter to common practice at SSOs. With a FRAND promise, discrimination amongst the licensees is no longer possible. If the other licensees know that they will be able to obtain equivalent deals at a later date, they can wait for the most pivotal of licensees to negotiate first and again reach reasonable ex ante licensing terms. Finally, in this one extreme case we have assumed that full consensus is not required for the patented technology to be included in the standard. While full consensus is not the norm within standard setting, majority rules often are. The larger the quorum needed, the more likely it is that a significant proportion of licensees will receive a reasonable ex ante rate (necessary to obtain their support). We therefore conclude that the worst case scenario of hold up royalty rates emerging from an ex ante bilateral negotiation process, although possible in theory, is quite unlikely to happen in practice.
5. Policy Implications and Conclusions

We began this paper by discussing several potential routes for reducing or eliminating the risk of opportunistic licensing and patent hold up. Among the alternatives is joint negotiation among licensees within an SSO, as originally proposed in the academic literature but recently acknowledged by US antitrust agencies. In a joint report issued in spring 2007, the DOJ and FTC announced that they intend to take a more permissive view of joint licensing negotiations in the context of standard setting, evaluating such discussions under a rule of reason rather than as per se illegal. This announcement can be seen as a signal to SSOs that experimentation with joint negotiation is now possible—a dramatic shift from prior policy, where any sort of coordination among SSO members over prices was viewed with suspicion. In light of the remaining competitive risks possible with joint negotiation, we offered a counter alternative: the encouragement of ex ante bilateral negotiations. Using a simple but nonetheless informative model for real world behavior, we compared these two forms of ex ante license negotiations in an attempt to determine which was more likely to reduce the risk of patent hold up without introducing anticompetitive risks of its own.

We find that ex ante joint negotiations tend to under-compensate patent holders, as compared to a reasonable ex ante benchmark developed in the literature that sets the royalty rate equal to the incremental value the patent contributes to the standard. With joint negotiations, the upper bound royalty rate is the ex ante benchmark rate, but is only reached in the unusual circumstance of the patent holder having all of the bargaining power while the aggregated licensees have none. This condition is unlikely to hold in most real world situations, especially given the common presence of pivotal SSO members that hold significant voting rights or that have powerful positions in the downstream market relevant for the standard.

Ex ante bilateral negotiations, on the other hand, are likely to come far closer to the reasonable royalty benchmark, whereby the patent holder charges no more than the incremental value its technology contributes to the standard. In fact, even when the patent holder has all of the bargaining power (i.e., $\beta = 1$), in most cases the patent holder will still charge no more than the ex ante reasonable benchmark because licensees would otherwise move to other (inferior) alternatives. Negotiations are a complex combination of sequential and simultaneous, and most SSOs do have FRAND commitments. The presence of a FRAND commitment reinforces the
reasonable royalty outcome even when no SSO member is pivotal.

Our analysis suggests a number of policies that could help to prevent patent hold up. First, SSOs should consider policies that encourage bilateral licensing negotiations to take place ex ante, before the technologies are chosen for a standard. This could be accomplished along the same lines as the licensing term disclosure experiments currently underway at VITA and IEEE. That is, SSO members could pledge to engage in good faith efforts to license with as many key firms as practicable. For patent holders, that would mean starting negotiations with the largest implementers; for licensees, it would mean approaching firms that hold patents likely to be essential for the standard. These firms could be identified from the IP disclosure process already in place at most SSOs.

Second, a sensibly high degree of consensus required for the acceptance of a technology within a standard would create a number of pivotal licensees who would be able to maintain royalties at the reasonable ex ante benchmark. SSOs could therefore examine the mechanisms by which they assess technologies for inclusion in standards. Moving toward majority rules will help to prevent patent hold up. The larger the quorum needed, the more likely it is that a significant proportion of licensees receive a reasonable rate ex ante (necessary to obtain their support ex ante), and these licenses could then ensure reasonable rates ex post through non-discrimination commitments and Most Favored Nation clauses. While there would be a cost in terms of the speed at which standards are promulgated—consensus building tends to take more time to achieve—if patent hold up is seen as a serious potential problem within an SSO then the tradeoff could be worthwhile.

Third, those few SSOs that do not yet have FRAND commitments in place should consider adding them. The non-discrimination component of these promises offers a route to maintaining reasonable royalties for all licensees, even those contracting ex post, and is a tool that has largely been ignored in the debate over patent hold up. In light of this last point, we offer a fourth suggestion: antitrust authorities could consider ways in which to signal the enforcement of non-discrimination commitments, just as they have done for joint negotiation. Determining what is and what is not discriminatory may not be easy, especially when firms are differentiated or when patent valuations differ by firm, but royalty discrimination is an issue that the courts are already well equipped to deal with as it is a regular issue in patent cases today. Moreover, determining what rates are or are not “fair” or “reasonable” strikes us as a far more complicated, controversial,
and subjective task. Rather than defining a but-for world in which to estimate fair and reasonable rates to serve as a benchmark for an existing rate, assessing discrimination would involve comparing only those rates actually charged.

We conclude that ex ante bilateral negotiations are a promising and as yet not fully explored option for preventing ex post opportunistic licensing. Joint negotiations, on the other hand, would likely introduce new problems even as they solved old ones. The potential for cartel-like behavior is particularly worrisome in light of the fact that most SSOs have far more licensee members than licensor members. Even if joint negotiation did not result in overt collusion among licensees, it would tend to result in under-compensation for patent holders, as compared to the reasonable ex ante benchmark, and could therefore affect the incentives to innovate. Encouraging ex ante bilateral negotiations and other simple changes in SSO IP policy appear a less risky solution to ex post licensing problems.
Appendix: A General Model for Individual Negotiations

Assume that $N>1$ firms comprise the SSO. We denote (potential) licensee $i$ as $L_i$. This licensee controls a percentage of voting shares $\alpha_i$. As in the main body of the paper, we restrict our environment to the competition between two technologies: technology 1 represents a value $v_1$ for the licensees, arising for example from a cost reduction over the already available technology 0. The patent holder’s bargaining power is again denoted as $\beta$. Finally, in order to make the problem non-trivial we assume that a proportion $A<1$ of voting shares is necessary for the standard to be accepted, where $A>\alpha_i$ for all $i=1,...,N$. That is, more than one firm is required for the technology to be accepted.

The timing of the game is as follows. The patent holder makes sequential offers to each innovator $i$. After all offers have been made and accepted or rejected all members of the SSO vote between technology 1 and 0. Once a technology has been accepted, firms that do not already have a license to the technology must negotiate ex post, where we assume that the patent holder can extract a royalty $r'$. We denote the ex ante royalty offered to firm $i$ as $r_i$.

We now introduce some definitions. We denote firm $i$’s decision as $d_i$, which takes one of two values. The value $d_i=1$ indicates the choice of technology 1 whereas $d_i=0$ indicates the choice of technology 0. Denote as $\gamma_i^*$ the percentage of shares secured by the patent holder before an offer to firm $i$ is made.

**Definition A.1.:** Given $\{d_i\}_{i=1}^N$, firm $i$ is pivotal if

$$\gamma_i^* + \sum_{j=i+1}^N \alpha_j < A < \gamma_i^* + \alpha_i + \sum_{j=i+1}^N \alpha_j.$$

The interpretation is straightforward. A firm is pivotal if, given what the previous firms have chosen, its acceptance is necessary for the standard to be accepted even in the case where all successive firms also accept.

The next proposition shows that the equilibrium royalty offered in the benchmark model where discriminatory royalties are possible coincides with the ex post one.

**Proposition A.1:** With discriminatory sequential offers, technology one is always chosen and firms pay a royalty $r_i = r'$. 
Proof: First notice that ex post, if technology 1 has been chosen any firm i that has not secured an ex ante license will pay a license \( r' \).

Using an induction argument we now show that for all decision histories of previous firms, licensee i will always accept the equilibrium royalty offered by the patent holder. In order to do so, we establish this result first for the last licensee and show that it holds for a generic licensee i.

Regarding the last potential licensee, firm N, two possibilities might occur depending on whether this licensee is pivotal or not in the final decision.

If licensee N is pivotal, per unit profits for the licensee are increased by \( v_1 \) when \( d_N = 1 \), as opposed to choosing technology 0 and paying a royalty 0. Hence, because acceptance of the standard increases profits for the patent holder and accounting for bargaining power, the royalty offered will be \( r_N = \beta v_1 \). If licensee N is not pivotal, the patent holder will offer ex ante the same royalty it could collect ex post, \( r' \).

Let's consider now the case of firm i, where using the induction argument we assume that \( d_j = 1 \) for all \( j > i \). Given a history \( d_k \) for \( k < i \), two situations can occur. If firm i is pivotal, as before, the patent holder will offer the highest royalty compatible with the firm optimally choosing technology 1, that is, \( r_i = \beta v_1 \). Otherwise, if firm i is not pivotal, \( r_i = r' \).

We can now turn to the first licensee, firm 1. Since by assumption \( \alpha_i < \alpha \) for all i, firm 1 is not in equilibrium pivotal. As a result, in the equilibrium path of play \( r_1 = r' \). Similarly, given that in equilibrium \( d_i = 1 \) for all i, no firm is pivotal and \( r_i = r' \) for all i.

Incidentally, the proof of the previous proposition also shows that if a firm, say firm i, had enough voting power for the standard to be accepted only if it were present (that is, if it were pivotal), its royalty would be \( r_i = \beta v_1 \).

We now turn to the case in which the patent holder is restricted to making non-discriminatory offers. As in the rest of the paper, we understand non-discrimination as the possibility that any firm can obtain a royalty ex post that is no worse than what its (identical) competitors might have obtained ex ante.

**Proposition A.2:** Under non-discriminatory sequential offers, technology 1 is always chosen and firms pay a royalty \( r_i = \beta v_1 \).
Proof: First, notice that technology 1 will always be implemented, since the patent holder can always offer a royalty sufficiently small to lure acceptance.

Second, we show that in the unique subgame perfect equilibrium, \( \max_i \{ r_i \} \leq \beta v_1 \) for all firms that have chosen \( d_i = 1 \). We do that by contradiction. Suppose that \( \{ d_i^* \} \) is an equilibrium where technology 1 is accepted. If \( \max_i \{ r_i \} > \beta v_1 \) then at least one firm that has accepted technology 1 ex ante is not pivotal. Otherwise, this firm, denoted as \( i' \) would have rejected the offer since pivotal firms can always negotiate \( r_i = \beta v_1 \) through the threat of non-acceptance. Moreover, firm \( i' \) is such that if it had not accepted technology 1, no future firm would be pivotal. The reason is that a future pivotal firm could have secured \( r_j \leq \beta v_1 \) exploiting the patent holder’s higher earnings from \( i' \), leading to an ex post royalty \( \beta v_1 \) by non-discrimination. Moreover, using this argument recursively, firm \( i' \) is such that if it had not accepted technology 1, no future firm \( i'' \) would be in the position that by also not accepting another future firm would be pivotal, and so on. This argument would eventually result in a contradiction since at some point some firms must be pivotal.

Third, we show that \( \min_i \{ r_i \} \geq \beta v_1 \) for all firms that have chosen \( d_i = 1 \). Otherwise, if there exists an \( i \) for which \( r_i < \beta v_1 \), the patent holder can simply increase \( i \)'s royalty rate without changing firm \( i \)'s or any other firm's decision. ■