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Standard Setting, RAND Licensing and Ex Ante Auctions: The Policy Implications of Asymmetry

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STANDARD SETTING, RAND LICENSING AND EX ANTE AUCTIONS: THE POLICY IMPLICATIONS OF ASYMMETRY

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Abstract

Standard setting organizations may in some circumstances confer market power on participants whose patented technologies are included in standards. Promises to license on reasonable and non-discriminatory (RAND) terms play a key role in mitigating any such market power, but the usefulness of those commitments has recently been questioned. The problem allegedly lies in the absence of a generally agreed test to determine whether a particular license satisfies a RAND commitment. Swanson and Baumol (2005) have suggested that “the concept of a ‘reasonable’ royalty for purposes of RAND licensing must be defined and implemented by reference to ex ante competition.” In their opinion, a royalty should be deemed “reasonable” when it approximates the outcome of an ex ante auction process where IP owners submit RAND commitments coupled with licensing terms and selection to the standard is based on both technological merit and licensing cost. This test has recently been adopted by the Federal Trade Commission in Rambus. In this paper we investigate whether an ex ante auction approach is likely to deliver efficient outcomes, both from static and dynamic standpoints. Applying lessons from the economics literature on auctions, we find that due to several forms of asymmetry characteristic of the industries where standardization takes place the ex ante auction approach is not likely to deliver the right outcomes from a social welfare viewpoint.

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I. INTRODUCTION

The adoption of proprietary technologies by standard-setting organizations (SSOs) is often necessary to ensure that the resulting standard provides the greatest possible value to its users and, therefore, to guarantee the success of the standardization process. Nonetheless, some claim that the selection of proprietary technologies as standards may also create significant market power, generate returns in excess of those needed to remunerate innovation, distort competition and restrict the dissemination of new and superior technologies.\(^2\) A necessary (but not sufficient) condition for the creation of ex post market power (i.e., attributable to standard selection) is the absence of alternative technologies that can be substituted for the selected technology at comparable user costs.\(^3\) When alternative technologies are available, an SSO’s endorsement of a proprietary technology as a standard may result in a reduction of short-term competition in the technology market and may have longer-term implications for the technological path that evolves.

Reasonable and non-Discriminatory (RAND) licensing is one mechanism for curbing the abuse of such ex post market power. Most SSOs request participating technology owners to commit to license their intellectual property (IP) on RAND terms,\(^4\) but offer little guidance on what a RAND commitment means in practice. In a recent paper, Daniel G. Swanson and William J. Baumol propose a solution: “the concept of a ‘reasonable’ royalty for the purposes of RAND licensing must be defined and implemented by reference to ex ante competition.”\(^5\) To implement this reference to ex ante competition, they propose that SSOs conduct ex ante auctions of

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their standards, where IP owners would submit RAND commitments coupled with licensing terms and the standardization selection process then would be based on technological merit and price.

For Swanson and Baumol a “reasonable” royalty for RAND purposes “is or approximates the outcome of an auction-like process appropriately designed to take lawful advantage of the state of competition ex ante … between and among available IP options.”\(^6\) This definition of RAND requires some explanation. First, the reference to a “lawful advantage” rules out the operation of a buyers’ cartel. Second, as the authors acknowledge, the proposal only makes sense where competition exists ex ante among feasible substitute technologies. This means that auctions will not work in potentially many cases where technological choice does not exist. Lastly, but not less importantly, Swanson and Baumol recognize that the ex ante auction must be “appropriately designed” to ensure that it produces reasonable results. Not every auction-like process may do the job from a RAND standpoint. In fact, they suggest the adoption of the “sealed bid” auction model, where IP owners would simultaneously submit best and final offers.

The issue of auctions within standard setting has been at the forefront of recent policy decisions. For instance, the ex ante auction benchmark approach was recently used by the Federal Trade Commission when determining the maximum royalty rates that Rambus may charge those practicing the SDRAM and DDR-SDRAM standards.\(^7\) However, policy decisions such as this one, and the general discussions surrounding them, have not been well informed by the vast technical economics literature on auction design. This is not surprising, but it is unfortunate as economic models and insights on auctions have much to offer the policy debate over ex ante pricing.

In this paper, we provide a bridge between these two worlds: the technical economics literature on auction design and the policy oriented legal literature that has recently been exploring ex ante auctions as a means of limiting ex post opportunistic

\(^6\) Swanson & Baumol, supra note 3, at 11.

\(^7\) In the Matter of Rambus, Inc., FTC Docket No. 9302.
behaviors. Despite the size of the economics literature on auctions,\(^8\) it has not anticipated the specifics of IP auctions in standard setting contexts. We therefore extend and apply the lessons of economic thinking about auctions to the particulars of IP in standard setting. Our focus is on auction design. Is the auction process proposed by Swanson and Baumol likely to yield efficient outcomes? That is, is it likely to appropriately compensate innovators and hence preserve the incentives to invest and innovate in new technologies? Is it likely to keep the cost of the selected technologies under control and ensure their optimal diffusion ex post? And lastly, would SSOs using ex ante auctions select the most efficient technologies, i.e., those that create the most value for the standard’s users at a reasonable cost?

We begin in Section II with a brief discussion of the Swanson and Baumol proposal in order to fix ideas. In Section III we turn to the lessons that the economics literature has to offer in terms of understanding auctions and their potential use within SSOs. The discussion here is centered on the many forms of asymmetry present within standard setting and the implications of that asymmetry in designing an efficient and well-functioning auction. We conclude in Section IV with policy recommendations.

We show that Swanson and Baumol’s concern over the design of the auction is well justified. Given the peculiar characteristics of the industries where standardization takes place (telecoms, semi-conductors, audio-visual, etc.), and especially the asymmetry across firms in those industries, some auction formats (e.g., a sealed-bid auction) may be preferable to others (e.g. an open ascending auction) in an economic sense. Unfortunately though, no auction format—including the sealed-bid auction proposed by Swanson and Baumol—is likely to yield efficient outcomes once the specific characteristics of these industries and the asymmetric nature of the companies that operate in them is fully taken into account. We therefore conclude that before more is done to implement the ex ante auction proposal in policy recommendations, authorities should better understand the limitations.

II. THE SWANSON-BAUMOL EX ANTE AUCTION

Swanson and Baumol maintain that the outcome of an auction in which the owners of competing technologies bid for selection into a standard through the submission of RAND commitments coupled with representative licensing terms provides a plan or at least an ex post benchmark for what a reasonable royalty should be. These auctions would be conducted by SSOs under three important assumptions:

(1) No Joint Negotiations: there would be no collective royalty negotiations with bidders after a bid has been submitted;

(2) No Manipulation: SSOs would select the winning bid by means of a decision-making (voting) process that is not susceptible to manipulation or bias by any SSO members; and

(3) Voluntary Participation: all parties would remain free to contract privately outside the standard-setting process and participation by potential licensors would be purely voluntary.

These assumptions, Swanson and Baumol maintain, ensure that the outcome of the auctions would differ materially from the outcome of potentially unlawful and probably economically inefficient joint negotiations.

Swanson and Baumol illustrate the operation of the auction mechanism by means of a simple model where, crucially, none of the bidders produce final products—i.e., there are no vertically-integrated bidders that both own relevant patents and produce downstream products. In this simplified scenario there are two competing technologies, A and B owned by firms A and B respectively, with different cost implications for downstream firms. The best IP option is A: it would result in downstream production costs of $c_A$ per unit of output. Using technology B would lead to downstream production costs of $c_B$ per unit of output, where $c_A < c_B$.

Define the value of the standard per unit of final product as the downstream price less the cost of production, $v(i) = p - c_i$, where $i = A$ or $B$, and denote as $f_i$ the royalty fee charged by technology owner $i$. Assume that (a) licensing to third parties involves recurring costs equal to $t$ for the patent holder, and (b) both bidders know

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9 Swanson & Baumol, supra note 3, at 9.
the cost reductions to producers that can be achieved with each technology (which may or may not be passed on to consumers). Given that both technology owners earn revenues exclusively through licensing (by assumption, as noted above), the following inequality must hold: $f_i \geq t$ for all $i$.

There is a unit mass of technology users which are members of the SSO. That is, the population of users is normalized to equal one. The users are all identical and have no stake in either of the two competing technologies. Thus, the SSO will select technology A when its value less its licensing fee exceeds that for technology B—formally when $v(A) - f_A \geq v(B) - f_B$. We can also express this condition as follows: when $f_A \leq f_B + \Delta$, where $\Delta = v(A) - v(B) = c_B - c_A \geq 0$. Otherwise, technology B will be selected.

**Proposition 1.** There is a unique Nash equilibrium in the Swanson and Baumol ex ante auction.\(^1\) In this equilibrium, the SSO selects technology A and the license fee charged for this technology is equal to the recurring cost of licensing to third parties plus the incremental value of technology A over B in producing the standard (i.e., $f_A = t + \Delta$) per unit of final product. Technology B is offered at $f_B = t$.

The outcome of this auction replicates ex post the outcome of unrestrained competition ex ante: the selection of the best IP option at a fee equal to the recurring costs of licensing plus the difference in value between the best and next-best IP alternatives. As rival technologies come closer to being perfect substitutes (as $c_A \to c_B$), the competitive royalty will approximate the incremental cost of licensing ($t$ in the simplified example).

Swanson and Baumol “acknowledge, of course, that standards auctions may not always yield results as socially desirable as those of the basic model, particularly if the number of competing IP solutions is very limited and there is incomplete

\(^{10}\) Stated simply, A and B are in Nash equilibrium if A is making the best decision A can, taking into account B’s decision, and B is making the best decision B can, taking into account A’s decision. A set of strategies is a Nash equilibrium if no player can do better by unilaterally changing his or her strategy. See John Nash, *Non-cooperative games*, 54 *Annals Math.* 286 (1951).
They also acknowledge that the auction process may yield rewards for innovation that are appropriate from a social standpoint only if the three conditions listed above are satisfied. Unless all three conditions are met, Swanson and Baumol note that an auction-like process would harm innovation by creating monopsony power. We agree with this last statement, but note that even when these conditions are met, an auction-like process may still harm innovation, as we explain below.

Each of the three assumed conditions behind the auction model warrants careful attention. The first condition requires SSO members to “credibly commit” and adhere to the auction mechanism initially adopted. Full commitment is a critical assumption in auction theory; but one that frequently does not hold in practice. Economic theory has shown that the party who designs the auction generally has the incentive to change the auction rules in the middle of the play—and in many circumstances it may also have the ability to do so. As Vartianen states, “in an institutionally weak environment, where formal enforcement power is absent, commitment may be hard to achieve.”

McAdams and Schwarz note that “buyers and sellers in many transactions conspicuously lack the ability to commit to an orderly sales process.”

This has implications for auction design. As noted by Klemperer, sealed-bid auctions like those proposed by Swanson and Baumol may be vulnerable to rule-changing by the auctioneer (the SSO in this case). For example, the SSO may decide to open a further round of negotiations with the bidders (the technology owners) after the sealed-bid auction is closed if the losing bidders are willing to provide more favorable terms. Vartianen shows that when the auctioneer cannot commit to an auction mechanism, the English (or open ascending) auction is the only robust procedure. Unfortunately, the alternative English auction format may, as we will

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11 Swanson & Baumol, supra note 3, at 11.
14 McAdams & Schwarz, supra note 12, at 260.
16 Vartianen, supra note 13, at 21.
see below, facilitate the adoption of collusive or predatory strategies and hence produce inefficient outcomes.

The inability to commit to close a sale under a pre-specified auction format hurts both the SSO and the technology owners. Consider again a sealed-bid auction à la Swanson and Baumol. If the SSO could trick the bidders into believing that it will accept the best offer (i.e., the offer with the most attractive price-quality ratio) emerging from the auction, then its ability to impose additional rounds of negotiations after the auction is closed can only improve its payoffs. However, if the bidders understand the SSO’s incentives, as sophisticated patent holders are likely to do, they will bid more cautiously in anticipation of further rounds and the SSO may end up being worse off.

The second condition, which assumes that the SSO voting mechanism cannot be manipulated by any individual member or group of members, may be problematic also. This follows because in practice some SSO members—those that are vertically integrated—are also the owners of some of the competing technologies. Hence, vertically integrated firms will have the incentive and, depending on the selection criteria adopted by the SSO, may also have the ability to tailor the selection mechanism in their favor. For example, if only technology users have voting rights within the SSO and the voting rule is such that the vertically integrated companies are pivotal for the selection of technologies into the standard, then they will be able to impose their technologies even if they are less efficient. Even if non-integrated IP owners do win a vote under such circumstances, they can only do so by bidding more aggressively in order to compensate for the bias, thus increasing the profitability of downstream operations for the vertically integrated SSO members\(^\text{17}\).

Finally, the third condition of voluntary participation may not hold because it is not always possible for licensors to opt out of the formal standard-setting process. One option for an IP owner wanting to defect from an SSO might be to attempt a de

facto standard by offering its own proprietary solution as a competing standard over that offered by the cooperative SSO. This option, however, only works if certain prerequisites hold. Namely, the firm must be able to offer a complete proprietary solution. In many instances—especially when complex products are involved—this is not possible as many firms hold only a piece of the overall technical solution and cannot establish a de facto standard on their own. Even if they could, it would have to be clear to potential users of the standard that the proprietary solution was either technically superior to the SSO standard or low enough in cost to offset any technical inferiority. Otherwise, the defecting firm would have little hope of winning a de facto standards battle. Absent this option, the licensor might be able to join a competing SSO. Certainly some standards do face competition from other cooperative efforts centered on different technological solutions for the same or largely similar issues, but this is far from the norm. As a last option, the firm considering defection might just abstain altogether from participating in standard setting efforts. For certain standards, this might be a viable strategy. For example, if the standard does not cover the firm's core technologies, but is instead peripheral to its primary commercial interests, abstention may be attractive. For products that are core, however, abstaining will not be practical. In many industries, not participating in the standard setting efforts can effectively shut a firm out of a market. This is apparently the case for 802.11 technologies: for any firm that wants to offer products or help direct the evolution of wireless networking, participation in the IEEE standard setting efforts is mandatory.\(^\text{18}\)

In sum, none of the three conditions is trivial. The model that Swanson and Baumol present is eloquent and informative, but there are reasons to believe that one or more of their three necessary conditions may fail in any given real-world standard-setting process. In particular, there is a serious risk that the result of the auction process would be manipulated or would lead to collective price negotiations, either of

\(^{18}\) See Thomas Eisenmann & Lauren Braley, *Atheros Communications*, HARV. BUS. SCH. CASE STUD. 9-806-093, (2006). The discussion of implementing 802.11 products and competing with other firms doing the same makes clear that those not involved in the IEEE standard setting process have little hope of competing effectively in this market.
which would under-compensate patent holders and reduce incentives for innovation. These are, however, not the only difficulties faced by an ex ante auction approach. Related to issues with the three assumed conditions are problems with asymmetries across auction participants, as we explain next.

III. THE IMPORTANCE OF ASYMMETRIES

The efficiency of the ex ante auctions proposed by Swanson and Baumol hinges in large part on the assumed underlying symmetry between parties. Neither of the two firms offering technologies to a standard in their model is vertically integrated. Nor do their offerings differ on quality; they differ only in the cost implications for production. Moreover, bargaining power is assumed to be evenly distributed across parties as no one SSO member or contingent of members is able to control or bias the vote. In reality, however, non-integrated firms and firms with both IP and manufacturing interests compete to see their technologies adopted by SSOs, and member firms clearly differ in their bargaining positions. These factual discrepancies have important implications along a number of dimensions for the use of ex ante auctions in standard setting.

A. Asymmetric bidders

One of the most obvious discrepancies between ex ante auction theory and reality is the diversity of business models among SSO members. Consider 3G mobile telecoms standardization efforts shepherd by the European Telecommunications Standards Institute (ETSI) to illustrate the variety of business models frequently present within SSOs. Some members, such as Ericsson and Nokia, are large firms that conduct R&D and have contributed a significant number of patents to the 3G standard, but earn their revenues chiefly downstream through the manufacture and sale of mobile handsets. Qualcomm, relatively smaller by comparison, also conducts substantial R&D, has contributed substantial patents to the standard, and has a subsidiary that designs and sells chipsets for inclusion in mobile handsets.
Qualcomm does not make handsets itself, though, and thus has some revenues from an intermediary market but no downstream revenues. Other firms, such as Interdigital and Wi-Lan Inc., are pure research firms and conduct no manufacturing at all, thus fitting Swanson and Baumol’s model criteria for IP holders. Others, such as Kyocera and LG Electronics, have little R&D, have contributed no IP to the 3G standard, and instead focus on manufacturing and selling handsets downstream. Still other participants, such as Telia AB or Digital Theater Systems, are relatively smaller niche players, focusing on a narrow geographic area or a product peripheral to the standard. As this one example shows, assuming symmetry across firms, even just across those firms contributing IP to a standard, is likely to be quite unrealistic.

Business model choices have serious implications for how an ex ante auction process would work. Vertically integrated competitors may be able to win an auction sponsored by an SSO even if their technologies are less valuable than those of their non-integrated counterparts. This follows because vertically integrated companies not only license to third parties, but also implicitly license to themselves as manufacturers. This means that they simultaneously act as sellers and buyers of their own IP. Economic theory predicts that holding a stake in the prize of an auction, generally referred to as a “toehold” in the literature, may have a significant impact on bidders’ behavior and hence on the results of the auction. This situation arises frequently (but not exclusively) in takeover auctions, where potential bidders acquire a small stake in the target company before the auction takes place. In the standard-setting context, a bidder will have a toehold in the auction prize if a share of the revenues generated by the owner of the technology selected to the standard corresponds to the payments made by its downstream subsidiary.

The literature has established that the presence of a toehold has two effects on bidding behavior. The first is a direct effect: a toehold changes a bidder’s valuation...
because a share of the auction prize flows back to him through his stake in the prize. In other words, having a toehold makes winning the auction more valuable so the toehold bidder can bid more aggressively. In addition, there is also an indirect effect, which requires that the values of competing technologies be private information. The existence of toeholds aggravates the risk of the so-called “winner’s curse” for bidders without (or with relatively smaller) toeholds, making them bid even less than they otherwise would have.\textsuperscript{21} This is because someone who beats a bidder with a (larger) toehold learns (or may subsequently learn) that the true value of the prize has been grossly over-estimated. Conversely, the risk of the winner’s curse is reduced for the bidder with the largest toehold, meaning this bidder will shade her bid less than she otherwise would have. As a result, the toehold bidder is more likely to win.

To illustrate the direct effect of vertical integration in the Swanson and Baumol ex ante auction setup, consider the simple model from above. There are two competing technologies, A and B again held by firms A and B respectively, with A resulting in production costs of \(c_A\) and B giving \(c_B\). Both \(c_A\) and \(c_B\) are public knowledge. Contrary to the Swanson and Baumol model, however, suppose that company B is vertically integrated: company B has an \(\alpha\) share of the downstream business with \(0<\alpha\leq 1\). In other words, company B has a toehold in the prize of the auction—a lower license fee increases its downstream profits—which has an impact on its bidding behavior. Formally, company B’s profits are equal to

\[
v(B,\alpha) - f_B = \alpha(p - c_B - f_B) + f_B - (1-\alpha)t,\]

when technology B is selected and

\[
v(A,\alpha) - f_A = \alpha(p - c_A - f_A),\]

when A is selected. In words, company B’s overall profits are equal to the profits made in the downstream market, \(\alpha(p - c_B - f_B)\), plus the revenues obtained by licensing technology B, \(f_B\), minus the recurring costs of licensing technology to third parties, \((1-\alpha)t\). Company B’s profits can be re-written as

\[
v(B,\alpha) - f_B = \alpha(p - c_B) - (1-\alpha)(f_B - t),\]

which emphasizes the role the toehold \(\alpha\)

plays in B’s incentives. The profits of the non-integrated members of the SSO are equal to their downstream net earnings minus the licensing fee they must pay to the patent holder: \( v(A) - f_A \), when A is selected and \( v(B) - f_B \), when B is selected, with \( v(i) = p - c_i, i = A, B \).

We assume that selection to the standard requires unanimity. Consequently, technology B will be selected when both the vertically integrated company B and the non-integrated members of the SSO prefer B to A. That is, when (i) \( v(B, \alpha) - f_B \geq v(A, \alpha) - f_A \) and (ii) \( v(B) - f_B \geq v(A) - f_A \).

We can show the following two Propositions:

**Proposition 2.** The unique Nash equilibrium of the ex ante auction with no vertical integration (\( \alpha = 0 \)) is not a Nash equilibrium of the ex ante auction with vertical integration (\( \alpha > 0 \)).

The intuition is simple. Technology owner B has an incentive to undercut A’s licensing fee \( f_A = t + \Delta \) by setting its own fee slightly lower, \( f_B = t - \varepsilon \), with \( \varepsilon > 0 \) and arbitrarily small. The cost of such an strategy is equal to the subsidy given to the non-integrated SSO members, \((1-\alpha)\varepsilon\), which is negligible, and the loss in downstream profits from using a less efficient technology, \( a\Delta \). The benefit of the strategy to B is equal to the reduction in licensing costs, \( \alpha(t + \Delta) \). The net impact on B’s profits is therefore given by \( \alpha t - (1-\alpha)\varepsilon \), which is positive provided that \( t > 0 \). Thus, as long as there are positive ongoing costs to licensing patents, even if small, B has an incentive to undercut A’s licensing fee to win the auction.

**Proposition 3.** Provided that the recurring costs of licensing outweigh the difference in production costs between the two technologies, \( t > \Delta \), there is a value of the toehold \( \alpha \), \( 0 < 0 < \bar{\alpha} \leq 1 \), such that for all \( \alpha > \bar{\alpha} \), technology B is selected in equilibrium.
In short, when technology owner B is vertically integrated the ex ante auction proposed by Swanson and Baumol may produce inefficient outcomes: the SSO will select the inferior technology B when both the recurring cost of licensing to third parties and the stake of the vertically integrated company in the downstream market (the toehold) are sufficiently large. This is because under those conditions the savings in licensing costs for the vertically integrated company when the selected technology is proprietary exceed the profit losses resulting from using a less efficient technology and the cost of subsidizing the non-integrated SSO members so that they prefer the less efficient technology.

**B. Asymmetric bargaining power**

There is no reason to expect every member of an SSO to hold equal bargaining power. As illustrated above for 3G standardization efforts in ETSI, some members are large multinational corporations while others are far smaller concerns. Business model asymmetries themselves can lead to differences in bargaining power over IP licenses. Non-vertically integrated firms reliant on licensing earnings will be relatively more motivated to conclude licensing deals quickly to ensure a revenue stream. Waiting can be especially difficult for smaller innovators who have little or no cash reserves. In contrast, vertically integrated firms have the option of implementing their technologies in-house, without signing any outside licenses, so they can credibly wait longer to strike a deal. That is, vertically integrated companies have “outside options” in their negotiations with SSO members, which are not available to non-integrated IP holders. The bargaining power of the integrated technology owners is, therefore, likely to be greater than the power of their non-integrated competitors. So, while non-integrated technology owners may be forced to accept the terms imposed by buyers, even if that means that the firm’s investments are under-compensated, this is less likely for vertically integrated IP holders. These

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differences in bargaining power are of particular relevance given the difficulties that SSOs will face when attempting to commit to a given auction mechanism, which are likely to result in several rounds of negotiations after the official auction is closed.

**C. Asymmetric information**

Consider next the plausible scenario in which the values of competing technologies are private information, known only to the technology holder. In this case, the outcome of a standards auction will be a function of the precise auction mechanism adopted by the SSO. As explained in detail by Klemperer\textsuperscript{24}, different auction designs tend to produce different outcomes. The celebrated “revenue equivalence theorem” in auction theory states that the expected outcome of different auction mechanisms will coincide when the following assumptions, among others, hold: (a) each bidder’s (privately known) valuation is independent of competitors’ private valuations and (b) bidders are symmetric (more precisely, their privately known valuations are drawn from a common distribution).\textsuperscript{25} Neither of these two assumptions is likely to hold in the standard-setting context.

First, the valuations of various IP owners whose technologies compete to be selected to a standard are likely to be correlated (or to be precise, will not be independent\textsuperscript{26}). Each IP owner will estimate the size and profitability of the downstream product in which its technology will be embedded if selected. It will rely on its own understanding of the market, but only to some extent. IP owners will also lean on the views of market analysts and customers. In consequence, when the value estimate of an IP owner is high the estimated values of all other IP owners are also likely to be high. But when valuations are correlated, an open ascending auction will lead to more aggressive (lower royalty) bidding than a sealed-bid auction, potentially

\textsuperscript{24} PAUL KLEMPERER, AUCTIONS: THEORY AND PRACTICE (2004).

\textsuperscript{25} That is, the range of possible outcomes is the same. \textit{Id.}

\textsuperscript{26} To use an analogy from first semester statistics class, the two assumptions describe the process of pulling a marble from an urn, observing whether it is black or white, and then returning it to the urn. Each draw from the urn is unaffected by previous or subsequent draws and each draw has the same odds of producing a black versus a white marble. This is typically not the case with technologies in standards. There, some common factors affect each draw, so that the draws are no longer independent.
to the point of no longer providing necessary coverage for R&D expenditures aimed at developing the standard.27

Second, as already explained, many standard-setting processes involve both non-integrated and vertically integrated IP owners. While all of the SSO members are likely to have common influences in the form of market analysts and customers, we cannot assume a common distribution as the valuations of the two distinct player types (integrated and not) are bound to be different. In particular, vertically integrated companies are likely to have more precise information about the potential size and profitability of the downstream markets enabled by the standard. And firms with downstream operations in different markets are likely to produce different valuations as well. Maskin and Riley28 show that when bidders’ valuations are asymmetric an open ascending auction will tend to favor bidders with higher valuations, while the opposite is true with a first-price sealed-bid auction.

These factors imply that the outcome of an SSO-sponsored auction will depend on its precise design. Which design is more efficient depends critically on fine details about the values of competing technologies, which in reality will only be imperfectly known by SSO members. This is of course troublesome: in principle, there could be as many ex ante benchmarks as possible auction processes.

Swanson and Baumol address this problem by proposing the sealed-bid auction model. This auction mechanism has many virtues. As Klemperer explains, a first-price sealed-bid auction discourages collusion among bidders and encourages entry.29 In an ascending auction collusion is easier because bidders can use the first rounds of the auction to signal who should win and they can also detect a deviation easily due to the transparency of the bidding. Furthermore, in an open ascending auction

...there is a strong presumption that the firm which values winning the most will be the eventual winner, because even if it is outbid at an

29 See Klemperer, supra note 15, at 179.
early stage, it can eventually top any opposition. As a result, other firms have little incentive to enter the bidding, and may not do so if they have even modest costs of bidding.  

Nevertheless, the sealed-bid auction has its own drawbacks. Most importantly, it may lead to inefficient outcomes: the auction need not be won by the bidder with the highest valuation. In the context of standard-setting, that implies that the IP owner with the technology most likely to result in a wider and more profitable downstream market does not necessarily win the auction. Also, when valuations are correlated, as we would expect in standard setting, a first-price sealed bid auction is likely to result in higher royalty rates than an open ascending auction provided that the valuations of competing bidders are not too asymmetric. This is due to the winner’s curse, which leads bidders to behave less aggressively (i.e., set higher royalty rates) when there is uncertainty as to the true value of the auction prize (i.e., selection to the standard) and bidders’ valuations are correlated. The winner’s curse correction is smaller in open ascending auctions because each bidder can infer the valuations of its competitors by observing the points at which they stop bidding. Finally, though sealed-bid auctions make collusion and predation less likely, they do not eliminate those risks entirely.

Yet another practical complication arising from asymmetric information comes after the auction is held. At early stages of negotiations on a standard, uncertainty will run high over which IP will be included and which technological path will be followed. During the development process, some new and superior complementary IP could arise, or the mix of patents might be different than expected at the outset. Whenever SSO members receive new information, though, they may want to renegotiate licensing terms they agreed to before. In other words, the first condition for efficiency in the ex ante model, commitment, may be difficult to ensure in dynamic standard setting contexts. Of course, as long as one party insists on the

30 Klemperer, supra note 15, at 172.
31 Klemperer, supra note 21.
original contract such renegotiation is blocked, but if both parties find it profitable to renegotiate no one can prevent them from cancelling a contract to agree on more favorable terms. Thus, choosing when an auction is held would be critical to limiting any wasteful renegotiations.

D. Asymmetric technology

In the Swanson and Baumol model, technologies A and B differ in one dimension only: quality is symmetric but costs are not. In reality, the objects of an SSO auction often will be complex technologies with multiple asymmetric characteristics. SSO members are typically concerned not only with the royalty rate, but also a range of quality parameters such as the ease of use, the cost with which the technology can be implemented, the performance or processing speed, the degree of interoperability with other components, or the technical reliability. As a result, alternative technologies will compete not only on pre-committed royalty rates, but also on the various technical benefits from using one versus another.

The economics literature establishes that it is very difficult to design an auction which leads to the most efficient outcome when the subject of the auction involves multiple dimensions. For example, Dasgupta and Maskin\(^\text{33}\) show that when bidders’ characteristics are multi-dimensional there is no efficient auction in price only. Manelli and Vincent\(^\text{34}\) provide a good illustration of this general result. They consider an economic scenario in which a buyer (the SSO in the standard setting context) faces a number of potential sellers (the technology owners) who are privately informed about the “quality” of their products (the competing technologies). Increasing quality is costly. Manelli and Vincent show that an auction where sellers bid on price only may be very inefficient. The reason is that a simple auction of that sort will allocate the trade to the bidders offering the lowest prices (the SSO will select the technology of the IP owner quoting the lowest royalty


terms). But in their setting a low bid is associated with a product of low quality. They show that the winning bid converges to the lowest possible quality level when the number of sellers increases, and that this is unambiguously suboptimal when the contribution of quality to social surplus is large enough. Finally, they demonstrate that sequential bargaining may yield results which are superior from a social viewpoint as compared to an auction. Of course, sequential bargaining is what typically occurs under RAND obligations within SSOs today.

In practice, a number of different methods have been employed to deal with the multi-dimension problem. For instance, procurers frequently rely on detailed request-for-quotes that specify minimum standards a bidder must satisfy so that bids can be evaluated on price only. In other cases, a buyer might pre-select a small number of bidders and then negotiate on all dimensions of the product or service with each of them. It seems unlikely that either of these approaches would offer an efficient way to deal with auctions in standard setting.

Scholars have devised other solutions for multi-dimensional auctions—where bidders not only quote prices but also compete on non-price dimensions—but they too present some problems. One such method is the “scoring function”. According to this approach, the most straightforward way to evaluate multi-dimensional bids is to assign a score to each price/quantity combination and to rank the bids according to their scores. Applying a scoring function effectively reduces a multi-dimensional auction to a one-dimensional auction. However, it is crucial to choose a scoring

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35 For example, the Department of the Navy conducts procurement auctions for equipment manufactured to Navy specifications. Conditional on the items in question meeting specifications, the Navy then chooses a particular manufacturer based solely on price. For a description, see Omer Alper & W. Brent Boning, Using Procurement Auctions in the Department of Defence (The CNA Corporation, Working paper D0007515.A3, July, 2003) available at: http://www.cna.org/documents/D0007515.A3.pdf

36 For example, in California energy auctions use a scoring rule to determine the winner. The supplier submits a two part bid to the system operators, one for capacity availability and one for delivered energy. In other words, the system operators care about price and available capacity. See Hung-po Chao & Robert Wilson, Multi-Dimensional Procurement Auctions for Power Reserves: Robust Incentive-Compatible Scoring and Settlement Rules, 22(2) J. REGULATORY ECON. 161 (2002).
function that sets the right incentives.\textsuperscript{37} Some commentators argue, for instance, that the choice of an inappropriate scoring function led to inefficient bidding behavior in the Biennial Resource Planning Update (BRPU) auctions held in 1993 in the Californian electricity market.\textsuperscript{38} That scoring function was a naïve linear function of the two components of the bids, capacity and energy provision, which had an adverse incentive effect on bidders in that their bids deviated enormously from actual marginal costs.

The auction model in Swanson and Baumol works well because it concerns process innovations—i.e., technologies that facilitate reductions in the unit costs of production. This makes it simple to construct an additive scoring function that combines the licensing fee and the cost of production, $f_i + c_i$, so that the lowest score wins the auction. Matters become much more complicated when the standard is concerned with product innovations—i.e., when technologies differ on quality dimensions which cannot be easily translated into price equivalents. Defining a scoring function in the context of product innovations is not a trivial matter.

Another solution suggested in the literature is a two stage auction meant to split the various dimensions apart. In the first stage, the firm/bidder is chosen by an auction using a scoring function, combining price and aggregate quality; in the second stage, bargaining over specific product specifications and quality levels takes place. The economics literature shows that this auction form is superior to a single stage auction when bidders’ valuations are correlated.\textsuperscript{39} However, bargaining over quality in the second stage might not be feasible in the context of a SSO. Efficient bargaining requires that the buyers (the SSO members) be informed about the quality parameters of all the losing bidders, allowing efficient negotiations with the winning


\textsuperscript{39} Fernando Branco, \textit{The Design of Multidimensional Auctions}, 28(1) RAND J. ECON. 63 (1997).
bidder about the optimal product specifications. In the context of IP rights, the competing technologies are likely to be complex and asymmetric in nature so that without more than a scoring function to clarify losing bidders’ technologies members might be unable to negotiate efficiently. It also seems likely that commitment problems would be even worse under this approach, as unsuccessful or difficult second stage negotiations could lead to calls for new rounds of “first stage” auctions.

IV. POLICY IMPLICATIONS

As is likely clear by now, the technical complications of designing an ex ante auction that would actually work as planned is daunting. We therefore conclude our application of the technical economics literature to the standard setting policy issues under debate with some thoughts on the primary issue underlying our concern over the implementation of ex ante auctions—under-compensation—and with a recommendation that takes the good aspects of the auction proposal but avoids the bad.

A. Under-compensation

Because of all of the above asymmetry problems, the use of ex ante auctions in standard setting contexts may result in serious under-compensation of productive investment and innovation. That is, relying on an auction to both determine technologies included in a standard and the prices at which those technologies are licensed could very well result in the technology holders receiving less than a properly competitive mechanism would dictate, and perhaps even less than patent holders had expended to develop the technologies in the first place. This should be a matter of great concern for regulators and antitrust authorities. As is well recognized, under-compensation can lead to under-investment in R&D and reduced innovation.

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40 See Swanson & Baumol, supra note 3; Vincenzo Denicolò, Do Patents Over-Compensate Innovators? 22(52) ECONOMIC POLICY 679 (2007)
Note that even in the simple model developed by Swanson and Baumol, where none of the problems listed above applies, the payment received by the winner of the ex ante auction—company A—may not be enough to properly compensate the investment costs incurred in developing its superior technology. Indeed, company A receives a payment equal to the incremental value of its technology relative to the next best option plus the recurring cost of licensing to third parties. It will receive that payment for as long as the standard relies on its technology and its patent does not expire. But such an amount may or may not exceed its R&D costs (plus an adequate rate of return which takes into account the risky nature of its investment). Consequently, even in the basic setting analyzed by Swanson and Baumol the ex ante auction may over- or under-compensate innovation. However, under-compensation is more likely when alternative technologies are close substitutes, which are precisely the cases where an ex ante auction makes most sense. In those cases, the licensing fee will be approximately equal to the recurring cost of licensing to third parties and, hence, unlikely to cover R&D costs.

The under-compensation risk becomes more worrisome when the assumptions of the basic Swanson and Baumol model fail to hold. Under-compensation is a serious risk when the ex ante auction degenerates into a buyers’ cartel. And it is likely to be a problem even if there is no coordination amongst SSO members: as we saw above, non-integrated (pure) innovators may have to bid very low to win over their vertically integrated competitors.

B. A Practical Application

Nevertheless, the analytical framework developed by Swanson and Baumol provides useful guidance on the meaning of RAND licensing. The intuitive appeal of an ex ante auction in the context of ex post market power is clear. However, while we agree that an ex ante reference point can be informative, we are concerned with the practical application of their definition of RAND royalties as those that equate or approximate the outcome of ex ante auctions operated by SSOs. As shown above, a number of business, information, and technological asymmetries undermine the
necessary conditions for SSO auctions to deliver efficient outcomes in practice. For example, when technology owners differ with respect to their degree of vertical integration, ex ante auctions may not lead to efficient outcomes. The dual role of vertically integrated companies in the standard setting process—as innovators and users—will place them at a competitive advantage in an ex ante auction. These companies may afford setting very low royalty rates because they have the option to fund their investment with downstream profits. As a result, SSOs may end up selecting the technologies owned by vertically integrated companies even when those technologies are not the most valuable. Furthermore, non-integrated companies may have to bid very low to match the terms offered by their vertically integrated counterparts, which may reduce their incentives to innovate and participate in the cooperative standardization process, and may even force them to exit the relevant innovation market. For all these reasons, we caution against the mechanistic application of the ex ante benchmark proposed by Swanson and Baumol by SSOs, courts and competition authorities.

What, then, can be done to take advantage of the insight offered by Swanson and Baumol’s proposal? Our proposal is to use the ex ante auction framework to construct a “sufficiency test” (i.e., to define a safe harbor). Evidence that ex post and ex ante licensing terms coincide would be sufficient, though not necessary, to establish compliance for RAND purposes.

The absence of a precise, unambiguous test (that is, a test specifying necessary and sufficient conditions) may be regarded with apprehension, but we do not find this absence troubling. First, “it is entirely possible that after selection, alternative technologies (or even alternative standards) may remain viable substitutes for the standard technology.” Swanson & Baumol, supra note 3, at 10. Such alternatives eliminate the risk of ex post opportunism without need for any ex ante mechanism.

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41 Swanson & Baumol, supra note 3, at 10.
Second, as explained by Prof. Doug Lichtman, it is precisely its vagueness which makes RAND commitments such a powerful ex ante mechanism. Imprecise RAND commitments promote competition among the implementers of a standard. Actual negotiations take place bilaterally and confidentially, with public knowledge of the license offer no more specific than that it will be reasonable and fair. Each firm seeking a license therefore has strong incentives to negotiate the best terms it can win from the patent holder, so that its downstream operations acquire a competitive edge compared to other implementers. The RAND commitment then provides a backstop for this competitive process, enabling licensees to bring private lawsuits in the event that a patent holder is perceived as violating the commitment. With the threat of court imposed royalty terms (likely to be stringent, just as the US Federal Trade Commission imposed in the recent Rambus case), patent holders have strong incentives to live up to their RAND commitment. When viewed in this light, a vague RAND commitment can be seen as fostering competition.

Finally, there are several other reasons why the owners of technologies selected to a standard may not be able to exercise market power ex post and thus obviating the need for any precise ex ante mechanism. Regardless of whether the patented technology faces viable substitutes, licensing prices are constrained by the prices commanded by complementary patents within the standard. As noted by Swanson and Baumol, “much technology involves large amounts of intellectual property owned by many different firms, so a potential opportunist may place little weight on

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43 In the Matter of Rambus, Inc., FTC Docket No. 9302.
44 This argument constitutes an application to standard setting of the ideas developed in Oliver Hart & Jean Tirole, Vertical Integration and Market Foreclosure (MIT, Dep’t of Econ., Working paper 548, 1990); Oliver Hart & Jean Tirole, Contract Renegotiation and Coasian Dynamics, 55(4) REV. ECON. STUD. 509 (1988); and Patrick Rey & Jean Tirole, A Primer on Foreclosure, in Mark Armstrong and Robert Porter (eds.) HANDBOOK OF INDUSTRIAL ORGANISATION, vol 3 (forthcoming, 2007). These authors show that an upstream monopolist may not be able to extract all downstream rents when negotiations with its customers and bilateral and confidential and it is unable to commit to non-discriminatory wholesale prices. It is precisely for this reason that a vague RAND commitment is likely to lead to low royalty rates. In their models, the upstream monopolist will be able to exercise its market power without restrictions if it becomes vertically integrated or has access to a commitment device.
such freedom, recognizing that misbehavior only invites revenge by the proprietors of other essential IP rights who can wield them to block the activities of the hold out firm!”  

That is, patent prices are limited by their context. In addition, patent holders without any downstream operations (upstream firms) are constrained by the elasticity of demand for the product in the end market. While vertically integrated firms can have incentives to raise rival downstream firms’ prices through their licensing terms, they may also be open to cross licensing agreements with other integrated companies, which can hold down royalty rates as well. And lastly, all firms face dynamic constraints through the formal standard setting process. Because standards evolve over time, and many high technology standards pass through multiple versions—mobile telecom is on its “third generation” (3G) currently, with 3.5G, 4G, and “beyond 4G” already under development—any unreasonable pricing or abuse of market power can be punished in future iterations of the standard.

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45 Swanson & Baumol, supra note 3, at 49.