Patent Holdup and Royalty Stacking

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Abstract

We study several interconnected problems that arise under the current U.S. patent system when a patent covers one component or feature of a complex product, This situation is common in the information technology sector of the economy. First, we show using bargaining theory that the threat to obtain a permanent injunction greatly enhances the patent holder's negotiating power, leading to royalty rates that exceed a natural benchmark level based on the value of the patented technology and the strength of the patent. Such royalty overcharges are especially great for weak patents covering a minor feature of a product with a sizeable price/cost margin. These royalty overcharges do *not* disappear even if the allegedly infringing firm is fully aware of the patent when it initially designs its product. However, the holdup problems caused by the threat of injunctions are reduced if courts regularly grant stays to permanent injunctions to give defendants time to redesign their products to avoid infringement when this is possible. Second, we show how holdup problems are magnified in the presence of royalty stacking, i.e., when multiple patents read on a single product. Third, using third-generation cellular telephones and Wi-Fi as leading examples, we illustrate that royalty stacking has become a very serious problem, especially in the standard-setting context where hundreds or even thousands of patents can read on a single product standard. Fourth, we discuss the use of "reasonable royalties" to award damages in patent infringement cases. We report empirical results regarding the measurement of "reasonable royalties" by the courts and identify various practical problems that tend to lead courts to over-estimate "reasonable royalties" in the presence of royalty stacking. Finally, we make suggestions for patent reform based on our theoretical and empirical findings.

Patent Holdup and Royalty Stacking[1]

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The patent system is designed with a paradigm invention in mind – a new device or machine covered by a single patent. Historically, this paradigm was a fairly accurate portrayal of the typical patent.[4] As Robert Merges put it, "for Jefferson, if you put technology in a bag and shook it, it would make some noise."[5] In the last few decades that has begun to change markedly. Not only have patents on chemical, biotechnological, hardware, and software inventions proliferated, but more and more products incorporate not of a single new invention but a combination of many different *components*, each of which may be the subject of one or more patents.[6] In the information technology sector in particular, modern products such as microprocessors, cell phones, or memory devices can easily be covered by dozens or even hundreds of different patents. As a striking example, literally thousands of patents have been identified as essential to the proposed new standards for 3G cellular telephone systems.

The fact that a great many patents can read on a single product, and that his is common in certain critical industries, creates numerous practical problems for the operation of the patent system.[7]

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[4] John R. Allison & Mark A. Lemley, *The Growing Complexity of the U.S. Patent System*, 82 **B.U. L. Rev.** 77, 93 tbl. 1 (2002) (noting that until quite recently the majority of all U.S. patents were for mechanical inventions).

[5] Robert P. Merges, *As Many As Six Impossible Patents Before Breakfast: Property Rights for Business Concepts and Patent System Reform*, 14 **Berkeley Tech. L.J.** 577, 585 (1999).

[6] We have occasionally seen problems like this before, see Ted Sabety, *Nanotechnology Innovation and the Patent Thicket: Which IP Policies Promote Growth?*, 15 **Alb. L.J. Sci. & Tech.** 477, 495-503 (2005) (discussing example of radio patents in the 1920s), but they are much more common now than in the past.

[7] See M.A. Heller and R. S. Eisenberg, (1998), "Can Patents Deter Innovation? The Anti-Commons in Biomedical Research," *Science*, 280, 698-701, and Carl Shapiro, (2001), "Navigating the Patent Thicket: Cross-Licenses, Patent

We focus here on two critical, intertwined areas in which problems arise: *injunction threats* and *royalty stacking*. We are especially interested in how these problems affect the royalties that will be negotiated between patent holders and downstream firms who produce products that may infringe those patents. After all, since far more patents are licensed or settled than litigated to judgment, the primary economic effect of rules governing patent litigation arises through the effect of those rules on the licensing terms that are negotiated in the shadow of litigation.

The threat that a patent holder will obtain an injunction that will force the downstream producer to pull its product from the market can be very powerful. These threats can greatly affect licensing negotiations, especially in cases where the injunction is based on a patent covering one small component of a complex, profitable, and popular product. Injunction threats often involve a strong element of *hold-up* in the common circumstance in which the defendant has already invested heavily to design, manufacture, market, and sell the product with the allegedly infringing feature. As we show below, the threat of an injunction can enable a patent holder to negotiate royalties far in excess of the patent holder's true economic contribution.

Royalty stacking refers to situations in which a single product potentially infringes on many patents, and thus may bear multiple royalty burdens. The term "royalty stacking" reflects the fact that, from the prospective of the firm making the product in question, all of the different claims for royalties must be "stacked" together to determine the total royalty burden borne by the product if the firm is to sell that product free of patent litigation. As a matter of simple arithmetic, royalty stacking magnifies the problems associated with injunction threats and hold-up, and greatly so if many patents read on the same product. In this key sense, the problems of injunction threats and royalty stacking are intertwined.

In Section I, we explain how the threat of an injunction can dramatically influence the negotiations between a single patent owner and an alleged infringer, especially if the patented technology covers one component of a complex product. We identify the key economic variables that determine the royalty rate that economic theory predicts will be negotiated between the patent holder and the alleged infringer. We show how the threat of injunctive relief causes the negotiated royalty rate to exceed the true economic contribution of the patent holder, especially if the value of the patented technology is small relative to the value created by the product as a whole. We also explain why the threat of injunctive relief is especially troublesome for weak patents, i.e., patents that may well be found invalid if actually litigated.

Section II addresses the additional problems that arise when hold-up occurs along with royalty stacking. In part, these added problems result from simple arithmetic: the combined royalty rate owed to all of the patent holders asserting infringement is equal to the sum of the royalties owned to each individual patent holder. But the problem also resides in legal rules for royalty calculation that do not sufficiently account for the presence of other inventions included in the infringing product. Unfortunately, the rules commonly used by the courts to assess "reasonable

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Pools, and Standard Setting," in *Innovation Policy and the Economy*, Adam Jaffe, Joshua Lerner, and Scott Stern, eds., National Bureau of Economics, 2001, for further discussion of how many patents often read on a single product.

royalties" can perform especially poorly in the combined presence of injunction threats and royalty stacking.

Section III complements our theoretical work by providing two types of empirical evidence of royalty stacking. Section III.A discusses selected case studies of royalty stacking to illustrate the nature and magnitude of the problems that can arise for companies seeking to commercialize new products. Section III.B provides systematic evidence based on a study of all reported decisions awarding reasonable royalties as damages for patent infringement. This evidence suggests that there are indeed very real problems associated with royalty stacking. The courts applying the rules for computing "reasonable royalties" have to some degree helped mitigate those problems by granting lower royalty rates to component inventions and to inventions in the electronics and information technology industries. Nonetheless, economic theory, the empirical evidence, and our own experience as practitioners all indicate that these judicial efforts have not fully solved the problems associated with injunction threats and royalty stacking.

In Section IV, we make a series of proposals for judicial and legislative reform to address the dual problems of injunction threats and royalty stacking as they apply in the information technology sector of the economy. Our proposals for patent reform fall into two areas: the rules for granting permanent injunctions, and the methods used to calculate "reasonable royalties." We also argue that the antitrust treatment of cross-licenses, patent pools, and collective standard-setting take careful account of how these "market" arrangements promote competition by working around some of the difficulties caused by flaws in the patent system.

I. Injunction Threats and Negotiated Royalty Rates

We are concerned in this paper with situations in which a downstream firm produces a complex product that potentially or allegedly infringes many patents. Each patent holder's threat to obtain an injunction is fundamental to licensing negotiations in these settings. In this section, we explain how injunction threats affect patent licensing negotiations when a *single* patent holder alleges infringement against the downstream firm.[8] This analysis will serve as a building block for our analysis of royalty stacking in Section II.

A. Basic Economic Model

Consider a downstream firm that is approached by a patent holder who alleges that the downstream firm's product incorporates a feature that infringes its patent. Suppose, for now, that the downstream firm is already selling its product when it learns of the patent claim. This timing may result because the downstream firm designed its product including a feature for

[8] The analysis in this Section draws heavily on Carl Shapiro, (2006b), "Injunctions, Reasonable Royalties, and Patent Licensing," Working Paper, University of California at Berkeley, which is available at faculty.haas.berkeley.edu/shapiro. See that paper for derivations of the equations and relationships asserted here.

which a patent application was subsequently published or a patent was subsequently issued.[9] Alternatively, the downstream firm may simply have been unaware at the time it designed its product that the patent now being asserted had been issued, or it may have been aware of the patent but have had no reason to believe the patent owner would argue that the downstream firm's product infringed it. In some cases, the patent holder can engage in strategic delay or concealment, knowing it will be in a stronger bargaining position once the downstream firm has already designed its product incorporating the patented feature. Regardless of these particulars, we ask how the patent holder's threat to obtain an injunction influences the royalty rate that the two parties are likely to negotiate in this situation.

We now sketch out a model of the process by which patent licenses are negotiated and patents are litigated. One must employ some type of model to analyze the impact of injunction threats on negotiated royalty rates. We believe the our model is the simplest possible game-theoretic model rich enough for this purpose.

The patent holder and the downstream firm negotiate over a royalty rate. Using the standard economic theory of Nash Bargaining, the negotiated royalty rate depends upon the payoff that each party would obtain if the negotiations break down, i.e., on each party's "threat point" in the licensing negotiations. If no licensing agreement is reached, the patent holder sues the downstream firm for patent infringement, forcing both firms to bear certain litigation costs. Litigation takes some time, and the outcome of the patent litigation is uncertain. The patent will be found valid and infringed with some probability, which we call the "patent strength." If the patent is ruled invalid or not infringed, the downstream firm, of course, owes nothing to the patent holder and is free to keep selling its product without any royalty obligations. However, if the patent is ruled valid and infringed, the downstream firm must pay "reasonable royalties" to the patent holder for any past infringement, and we assume that the court enters an injunction preventing the downstream firm from selling the infringing product.[10] In that event, the two firms again sit down (again) to negotiate a license. Having won the patent litigation and obtained an injunction, the patent holder clearly is in a very strong position. If *these* negotiations break down, the downstream firm cannot sell the infringing product and must withdraw from the market unless and until it can introduce a redesigned version that does not contain the patented feature, or until the patent expires.

The following economic variables govern the royalty rate that will be negotiated in this setting:

- V: The *Value* per unit of the patented feature to the downstream firm, in comparison with the next best alternative technology. For example, if the patented feature enhances the value of the product to consumers by $1 over the next best alternative, then V = $1.

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[9] In that case, one of us has argued for granting the downstream firm prior user rights, in which case it would not have to pay any royalties at all. See Shapiro (2006a), "Prior User Rights," *American Economic Review Papers and Proceedings*, forthcoming.

[10] Under existing Federal Circuit law injunctions are effectively mandatory after a finding of patent infringement. *See* eBay, Inc. v. MercExchange LLC, 401 F.3d 1323, 1339 (Fed. Cir. 2005). An appeal from that decision is pending at the Supreme Court, and may change the rule, but it is unlikely to change the normal practice of granting injunctions after a finding of infringement.

- M: The *Margin* per unit earned by the downstream firm on its product. For example, if the product is sold at a price of $40 and the marginal cost is $30, then M = $40-$30 = $10.

- θ: The *Strength* of the patent, i.e., the probability that litigation will result in a finding that the patent is valid and infringed by the downstream firm's product.

- C: The *Cost* to the downstream firm of redesigning its product to avoid infringing the patent claims, measured as a fraction of the total value of the patented feature. For example, if the per-unit value of the patented feature is V = $1 and the downstream firm expects to sell 10 million units then the total value of the patented feature is $10 million. If redesigning the product costs $2 million, then C is equal to $2 million/$10 million or 20%.

- L: The fraction of the downstream firm's total unit sales during the lifetime of the patent that would be lost if the downstream firm were forced off the market by an injunction, as reflected by the *Lag* in time required for the downstream firm to redesign a non-infringing product and introduce it to the market.

- B: The *Bargaining* power of the patent holder, as measured by the fraction of the combined gains from settling, rather than litigating, that are captured by the patent holder. This variable falls between zero and one. Equal bargaining power, B = 0.5, is a common assumption.

B. Benchmark Royalty Level

Our goal is to understand how the patent holder's threat to obtain an injunction affects the negotiated royalty rate. Before providing that discussion, we first develop a benchmark level for the royalty rate, i.e., the royalty rate that would be reasonable and expected in the ideal patent system, *without* any element of hold-up.

We illustrate our benchmark using a numerical example. Suppose that the two firms have equal bargaining power, so they split equally any gains from reaching an agreement. This corresponds to a value of B = 0.5. Suppose that the patented feature is worth V = $1 per unit to the downstream firm, compared with the best non-infringing alternative.

If the patent were surely valid, and if hold-up were not a factor in the negotiations, the two firms would split the gains of $1 per unit from using the patented technology, which would lead to a royalty rate of $0.50 per unit. More generally, the benchmark royalty rate for an ironclad patent is equal to B*V.[11] We also consider this the proper benchmark for "reasonable royalties," since

[11] We are agnostic about the patent holder's bargaining power as measured by the variable B. Our analysis and conclusions apply regardless of the value of B. Indeed, the percentage royalty "over-charges" we compute below are independent of B.

"reasonable royalties" are meant to reflect the royalty rate that would be negotiated, prior to any infringement, if the patent were known to be valid.[12]

Because the royalty negotiations take place before a final court decision, the benchmark royalty rate must be discounted to reflect patent strength. To illustrate, suppose that there is a 40% chance that the patent will be found valid and infringed. Absent any hold-up, the benchmark royalty rate would just be 40% of the value that would apply if the patent were ironclad. In our numerical example above, the benchmark for an ironclad patent was $.50 per unit, so the benchmark for the same patent with strength 40% equals $0.20 per unit.[13] More generally, the benchmark royalty rate is given by θ*B*V, where θ is the patent strength.[14] This benchmark has the very attractive property that the patent holder's reward is proportional to patent strength, i.e., to the probability that the patent holder in fact is responsible for an innovation that the downstream firm is using.

Our discussion below is framed in terms of the gap between the negotiated royalty rate and this benchmark level. We explain how this gap, effectively a royalty "over-charge," is driven by the threat of obtaining an injunction and the rules by which "reasonable royalties" are calculated.

C. Negotiated Royalty Rates

The negotiated royalty rate depends upon the downstream firm's best strategy in the event that negotiations with the patent holder break down. Two cases are relevant and realistic in the settings of interest to us here, namely where the patent covers one feature of a complex product whose production involves significant fixed costs, which must be recovered in the form of margins between price and marginal cost.

The first case arises when the downstream firm's best strategy, if negotiations break down, is to defend the patent suit and redesign its product only if it loses that suit and is unable to negotiate a license after losing. We call this the "Litigate" strategy. The second case arises when the downstream firm's best strategy is to develop a non-infringing version of its product while the patent litigation is pending so that it has an immediate backup plan in place if loses the patent litigation and faces an injunction. We call this the "Redesign and Litigate" strategy. We consider these two cases in turn.[15]

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[12] See, for example, Roger D. Blair & Thomas F. Cotter, **Intellectual Property: Economic and Legal Dimensions of Rights and Remedies** 229-30 (2005).

[13] The patent holder's contribution is zero with probability 0.6 and $1 with probability 0.4, for an expected value of $0.40. With equal bargaining power, the patent holder captures half of this value, or $0.20 per unit.

[14] Strictly speaking, the benchmark royalty should also include savings in litigation costs from not going to trial, and Shapiro's model does in fact include those costs. We do not include them here for simplicity. Because they are relevant in both the benchmark and the holdup royalty calculations, they drop out of the comparison between the two and are therefore of no significance for our purposes.

[15] There are of course other possible strategies, and they are discussed in more detail in Shapiro, *supra* note __.

In both of these cases, the formula for the negotiated royalty depends upon the level of "reasonable royalties" that the court would apply. For now, we make the optimistic assumption that reasonable royalties are at the benchmark level of B*V. If a higher figure is used for "reasonable royalties," the negotiated royalties are even higher than discussed here. Below, we discuss at some length the problems that arise in practice when the courts seek to implement the concept of "reasonable royalties."

1. "Litigate" Strategy

An accused infringer will litigate without redesigning if the redesign costs are relatively high in comparison with profits that the downstream firm would lose by withdrawing from the market while redesigning its product, and if the patent is relatively weak. Accused infringers employing this strategy are taking their chances that they can beat the patent in court, a strategy that makes sense at least for some patents, especially weak ones. In this case, the owner of that weak patent gains great bargaining leverage from its ability to threaten to force the downstream firm from the market if the patent is found valid and infringed, especially if the lion's share of the value associated with the downstream firm's product has nothing to do with the patented feature.

In this case, the percentage gap between the negotiated royalty and the benchmark level is given by $C + \frac{M - V}{V} * L$. The first term reflects fact that the downstream will be forced to incur duplicative expenses to redesign its product if it loses the patent litigation. If the costs of redesigning the product are equal to C = 20% of the value of the patented feature, then this term equals precisely that 20%.[16] The second term reflects the fact that the downstream firm will be forced from the market by an injunction while redesigning its product if its loses the patent litigation. For a complex product and a minor patented feature, the second term can be very large. For example, if M = \$10, V = \$1, and if the injunction would cause the downstream firm to lose 10% of the total unit sales expected during the patent lifetime, because it is forced off the market until the redesign can be implemented, then this term equals 0.9, corresponding to a 90% gap between the negotiated royalty and the benchmark level.[17] The reason this number is so large is that during that time, the patentee loses all sales of the downstream product, which includes much more than just the patented invention. Combined with the first term, the total overcharge equals 110%, so the negotiated royalty rate is more than double the benchmark level in this numerical example.

More generally, this analysis implies that the negotiated royalty rate for a single patent tends to be greatly elevated above a reasonable benchmark level if the value of the patented feature is small relative to the total value associated with the product. The intuition is that the accused infringer will lose the full value of its product, not just the value of the patented component, if it

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[16] The negotiated royalty rate is, of course, a function of the probability θ that the patent would be found valid. However, the patent strength, θ, does not appear in this expression because we are measuring the negotiated royalty rate as a percentage of the benchmark rate, and θ is in both the numerator and the denominator of this ratio.

[17] The "Litigate" strategy is indeed optimal for the downstream firm with these numbers so long as $\theta * B < 2/9$. With equal bargaining power, B=1/2, the "Litigate" strategy is optimal if the patent strength is less than 4/9.

is enjoined and has to redesign the product to avoid infringement. It will therefore be willing to settle for an amount that is greater than the expected value of the patentee's contribution but less than the expected loss in sales of the unpatented components of its product.

2. "Redesign and Litigate" Strategy

If the patent appears stronger, the accused infringer can avoid the risk of disruption in its business by redesigning the product even while litigating, particularly if the cost of redesign is relatively low in comparison with profits that the downstream firm would lose by withdrawing from the market while redesigning its product.[18] In this case, the patent holder benefits greatly from the fact that the downstream firm's "threat point" in the negotiations involves incurring redesign costs for sure, not just in the event that the patent holds up in litigation. Therefore, the patent holder's negotiating position is not properly discounted to reflect patent strength.

In this case, the percentage gap between the negotiated royalty and the benchmark level is the given by $\frac{C}{\theta}$. For an ironclad patent, $\theta = 1$, and this term just equals *C*, the same as the first term in the case where the "Litigate" strategy is optimal for the downstream firm. Recall that *C* measures the redesign costs as a fraction of the total value of the patented feature. For weaker patents, however, this figure is magnified; if the patent strength is 50%, the royalty over-charge associated with redesign costs is doubled. For example, with $\theta = 50\%$, and if the costs of redesigning the product are equal to C = 20% of the value of the patented feature, the overcharge equals 40%. The intuition here is straightforward – the accused infringer will have to spend money on a redesign that will be wasted if the patent is invalid or not infringed. It will therefore be willing to settle for an amount that is greater than the expected value of the patentee's contribution but less than the cost of redesigning the product while litigating.

D. What if the Patented Feature is Nothing Special?

We now comment on special case in which the patented feature is nothing special, in the sense that there alternative ways to achieve the same product performance without infringing the patent. Formally, this is the case in which V=0. This corresponds to the case in which the downstream firm has unwittingly designed a patented feature into its product, even though it could have used an equally good alternative approach had it known in advance about the patent.

In this case, we cannot talk about the percentage gap between the negotiated royalties and the benchmark level, since the benchmark royalty level is zero, reflecting the fact that the patented feature adds no value above and beyond the next best alternative. Therefore, all of negotiated royalty rate represents an over-charge based on hold-up.

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[18] This was the strategy eBay embarked upon in the MercExchange case.

If the downstream firm's optimal strategy is "Litigate," then the negotiated royalty rate in this case in equal to θ*B[M*L+K], where K is the redesign cost per unit.[19] For example, with equal bargaining power (B= 0.5) and a patent strength of θ = 0.4, and using the same numbers as above, namely M = $10, L = 0.1, and a redesign cost of $0.20 per unit, the negotiated royalty rate equals $0.24 per unit. These royalties are earned by the holder of a patent that made no real economic contribution at all to the downstream firm's product; they are entirely a function of the risk that the patent will be held valid and infringed and the accused infringer will lose sales of the valuable parts of the product while redesigning it to avoid infringement. Put differently, the negotiated royalties can be attributed entirely to hold-up and opportunism by the patentee.

Alternatively, if the downstream firm's optimal strategy is "Redesign and Litigate," then the negotiated royalty rate equals B*K. With these same numbers, except a stronger patent, θ = 0.5, the negotiated royalty rate equals $0.25 per unit.[20] Again, these royalties are earned by the holder of a patent that made no real economic contribution to the downstream firm's product but is in a position to capture part of the avoided cost of redesign.

Below we will discuss what happens when a single product can potentially infringe many such patents, each covering a patented feature that was arbitrary, in the sense that it could easily have been replaced with an alternative feature, had the downstream firm known about the patent before it designed its product.[21]

E. Early Negotiations Do Not Help (Much)

So far we have assumed that the downstream firm designed its product before it was approached by the patent owner and faced with an infringement allegation. Naturally, this timing is conducive to the patent owner holding up the downstream firm, since by the time the downstream firm learns that it is accused of infringing, it has already incurred design costs that would need to be wastefully duplicated if the downstream firm were forced to redesign its product to avoid infringing. Therefore, one might imagine that the problems just identified largely go away if the patent holder and the downstream firm engage in "early negotiations," i.e., negotiations before the product is designed.

There are indeed two polar cases in which early negotiations insure that the negotiated royalty equals the benchmark level. The first polar case is when the patented feature is nothing special, i.e., V = 0. In that case, if the downstream firm is aware of the patent before it designs its product, it can costlessly avoid infringing, so the negotiated royalty rate equals the benchmark level of zero. This case requires that the downstream firm not infringe on *another* patent by designing around the first one. The second polar case involves an ironclad patent, in which case the royalty rate arising from early negotiations equals B*V, the benchmark level.

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[19] We can no longer talk about the design cost C as a fraction of the underlying value of the patented feature since the latter is zero.

[20] The stronger patent makes "Redesign and Litigate" rather than "Litigate" be optimal for the downstream firm.

[21] *See infra* notes __-__ and accompanying text.

In all other cases, however, and especially for weak patents, the royalty overcharges already studied arise even if the patent holder approaches the downstream firm before that firm has designed its product. We now explain this somewhat surprising result.

What is different about the negotiations between the patent holder and the downstream firm if the latter has not yet designed its product? There is no change in the negotiated outcome predicted by standard bargaining theory unless the early knowledge creates a new, superior threat point for the downstream firm that was not available in the previous analysis, where we assumed that the downstream firm had already incurred the design costs at the time of negotiation. More specifically, the ability to negotiate early enables the downstream firm to negotiate better terms if and only if the downstream firm's optimal strategy (and thus its threat point) in the early negotiations is to design its product to avoid infringing the patent.

Once one recognizes that patents are probabilistic,[22] this proves to be a discouraging observation. If the downstream firm's threat in the early negotiations is to design its product to avoid using the patented feature, then the negotiated royalty rate will equal the patent holder's share of the value associated with that feature. In our example where the feature adds $1 per unit in value, with equal bargaining power the negotiated royalty rate would be $0.50 per unit. More generally, if the opportunity to negotiate early is valuable to the downstream firm, then the negotiated royalty rate will equal B*V. The key thing to note about this royalty rate is that it *does not involve any discounting based on patent strength*. There is no such discounting because, if licensing negotiations break down, the downstream firm will design its product to avoid infringing, which involves foregoing the use of the patented feature for sure, not merely in the event that the patent would be proven invalid.

In this case, the percentage gap between the negotiated royalty rate and the benchmark royalty rate is given by $(1-\theta)/\theta$. For an ironclad patent, $\theta = 1$, there is no overcharge at all, because there is no element of hold-up at all. However, some overcharge is inevitable if the downstream firm has any chance of winning the patent litigation. For example, if $\theta = 0.5$, the overcharge is 100%, i.e., the negotiated royalty rate is twice the benchmark level. Likewise, if the patent is a bit weaker, say $\theta = 1/3$, the overcharge is 200%, i.e., the negotiated royalty rate is three times the benchmark level. The accused infringer pays more than the benchmark rate because it has chosen to give up without a fight, and so the chance that it would have won that fight will not be reflected in the royalty.

More generally, if the patent is sufficiently weak, the downstream firm's optimal strategy if licensing negotiations break down will *not* be to design its product to avoid the patented feature, even if the downstream firm learns of the patent at an early date. Instead, the downstream firm will pursue a version of the "Litigation" strategy, with the over-charges already discussed. In this case, early knowledge of the patent provides no benefit whatsoever to the downstream firm.

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[22] *See* Mark A. Lemley & Carl Shapiro, *Probabilistic Patents,* 19 **J. Econ. Persp.** 75 (2005).

F. Multiple Downstream Firms

Our analysis so far has focused on a single patent holder and a single downstream firm. Economic analysis of licensing negotiations is considerably more complex if there are multiple downstream firms. We are unaware of formal models that study injunctions, hold-up, and patent licensing with multiple downstream firms. We can, however, indicate how the analysis just presented is affected by the presence of multiple downstream firms.

First, the benefits to the downstream firm of challenging the patent are reduced if it competes against other downstream firms who also use the patented technology.[23] Invalidating the patent benefits all of the downstream firms and typically will not give the downstream firm at issue a competitive advantage over its rivals. In fact, the invalidating firm has paid legal fees its competitors have not had incur. This effect makes litigation less attractive to the downstream firm and thus tends to *raise* the negotiated royalty rate. Farrell and Shapiro show that this "public good" effect leads to overcharges for weak patents even if redesign is immediate and costless so there is no possibility of opportunism by the patent holder.[24]

Second, the costs to the patent holder of litigating against one downstream firm are increased by the risk that the patent holder's royalties from *other* downstream firms will be reduced or eliminated if it loses the patent litigation. This effect is larger the weaker the patent. This effect may arise if other firms have already signed licenses, since they will no longer be obliged to pay royalties if the patent is found invalid.[25] However, the patent holder has the incentive to mitigate this risk by signing licenses that involve up-front payments which are not refundable if the patent is later found invalid. Even if running royalties are used, the patent holder can still mitigate this risk by signing licenses that are based in part on trade secrets or on a group of patents in its patent portfolio, and thus are protected from subsequent unfavorable patent rulings regarding any single patent.[26]

Licensees are likely to be amenable to these mitigation strategies. In equilibrium, if the parties consider it very unlikely that the patent will be litigated to final judgment – and recall that litigation to final judgment is rare in patent cases as an empirical matter[27] – any one licensee will

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[23] *See* Joseph Farrell & Carl Shapiro, "How Strong Are Weak Patents," U.C. Berkeley Competition Policy Working Paper, 2005, available at faculty.haas.berkeley.edu/Shapiro.; Joseph Farrell & Robert P. Merges, *Incentives to Challenge and Defend Patents: Why Litigation Won't Reliably Fix Patent Office Errors and Why Administrative Patent Review Might Help*, 19 **Berkeley Tech. L.J.** 943 (2004); Joseph Scott Miller, *Building a Better Bounty: Litigation-Stage Rewards for Defeating Patents*, 19 **Berkeley Tech. L.J.** 667 (2004).

[24] Farrell & Shapiro, *supra* note __, at __.

[25] *See* Brulotte v. Thys, 379 U.S. 29 (1964); Blonder-Tongue Labs. v. Univ. of Illinois Found., 402 U.S. 313 (1971).

[26] *See* Aronson v. Quick Point Pencil Co., 440 U.S. 257 (1979) (upholding continuing royalty obligation for trade secrets even after patent application was rejected).

[27] *See, e.g.*, Mark A. Lemley, *Rational Ignorance at the Patent Office,* 95 **Nw. U. L. Rev.** 1495 (2001) (the vast majority of patent disputes settle); Jay P. Kesan & Gwendolyn G. Ball, *How Are Patent Cases Resolved? An Empirical Examination of the Adjudication and Settlement of Patent Disputes,*

find it nearly costless to agree to conditions that only apply in that event. Yet these mitigation strategies clearly benefit the patent holder by placing it in a stronger bargaining position with other licensees in the future. The mitigation strategies therefore raise the joint profits of the patent holder and the downstream firm in bilateral bargaining. Thus, bargaining theory predicts that in many settings the licensing agreements will preserve the patent holder's strength in subsequent negotiations. In fact, if the downstream firms are rivals, an early licensee will actually *benefit* from agreeing to conditions that will strengthen the patent holder in subsequent negotiations with other downstream firms, since the early licensee benefits if subsequent licensees (its rivals) must pay higher royalties. However, none of these mitigation strategies can protect the patent holder from the risk that it will lose the ability to sign licenses in the future for the patent in question with other downstream firms if that patent is invalidated.[28]

Third, the presence of additional downstream firms creates an additional *upside* from litigating for the patent holder, because the patent holder will be in a stronger position relative to these downstream firms if its patent is tested in court and upheld. This effect is larger the stronger the patent.

Additional complexity arises if one takes account of differences among the downstream firms. For example, the patent holder may choose to go to trial early against a downstream firm that is in a relatively poor position to litigate. Or the patent holder might settle early with a downstream firm that possesses especially strong prior art, thereby raising its effective patent strength vis a vis other downstream firms.

The economic literature on many of these points is in its infancy, and a thorough discussion of the strategic issues that arise when a single patent holder negotiates with multiple downstream firms, either simultaneously or sequentially, is beyond the scope of this paper. We do not know enough at this point to make general statements about just how the results reported above, based on a model with a single downstream firm, differ in the presence of multiple downstream firms. We can say, however, that if one downstream firm earns far greater revenues than do the other downstream firms, our model of negotiations involving a single downstream firm will remain a very good guide to negotiations with that firm, even if other downstream firms are present.

G. Summary of Theory

For weak patents, the downstream firm's optimal strategy tends to be "Litigate." In this case, the negotiated royalty rate can be a large multiple of the benchmark level if fraction of the product's value attributable to the patented feature is small. For stronger patents, the downstream firm's optimal strategy tends to be "Redesign and Litigate." In this case, the negotiated royalty rate includes an overcharge based on fact that the downstream firm incurs the redesign costs for sure if licensing negotiations break down, not just in the event that the patent is found valid and

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http://papers.ssrn.com/sol3/papers.cfm?abstract_id=808347 (working paper 2006) (finding that 80% of patent disputes settle).

[28] An adverse decision on infringement or claim construction by one downstream firm may or may not have effects on royalties earned from other downstream firms, depending upon how similar are the different downstream firms' products, and thus on the correlation between one downstream firm infringing and another doing so.

infringed. The negotiated royalty remains above the benchmark level even if the downstream firm is able to negotiate with the patent holder before the downstream firm initially designs its product, especially for weak patents.

H. Injunctions and Hold-Up in Practice

The patent statute provides not for mandatory injunctions, but for discretion for the courts to grant injunctive relief in accordance with principles of equity.[29] The goal of the injunctive relief sections of the patent law is to ensure that people who actually need injunctive relief to protect their markets or ensure a return on their investment can get it, but that people cannot use the threat of an injunction against a complex product based on one infringing piece to hold up the defendant and extract a greater share of the value of that product than their patent warrants.

Unfortunately, such holdup occurs on a regular basis under the Federal Circuit's reinterpretation of the statute. The Federal Circuit has created an all-but-mandatory-injunction standard. We agree that patent law is a property rule, and injunctive relief is the appropriate remedy in ordinary cases, particularly cases where the patentee participates in the market and enforces its patent in order to preserve market exclusivity.[30] However, in conjunction with other features of current patent law, extending injunctive relief to non-competing patent owners in cases involving component inventions can have pernicious consequences. The potential for injunctive relief against the whole product can and does permit so-called "patent trolls" to hold up defendants by threatening to enjoin products that are predominantly non-infringing. As we have just shown, this threat can easily enable a patent holder to negotiate a settlement for an amount of money significantly exceeding the amount that the patent holder could expect to earn in damages based on reasonable royalties. In these cases it is not the underlying value of the patented technology, but the cost to the defendant of switching technologies midstream, that is driving the high royalties being paid.

This is not just a theoretical problem. In the real world, it is common for patent defendants to settle cases for more money than the patentee could have won in damages and license fees, simply to avoid the threat of an injunction shutting down the core product. For example, one patent owner charges a 0.75% royalty for patents that don't cover industry standards, and 3.5% for patents that do cover industry standards.[31] The technology does not have any greater inherent value when used as part of an industry standard, but the patent holder can demand almost five times as much money once the industry has made irreversible investments. In another highly visible case, the Blackberry wireless email service, the threat of

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[29] The statute provides that courts "may" grant injunctions once infringement is found, but only "in accordance with principles of equity" and "on such terms as they deem reasonable." 35 U.S.C. § 283.

[30] *See, e.g.,* Odetics, Inc. v. Storage Tech. Corp., 185 F.3d 1259 (Fed. Cir. 1999) ("the general rule [is] that an injunction should follow an infringement verdict"); Robert P. Merges & John Fitzgerald Duffy, **Patent Law & Policy** 1040 (3d ed. 2002) ("the issuance of a permanent injunction after a patent is found valid and infringed . . . is the general practice, to which there are only limited exceptions.").

[31] *See, e.g.,* Mark R. Patterson, *Antitrust and the Costs of Standard-Setting*, 87 **Minn. L. Rev.** 1995, 2001 n.33 (2003).

an injunction led to a settlement of $612.5 million, significantly more than the actual damages awarded by the jury.[32]

Our analysis strongly supports the conclusion that hold-up is of particular concern when the patent itself covers only a small piece of the product. A microprocessor may include 5,000 different inventions, some made by the manufacturer and some licensed from outside. If a microprocessor maker unknowingly infringes a patent on one of those inventions, the patent owner can threaten to stop the sale of the entire microprocessor until it can retool its entire fab to avoid infringement. Small wonder, then, that patentees regularly settle with companies in the information technology industries for far more money than their inventions are actually worth. The companies are paying hold-up money to avoid the threat of infringement. That is not a legitimate part of the value of a patent; it is a windfall to the patent owner that comes at the expense not of unscrupulous copyists but of legitimate companies doing their own R&D.

The Federal Circuit has concluded that this "additional leverage in licensing" is "a natural consequence of the right to exclude and not an inappropriate reward" to a patentee.[33] We respectfully but vigorously disagree with the court . The leverage comes from the ability of a patent owner to capture value that has nothing to do with its invention, merely because the accused infringer cannot separate the infringing component from the non-infringing ones after the fact. There is no reason in law or policy to give such power to a patent owner. Doing so will produce circumstances in which no one can afford to produce a product with social value.

II. Royalty Stacking and Hold-Up

In the last section, we demonstrated that substantial holdup was a very real possibility even when there was only one patent asserted against a particular product. Under many plausible circumstances, the royalty negotiated in the shadow of litigation and hold-up can significantly exceed the intrinsic value of the invention itself. We now discuss situations in which multiple patents read on a single product, so that the downstream firm must deal with the stacking of royalties paid to two or more patent holders.

Not surprisingly, the existence of such "royalty stacking" exacerbates the holdup problem. Simply as a matter of arithmetic, the problems noted above are greater when the downstream firm faces infringement claims from multiple patent owners. As a first approximation, the magnitude of the problem is multiplied by the number of patents that read on the product.

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[32] *See* NTP v. Research in Motion, 2003 WL 23100881 (E.D. Va. Aug. 5, 2003) (awarding reasonable royalty damages in the amount of about $33.5 million). The settlement was 18 times the jury award. To be sure, the damages the jury awarded were only for 6 of 15 remaining years on the patent, so adding a going forward royalty would presumably have raised the total award. And there is reason to believe RIM will sell more Blackberries in the future than it has in the past. But even that continuing royalty would likely have been significantly less than the $612.5 million settlement that was reached in March 2006. See "RIM to Pay NTP $612.5 Million to Settle BlackBerry Patent Suit," *Wall Street Journal*, March 4, 2006.

[33] eBay, Inc. v. MercExchange LLC, 401 F.3d 1323 (Fed. Cir. 2005).

However, a closer look at the underlying economics reveals that the aggregate or stacked royalty rate is not simply the sum of the royalty rates that would be negotiated bilaterally by each patent holder in the absence of the other patent holders. Put differently, the royalty rate negotiated by one patent holder is affected by the rates the downstream firm pays to *other* patent holders, so a proper analysis must account for the joint determination of all of the royalty rates. We have identified three reasons why the royalty rate paid to one patent holder on a given product is affected by the rates paid to the holders of other patents reading on that same product: (1) rent splitting; (2) shutdown; and (3) Cournot Complements.[34]

First, bargaining theory, as used above, tells us that the downstream firm and a patent holder who are negotiating will split the additional profits ("rents") that result from reaching a settlement rather than litigating. As emphasized above, litigation can lead to an injunction and the loss of profit margins by the downstream firm. The larger are the royalties that the downstream firm is paying to *other* patent holders, the smaller are the margins on the downstream firm's product (the variable "M" in the numerical examples above), and the lower is the negotiated royalty rate. To put it bluntly, if the downstream firm is paying royalties to many other patent holders, its margin is reduced, making the threat of an injunction by any one patent holder less powerful.

Second, and related, some limits on the aggregate royalty burden arise because of the constraint that the downstream firm's margin cannot be driven below zero.[35] Unfortunately, however, this constraint does not prevent very substantial royalty overcharges, especially if the downstream firm has made substantial investments to design, manufacture, market, and sell its product. To illustrate, suppose that there are 10 patent holders, with each patent covering a technology that adds V=$1 in value to the downstream firm's product. Suppose that the downstream product sells for $40 per unit and involves a marginal cost of $10 per unit before accounting for any patent royalties.[36] So long as the aggregate royalty burden is less than the gross margin of $30 per unit, the downstream firm will produce its product. Therefore, in a symmetric situation, each patent holder could obtain a royalty as high as $3 per unit, or three times its underlying value, before the downstream firm shut down. If the patents have, say 40% strength, and if the bargaining power is equal, then the benchmark royalty level would be $\theta*B*V=0.4*0.5*\$1$ or $0.20. So each patent holder could charge 15 times the benchmark royalty rate before the downstream firm would shut down.[37]

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[34] Simple benchmarking could provide a fourth reason, if the rate negotiated between the downstream firm and one patent holder is used as a benchmark in negotiations with other patent holders. However, for benchmarking to be important, the second patentee must have information about the negotiated rate and the patents involved must be considered at least somewhat "comparable" by the negotiating parties.

[35] *See* Doug Lichtman, *Patent Holdouts in the Standard-Setting Process* (working paper 2006) (making this point).

[36] Gross margins of 75%, as in this example, or higher, are not unusual in the information technology sector, where R&D costs can be large and marginal production costs can be small. High margins are especially common for software.

[37] Of course, in practice, higher royalty burdens will lead to higher prices and reduced output, with associated deadweight loss. Accounting for these effects, while complicating the math, strengthens our argument.

The fact that royalties from all the patents reading on a single product must be added up is one reason why we focused on the *percentage overcharge* associated with each patent. Perhaps it seems like a relatively small matter if the threat of holdup causes the downstream firm to pay a royalty equal to $1 per unit to a single patent holder, rather than the benchmark level of $0.20 per unit. But royalties that are five times their benchmark level can have dramatic effects if these royalties are due not just for one patent, but for many patents. With the recent surge in patenting,[38] especially in the information technology industry where royalty stacking is a serious concern, these overcharges, when aggregated, can lead to a very significant cost burden on producers. If these royalties accurately reflected the contributions made by the patent owners, the additional cost is one producers should be made to bear in order to encourage innovation. However, by focusing above on the gap between the negotiated royalty and the benchmark level, we have already shown that much of this cost burden is *not* justified based on the actual contributions of the patent holders who earn these royalties.

Third, a complete analysis should account for the fact that higher royalties will raise the downstream firm's marginal cost, which will raise its price and thus reduce its level of output. This is an example of the effect well known to economists under the label of "Cournot Complements." The Cournot Complements effect arises when multiple input owners each charge more than marginal cost for their input, thereby raising the price of the downstream product and reducing sales of that product.[39] Effectively, each input supplier imposes a negative externality on other suppliers when it raises its price, because this reduces the number of units of the downstream product that are sold. Shapiro provides a simple derivation of the well-known result that output is depressed even below the level that would be set by a downstream monopolist if multiple input owners each control an essential input and separately set their input prices.[40]

Unfortunately, the stacking of royalties for a product sold at a positive margin by the downstream firm combines the inefficiencies associated with two well-known pricing problems in industrial organization: *double marginalization*, which arises when input suppliers with market power (here, the patentees) sell to a downstream firm that also has some power over price, and *Cournot complements*, which arises when multiple suppliers with market power sell complementary products. Together, these problems cause prices to be *higher* than would be set by an integrated monopolist who owned all of the patents and sold the downstream product.

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[38] *See* www.uspto.gov/statistics (documenting the tripling of patents issued in the last 25 years); Mark A. Lemley & Bhaven Sampat, *Rejected Patents* (vaporware 2006) (finding that modern patent applications are filed disproportionately in the information technology industries).

[39] Cournot used the example of copper and zinc suppliers selling to manufacturers of brass. See A. A. Cournot, (1838), "Researches into the Mathematical Principles of the Theory of Wealth," English Edition, New York, Kelley.

[40] Shapiro (2001), "Navigating the Patent Thicket: Cross-Licenses, Patent Pools, and Standard Setting," in *Innovation Policy and the Economy*, Adam Jaffe, Joshua Lerner, and Scott Stern, eds., National Bureau of Economics, 2001. In the special case of constant elasticity demand for the final product, if there are *N* essential inputs, each controlled by a single firm, and if the downstream firm(s) simply price at their marginal cost, the resulting markup on the final good, i.e., the percentage gap between price and the true marginal cost of producing that good, is *N* times the monopoly level.

According to the general theory of Cournot complements, the equilibrium level of output by the downstream firm tends to be smaller, the more fragmented is the ownership of a given set of patents that read on the downstream product. As an illustration, the Appendix considers situations in which the constraint on the royalty set by each of *N* patent holders is based on the reduction in output associated with higher royalty rates.[41] As shown in the Appendix, if marginal costs are constant and the downstream firm faces linear demand, the output level if *N* patents are owned by *N* separate firms is equal to the output level if all *N* patents were owned by a single firm times the factor $2/(N+1)$. For example, with three patents held by separate firms, downstream output is half as much as if it would be if a single company owned all three patents.

As usual with Cournot Complements, there is an incentive for the patentees to coordinate to reduce their royalties, e.g., by engaging in cross-licenses or by licensing their patents in a pool at an agreed-upon rate. However, the negotiations necessary to form such a pool can be very thorny if there are many firms involved, since each may be tempted to opt out of the pool and assert its patents separately. Indeed, it may be very difficult to induce patentees who are not themselves producers in the market to join a patent pool. Such a patent holder might well maximize its revenues by staying out of a proposed patent pool and asserting its patent rights independently, unless it believe that its failure to join the pool will undermine the formation of the pool and thus seriously hinder sales of the product in question. Negotiations are even harder if several of the patentees hold multiple patents, and if the relevant patents vary greatly in scope and strength. Of course, patent pools do sometimes overcome these obstacles and successfully form. We simply note that the transactions costs can be substantial and that the presence of non-manufacturing patent owners makes the formation of successful pools harder.

The theory of Cournot complements warns us that royalty stacking causes harm based on reduced output, higher prices, and thus deadweight loss. Furthermore, if anticipated, the combined royalty burden associated with royalty stacking may make it unprofitable for the downstream firm to incur the fixed costs initially necessary to develop the product in question. While no individual patent holder benefits from this result, the net result of the royalties that each of them negotiates separately with the downstream firm can lead to this mutually unattractive outcome. Less dramatic versions of this effect can arise as well. For example, the downstream firm may not find it worthwhile to develop some versions of the product if the royalty burden prevents it from selling enough units and a sufficient margin to recoup the additional development costs associated with those versions.

These problems of hold-up and royalty stacking can be severe in the case of private standard setting. Indeed, the leading recent antitrust cases involving allegations of hold-up by patent owners involve product standards.[42] In terms of the analysis already presented, the key point is

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[41] This is a fundamentally different approach than the one taken in the text above, where the downstream firms' threat was either to litigate the patent or redesign its product to avoid infringing, and the output by the downstream firm was fixed. The analysis in the Appendix thus complements that provided above in the text.

[42] *See, e.g., Rambus, Inc. v. Infineon Techs.* AG, 318 F.3d 1081 (Fed. Cir. 2003) (overturning a district court judgment of fraud against Rambus), *In re Rambus, Inc.*, FTC No. 9302 (Feb. 24, 2004) (rejecting the FTC's antitrust claims against Rambus); *In re Union Oil Co. of Calif.*, No. 9305 (July 7, 2004) (reversing an ALJ's decision to

that it can be extremely costly, or even impossible as a practical matter, to "redesign" a product standard to avoid infringing a patented technology, even if initially an alternative standard could easily have been selected. In the case of standards, such "redesign" actually involves going through some process by which the standard-setting organization (SSO) selects a new standard, or modifies an old standard. These processes, which often rely on consensus, can be slow-moving. Furthermore, if multiple manufacturers have begun selling products that comply with the initial standard, possibly including various complementary products associated with the standard, switching to a non-infringing design can be extremely costly and commercially infeasible. With very high "redesign" costs, we have already shown that the threat of an injunction can lead to large royalty over-charges, especially for weak patents.

There is a second reason why royalty stacking is especially problematic in the case of product standards: it is common for multiple companies to own patents covering essential aspects of product standards, at least for telecommunications and computer standards. The nature of the process by which standards are selected tends to involve consensus and compromise, leading to a product standard that reads on the patents of many firms. Each individual firm may place high value on having at least one patent that covers an essential feature of the standard, in part to strengthen its bargaining position vis a vis other companies who own essential patents. Tim Simcoe documents a dramatic increase over the past 15 years in the number of "essential patents" disclosed to standard-setting organizations.[43]

A final problem with royalty stacking has to do with the effects of multiple patents on the design-around alternative. In our model, the most significant factor limiting royalty overcharges was the availability of a non-infringing design-around. In a world with multiple patents, it is not necessarily the case that design-around alternatives will themselves be unpatented. If an accused infringer cannot turn to a non-infringing alternative, and if the different patent holders all have some hold-up power, the Nash bargaining solution will include a more significant departure from the benchmark royalty rate than we have measured above.

III. Reasonable Royalties

Our analysis so far has emphasized the problems that arise due to the patent holder's threat to obtain injunctive relief. However, there are a related set of problems that arise because of difficulties associated with the practical implementation of the concept of the "reasonable royalties" that an infringing firm owes the patent holder if the court finds that infringement has occurred.[44]

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dismiss an antitrust claim against Unocal, and remanding for trial before the ALJ); *In re Dell Computer Corp*., No. 93-10097 (F.T.C. 1995) (consent decree).

[43] Timothy S. Simcoe, *Explaining the Increase in Intellectual Property Disclosure*[draft at 1] (working paper 2005)

[44] Recall that we assumed above that "reasonable royalties" were at the benchmark level of $\theta*B*V$. After showing why "reasonable royalties" tend to be higher than this benchmark level, we explain how a higher level of "reasonable royalties" exacerbates the problems already identified based on injunctions and hold-up.

A. Legal Standards for Reasonable Royalties

The patent statute provides that a patentee can recover its lost profits from infringement, if it can prove them, but is always entitled to no less than a reasonable royalty.[45] Lost profits are difficult to prove,[46] and any patent owner who does not sell goods in competition with the defendant will be unable to demonstrate lost profits from infringement. Their only loss is the royalty for which they could have licensed the patent.

How does a court determine what royalty is reasonable? In a case called *Georgia Pacific v. United States Plywood*,[47] the court set out a detailed test designed to emulate the bargain the parties would have entered into at the time infringement began had they (1) been willing to negotiate and (2) known to a certainty that the patent was valid and infringed. While *Georgia Pacific* identified 15 different factors,[48] in fact they collapse into only three significant issues:

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[45] 35 U.S.C. § 284. For a detailed discussion of the history of patent damages, see Amy L. Landers, *Let the Games Begin: Expanding Patent Scope Through the Reasonable Royalty Analysis* (working paper 2005).

[46] The basic test is set out in *Panduit Corp. v. Stahlin Brothers Fibre Works*, 575 F.2d 1152 (6th Cir. 1978). Under *Panduit*, the patentee must show demand for the patented product, the absence of non-infringing substitutes, the patentee's ability to meet the demand for the infringing goods, and the amount of profit the patentee would have made from those sales. The Federal Circuit has adopted this test, see State Indus. v. Mor-Flo Indus., 883 F.2d 1573, 1577 (Fed. Cir. 1989); *Hebert v. Lisle Corp.*, 99 F.3d 1109, 1119-20 (Fed. Cir. 1996).

[47] 318 F. Supp. 1116 (S.D.N.Y. 1970).

[48] Those factors are:

> 1. The royalties received by the patentee for the licensing of the patent in suit, proving or tending to prove an established royalty.
> 2. The rates paid by the licensee for the use of other patents comparable to the patent in suit.
> 3. The nature and scope of the license, as exclusive or non-exclusive; or as restricted or non-restricted in terms of territory or with respect to whom the manufactured product may be sold.
> 4. The licensor's established policy and marketing program to maintain his patent monopoly by not licensing others to use the invention or by granting licenses under special conditions designed to preserve that monopoly.
> 5. The commercial relationship between the licensor and licensee, such as, whether they are competitors in the same territory in the same line of business; or whether they are inventor and promoter.
> 6. The effect of selling the patented specialty in promoting sales of other products of the licensee; that existing value of the invention to the licensor as a generator of sales of his non-patented items; and the extent of such derivative or convoyed sales.
> 7. The duration of the patent and the term of the license.
> 8. The established profitability of the product made under the patent, its commercial success; and its current popularity.
> 9. The utility and advantages of the patent property over the old modes or devices, if any, that had been used for working out similar results.
> 10. The nature of the patented invention; the character of the commercial embodiment of it as owned and produced by the licensor; and the benefits to those who have used the invention.
> 11. The extent to which the infringer has made use of the invention; and any evidence probative of the value of that use.
> 12. The portion of the profit or of the selling price that may be customary in the particular business or in comparable businesses to allow for the use of the invention or analogous inventions.
> 13. The portion of the realizable profit that should be credited to the invention as distinguished from non-

the significance of the patented invention to the product and to market demand, the royalty rates people have been willing to pay for this or other similar inventions in the industry, and expert testimony as to the value of the patent.[49]

While the stated goal of the reasonable royalty inquiry is to replicate the negotiation that might otherwise have occurred, it is important to recognize that the negotiation is counterfactual in important respects. First, and most obviously, the parties did *not* agree beforehand. If a court is calculating damages, the parties litigated the case all the way through trial, at an expense of many millions of dollars per side in legal fees and great time and effort.[50] There is likely a reason they did not agree and fought the case to a conclusion without settling. Assuming that they did settle necessarily elides whatever factors (competition between the parties, the effect of a deal on other licensees, disagreements over the merits of the claim, or – most significant – the possibility that the patentee stood to lose more than the defendant had to gain from licensing, so that no deal was rational)[51] prevented a deal in the first place. It also prevents a patent owner from structuring royalty rates by giving a price break to those who settle easily,[52] and indeed encourages the opposite – trying to fix royalty rates for subsequent litigation by creating a record of high royalty rates in early negotiations.[53] Second, the *Georgia-Pacific* factors assume that the

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patented elements, the manufacturing process, business risks, or significant features or improvements added by the infringer.
14. The opinion testimony of qualified experts.
15. The amount that a licensor (such as the patentee) and a licensee (such as the infringer) would have agreed upon (at the time the infringement began) if both had been reasonably and voluntarily trying to reach an agreement; that is, the amount which a prudent licensee-- who desired, as a business proposition, to obtain a license to manufacture and sell a particular article embodying the patented invention-- would have been willing to pay as a royalty and yet be able to make a reasonable profit and which amount would have been acceptable by a prudent patentee who was willing to grant a license.

Id. at 1120.

[49] *See* Nickson Indus. Inc. v. Rol. Mfg. Co., 847 F.2d 795, 798 (Fed. Cir. 1988) (relying on established market royalties as the strongest evidence of what royalty is reasonable). *Cf.* Blair & Cotter, *supra* note __, at 228-29 (noting that courts focus on only a small number of the *Georgia Pacific* factors, particularly other royalty rates in the industry).

[50] See AM. INTELL. PROP. L. ASS'N, REPORT OF ECONOMIC SURVEY 22 (2003) (reporting that patent litigants spent $4 million per side in legal fees in cases where more than $25 million was at stake).

[51] On this last possibility, see Blair & Cotter, *supra* note __, at 231-32. One example is *Golight Inc. v. Wal-Mart Stores*, 355 F.3d 1327 (Fed. Cir. 2004), where the court upheld a reasonable royalty that exceeded the infringer's profits from the product. Obviously, the parties had no room to come to a deal in that situation.

[52] Whether this is as good or a bad thing is unclear. There is some logic to requiring those who put a patentee to great time and expense to collect royalties to pay a higher rate than those who agree to license a patent quickly. On the other hand, such a tiered system may encourage too many people to settle, leading to underprovision of the public good of invalidating bad patents. On this public good, see, e.g., Joseph Farrell & Carl Shapiro, "How Strong Are Weak Patents," U.C. Berkeley Competition Policy Working Paper, 2005; Joseph Farrell & Robert P. Merges, *Incentives to Challenge and Defend Patents: Why Litigation Won't Reliably Fix Patent Office Errors and Why Administrative Patent Review Might Help*, 19 **Berkeley Tech. L.J.** 943 (2004); Joseph Scott Miller, *Building a Better Bounty: Litigation-Stage Rewards for Defeating Patents*, 19 **Berkeley Tech. L.J.** 667 (2004).

[53] For evidence of analogous conduct in copyright arbitrations, see Thomas Nachbar, *Monopoly, Mercantilism, and Intellectual Property* 70 (working paper March 1, 2005).

parties know the patent is valid and infringed.[54] That makes some sense, as by the time we determine damages we know that it is. But it is highly counterfactual. As we have explained elsewhere, patents are probabilistic rights.[55] Nearly half of all litigated patents are invalidated, and many more are found not to be infringed.[56] Any deal that occurs before or even during litigation will reflect the significant chance that the patent would ultimately be invalidated or that the defendant would be held not to infringe. As a result, royalty rates awarded in court under *Georgia Pacific* should systematically exceed the rates that parties would negotiate out of court.[57] Courts have recognized this problem, and periodically seek to modify the market-based royalty data by adding "kickers," either expressly or sub rosa.[58]

B. Practical Problems with Court-Determined Royalty Rates

Patent damages law theoretically recognizes that royalties should be based on the value of the patented feature, not the entire value of the product containing that feature, by calibrating the royalty to the importance of the inventor's contribution. Patents covering one small component of the larger invention are supposed to get lower royalty rates, measured as a fraction of the downstream selling price, than patents covering the whole product.[59] Indeed, the *Georgia Pacific* test includes several factors that might permit courts to take account of the relative value of the patented component to the infringing product.[60] And the Supreme Court long ago recognized the problem of awarding patentees damages based on an entire product when more than one inventor contributed components to that product. It would be "very grave error," the

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[54] *See* Blair & Cotter, *supra* note __, at 229-30.

[55] Mark A. Lemley & Carl Shapiro, *Probabilistic Patents*, 19 **J. Econ. Persp.** 75 (2005).

[56] John R. Allison & Mark A. Lemley, *Empirical Evidence on the Validity of Litigated Patents*, 26 **AIPLA Q.J.** 185 (1998) (46% of patents litigated to judgment are invalidated); Kimberly A. Moore, *Judges, Juries and Patent Cases: An Empirical Peek Inside the Black Box*, 99 **Mich. L. Rev.** 365 (2000).

[57] *See* John J. Barnhardt, III, *Revisiting a Reasonable Royalty as a Measure of Damages for Patent Infringement*, 86 **J. Pat. & Trademark Ofc. Soc'y** 991 (2004).

[58] The Federal Circuit has rejected the affirmative use of a multiplier to enhance damages. *See* Mahurkar v. C.R. Bard, Inc., 79 F.3d 1572, 1580-81 (Fed. Cir. 1996) (rejecting the use of a "kicker" to enhance reasonable royalty damages to account for litigation costs). But there is reason to believe that courts engaged in such enhancements anyway by manipulating their findings on the appropriate royalty rate. Amy L. Landers, *Let the Games Begin: Expanding Patent Scope Through the Reasonable Royalty Analysis* (working paper 2005). Cf. Stickle v. Heublein, Inc., 716 F.2d 1550, 1563 (Fed. Cir. 1983) (contemplating an "increase" in the reasonable royalty rate to ensure that damages are adequate to compensate patentees); King Instruments Corp. v. Perego, 65 F.3d 941, 951 n.6 (Fed. Cir. 1995) (approving of "discretionary increases" in the royalty rate). Landers is troubled by this, but in our view it is appropriate to compensate for the differences between the circumstances of market and judicial royalty-setting.

[59] *See* Donald S. Chisum, *Reforming Patent Law Reform*, 4 **J. Marsh. Rev. Intell. Prop. L.** 336, 347 (2005) ("If a royalty is based on the whole product rather than the part, the appropriate royalty rate should be correspondingly low.").

[60] *See* Georgia-Pacific, 318 F. Supp. 1116, 1120 (S.D.N.Y. 1970). (factors 6 (value of invention in generating derivative or convoyed sales), 9 (advantages of patent over old modes and devices), and 13 (portion of profit credited to the invention)).

Court explained, "to instruct a jury that as to the measure of damages the same rule is to govern, whether the patent covers an entire machine or an improvement on a machine."[61]

This fundamental principle is reflected in the benchmark level of reasonable royalties we introduced above, B*V, which is based on the value of the patented feature and *not* the price of the entire downstream product, P, or the margin earned on that product, M, which can be far larger. Consider our numerical example in which price of the product is P = $40 and the value of the patented feature is V = $1. With equal bargaining power, the benchmark level of reasonable royalties is $0.50 per unit. However, in practice, the value of the patented feature, V, is difficult for courts to observe, and royalty rates are typically quoted as a fraction of the price of the product containing the patented feature. This practice mathematically links the per-unit dollar royalty to the price of the entire downstream product. While a royalty that is a "mere" 2% or 3% of the product price might seem "reasonable" for a patented feature, in this numerical example these correspond to royalty rates of $0.80 or $1.20 per unit, roughly twice the benchmark level.

But there are a number of theoretical and practical difficulties with judicial efforts to compensate for the existence of unpatented features of the invention. Those difficulties tend to drive royalty rates up, above the benchmark level, and cause courts in component cases to over-reward patentees.

The first problem comes from reliance on industry licensing rates. While an effort by courts to mimic the market seems unexceptionable,[62] in fact reliance on private license deals involves a degree of circularity, because the royalty rates in those deals are themselves set as a function of what patentees could get if they went to court.[63] Our previous analysis of hold-up abstracted away from this problem by assuming that infringement damages would be based on reasonable royalties set at the benchmark level of B*V. Shapiro shows what happens when the courts base reasonable royalties on royalty rates negotiated by private parties, even though private parties negotiate those royalties in the shadow of litigation, and thus are influenced by the level of court-awarded reasonable royalties.[64] The consequence of this circularity is that reasonable royalties

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[61] Seymore v. McCormick, 57 U.S. 480, 491 (1853). See also Westinghouse Elec. & Mfg. Co. v. Wagner Elec. Mfg. Co., 225 U.S. 604, 615 (1912) ("[The] invention may have been used in combination with valuable patents made, or other patents appropriated by the infringer, and each may have jointly, but unequally, contributed to the profits. In such case, if plaintiff's patent only created a part of the profits, he is only entitled to recover that part of the net gains.").

[62] *See* Lawrence M. Sung, **Patent Infringement Remedies** 281 (2003) (calling such evidence "one of the strongest measures of a reasonable royalty.").

[63] To the extent court decisions determine royalty rates based on other court decisions setting royalty rates in the same industry, of course, the circularity is even more obvious, since whatever court sets the first rate will end up influencing all subsequent rates.

[64] Theoretically, this circularity is resolved using the established concept of a self-fulfilling equilibrium. Logically, taking as given the level of reasonable royalties that the court would award, one calculates the negotiated royalty rate. Using the court's rule relating reasonable royalty awards to the royalty rates negotiated voluntarily, one then solves for the equilibrium royalty rate and level of reasonable royalties that are consistent with each other, or self-fulfilling.

are elevated above the benchmark level, and the problems of hold-up identified earlier "infect" the court-awarded level of reasonable royalties. Since negotiated royalties reflect a premium based on hold-up, so will the reasonable royalties awarded by the court. And this in turn gives patent holders more negotiating power in a self-reinforcing manner, which ultimately magnifies the effects of hold-up on negotiated royalty rates.[65]

A second problem comes from the source of available information about industry royalty rates. For obvious reasons, we rely on expert testimony to establish what the actual royalty rates are in any given industry. Those experts in turn must collect royalty data from non-litigated transactions in the industry. But most of those transactions are confidential. As a result, experts regularly look either to heuristics or idiosyncratic transactions about which they happen to have information that can be disclosed in court,[66] or – more commonly – they turn to established collections of publicly-available royalty rates.[67] Those sources in turn acquire their data from the only place they can – the subset of license transactions that are available to the public. But that subset is not random. The most significant source of public patent licenses is federal securities law filings, which require disclosure of a patent license or settlement if it is material to the bottom line of either party.[68] Not surprisingly, license agreements that involve the payment of a large sum of money are more likely to be material – and therefore more likely to show up in a public database – than license agreements that involve a small payment, a walkaway, or a cross-license. Thus, as a practical matter expert testimony about royalty rates overstates those rates, because the royalties that are reported tend to be higher than the average royalty. This too tends to drive court-awarded royalties above the benchmark level. Because of the circularity discussed above, it further contributes to higher royalty rates in patent settlements.

The third problem results from efforts to determine a reasonable royalty for a component not as a percentage of the sale of the component, but instead as a percentage of the sale of the whole product of which the component is a part. For obvious reasons, this issue is greatest in component industries, where P and V can differ very sharply in magnitude. Sometimes it can be avoided even in those industries, if the value of the patented component can be determined separately.[69] But in many cases, there is no obvious alternative to calculating patent damages using a royalty on the sale of the integrated product.[70] In theory, this doesn't present a problem;

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[65] These magnification effects are greatest if the patent litigation would take a large fraction of the time remaining in the patent lifetime. As the time required for litigation approaches the remaining patent lifetime, the circularity between the negotiated royalty rate and the level of reasonable royalties awarded by the court becomes complete.

[66] For example, Amy Landers documents the existence of a 25% "rule of thumb" among patent damages experts. Landers, *supra* note __, at [draft at 32].

[67] One major source of such data is www.royaltysource.com.

[68] S.E.C. Rule 10b5, 13 Fed. Reg. 8183 (Dec. 22, 1948), as amended at 16 Fed. Reg. 7928 (Aug. 11, 1951).

[69] For example, in Railroad Dynamics v. Stucki Co., 727 F.2d 1506 (Fed. Cir. 1984), the patented component of a rail freight car was sold separately, so while it was a component of the larger invention the court could set the royalty as a percentage of the separate sale.

[70] *See* Roger D. Blair & Thomas F. Cotter, **Intellectual Property: Economic and Legal Dimensions of Rights and Remedies** 215-17 (2005) (discussing the problems with apportionment and citing cases calculating reasonable royalty using the entire market value rule).

the fact finder will simply determine the portion of the value of the entire product that is attributable to the patentable component and reduce the royalty percentage accordingly.[71] In practice, however, things are more complicated. To begin, the "entire market value" rule will sometimes permit patentees to recover not just the value of the patented component but also other, unpatented components of the product to the extent that demand for the patented piece drove sales of the whole device.[72] This rule makes sense so long as it is in fact the patented component that is responsible for the value of the whole invention, i.e., if V really is such a significant portion of P that it is the cause of the consumer purchasing the product.[73] Unfortunately, courts have on occasion applied the entire market value rule outside that context, finding it sufficient that the patented component was functionally interrelated with other components and made a substantial contribution to the value of the whole invention.[74] This is the wrong standard, because it allows one patentee to capture the entire value of an invention that may also be subject to claims by other patentees or based on other input or investments made by the firm selling the product.[75]

Most component cases will have this characteristic; the value of the patent will be only a small part of the larger product. In order to determine the right proportion of the value, and therefore the right discount to the royalty rate in such a case, a court will have to determine what else is in the product besides the patented invention and how much those elements contribute to the value of the entire product.[76] Doing this might require, among other things, economic evidence or consumer surveys demonstrating how people value particular attributes of the product, along with evidence about substitutes for the patented component. Practically, it is not clear that parties have either the ability or the incentive to introduce evidence that *other* patented

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[71] For example, courts applying the *Westinghouse* standard discussed above did exactly that for many years.

[72] The leading case on the entire market value rule is *Rite Hite v. Kelley*, 56 F.3d 1538, 1548 (Fed. Cir. 1995). *See also* King Instruments v. Perego, 65 F.3d 941, 950 (Fed. Cir. 1995); Hem, Inc. v. Behringer Saws, Inc., 2003 WL 2321378 (N.D. Okla. 2003).

[73] Fonar Corp. v. General Electric Co., 107 F.3d 1543 (Fed. Cir. 1997) (entire market value rule should be applied only "when the patented feature is the basis for customer demand for the entire machine.").

[74] Bose Corp. v. JBL, Inc., 274 F.3d 1354 (Fed. Cir. 2001).

[75] The Federal Circuit acknowledged that royalty stacking may influence the hypothetical negotiation between the parties in *Integra Lifesciences I, Ltd. v. Merck KGaA*, 331 F.3d 860, 871-72 (Fed. Cir. 2003), *rev'd on other grounds* 125 S. Ct. 2372 (2005).

[76] Courts have on occasion engaged in such apportionment analysis, see Riles v. Shell Exploration & Prod. Co., 298 F.3d 1302, 1312 (Fed. Cir. 2003); Slimfold Mfg. v. Kinkead Indus., 932 F.2d 1453, 1458-59 (Fed. Cir. 1991); Procter & Gamble Co. v. Paragon Trade Brands, 989 F. Supp. 547, 612-13 (D. Del. 1997), but it is rare in modern damages case law.

Blair and Cotter argue for abandoning any effort to apportion damages in component industry cases, in favor of a slightly modified but-for causation test. Blair & Cotter, *supra* note __, at 232-34. While in theory a causation analysis done under perfect information would account for the contributions of components other than the patented one to the success of a product, we fear that eliminating any direct consideration of noninfringing components will make it even harder than it currently is to calculate the contribution of the patented invention accurately. A causation analysis would also result in distributional inequities, since only one patent could presumably be the cause of the success of the product. That patentee would capture the entire value of the product, and other patentees with lesser contributions would get nothing.

components contribute to a product's success. Certainly we rarely see such evidence introduced in actual cases. The patentee will not introduce such evidence, because it would only reduce their royalty rate. The accused infringer often will not introduce it, because that firm does not want to admit that it might be infringing other patented inventions. Even if the accused infringer tries to do so, courts do not want to admit such evidence, because it will require collateral litigation during the damages phase of the existence and value of parts of the product that are not covered by the patent at trial. In the absence of such evidence, it is reasonable to expect that the nominal ability of the law to adapt royalty rates to deal with multi-component products will be seriously hampered, and that royalty rates for component products will not be significantly smaller than for more traditional inventions. If juries never get to hear about the other things that contribute to the total value of the product, it is hardly surprising that they are willing to award a sizeable royalty rate for a patent on the one component they do learn about. We test that hypothesis in the next section.

The combination of all of these effects is to exacerbate the holdup problems we discussed in Parts I and II. Injunctive relief gives patent owners in component industries the ability to demand a disproportionate share of the value of the integrated product. The fact that there are many different patent owners multiplies the problem and leads to inefficiently high total prices. The fact that the patentees can obtain royalties that are greater than the value of their contribution to the product gives patentees still more bargaining leverage in settlement negotiations. It also means that solving the injunctive relief problem alone is not enough; problems in the calculation of damages can produce the same effect even without injunctive relief.

IV. Empirical Analysis of Royalty Stacking

In this section, we turn from theory to empirical evidence. We first document examples of the royalty stacking problem outside the litigation context, in the development of new technologies within a standard setting organization. We then examine how courts have actually determined reasonable royalties, and the extent to which existing legal measures are adequate to solve the royalty stacking problem.

A. Case Study: 3G Cellular Technology

Several standards are being developed for the next generation of cellular telephones. One important standard is 3GPP, www.3gpp.org, better known as WCDMA (Wideband Code Division Multiple Access), which involves descendants of GSM (Global Systems for Mobile Communications). A second important standard is 3GPP2, www.3gpp2.org, better known as CDMA2000, which involves descendants of CDMA.

Goodman and Myers have carefully studied the patent situation surrounding these standards.[77] They examined the patents and patent applications declared essential to 3G technology according

[77] David J. Goodman and Robert Myers, Proceedings of IEEE WirelessCom 2005, June 13, 2005, available at http://eeweb.poly.edu/dgoodman/wirelesscom2005.pdf.

to the web sites of the European Telecommunications Standards Institute (ETSI) and two Japanese standards organizations, ARIB and TTC.

For WCDMA, based on reporting at ETSI, they identified 6,872 essential patents issued prior to January 1, 2004. They reduce these to 732 "patent families," where the members of a family are patents obtained in different countries for a single invention. For CDMA2000, based on reporting at ARIB and TTC, they identified 924 essential patents issued prior to February 5, 2004. They reduce these to 527 patent families. Of these, there is an overlap of 327 patent families that apply to WCDMA and CDMA2000. The relevant patents are assigned to forty one different companies, with four companies owing the rights to three-quarters of these essential patents: Qualcomm, Ericsson, Nokia, and Motorola. ETSI's call not just for patents but for royalty rates at which the patentees would be willing to license those patents covering the standard that would be included in cell phones produced aggregate royalty rates of 130% of the total price of each phone![78]

The full scope of the problem is likely even worse than that. These data only include patents declared essential by companies participating in these SSOs. For example, Nortel has asserted to the U.S. Telecommunications Industry Association (TIA) that it has patents essential to CDMA2000, but has not listed its patents with the European and Japanese SSOs. Similarly, Lucent has not identified its essential patents. Nor does this list include patents that are essential to earlier standards (GSM, TDMA, CDMA) which also may be essential to WCDMA or CDMA2000. On the other hand, not all of these patents may in fact prove to be essential; some may just be commercially valuable and some may be commercially insignificant.[79]

B. Case Study: Wi-Fi

The IEEE 802.11 family of standards describe technology for wireless local area networking. This technology is generally known as Wi-Fi. Here we provide some information on patents claimed to be essential to Wi-Fi.

Our primary source of information on Wi-Fi comes from the IEEE 802.11 Working Group. In accordance with IEEE patent policy, the IEEE requests "patent assurance letters" from members. Such letters must indicate either that the member will not enforce any present or future patents required to implement the relevant standard, or that the member will license any such patents on reasonably, non-discriminatory terms. While there may exist holders of essential patents who do not participate in the IEEE standards process, these patent assurance letters provide an idea of

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[78] *See, e.g.*, Michael R. Franzinger, *Latent Dangers in a Patent Pool: The European Commission's Approval of the 3G Wireless Technology Licensing Agreements,* 91 **Cal. L. Rev.** 1693 (2003).

[79] Goodman and Myers report on a technical study by Fairchild Resources International of whether the claimed patents truly are essential in the narrow sense that "every element of at least one claim must be practiced in order to implement the standard." About 20% of the claimed essential patents were judged essential using this definition. The patents judged essential in this study are assigned to 20 companies, 19 for WCDMA and 13 CDMA2000, with 12 companies owning essential patents for both standards.

the minimum number of patents claimed to be essential to the 802.11 standard and the number of companies holding such patents.[80]

As of March 14, 2006, the following companies listed specific patents or patent applications in their letters of assurances: Agere Systems (at least 8), Aironet Wireless Communications (1), Apple Computer (2 or 3), AT&T (20), CSIRO, Cisco (at least 14), France Telecom (many), Golden Bridge Technology (2), Hitatchi (1), IBM (at least one), Intersil (at least 4), Japan Radio Co. (11), Nokia (at least 7), Norand (2), Proxim (3), Spectrix (1 or more), TDF (many), Toshiba (1), the University of California (3), and VDG. In addition, the following large companies have provided letters of assurance but have not listed specific patent numbers: AMD, Broadcom, Ericsson, KDD, Lucent, Motorola, NEC, Novell, Philips Semiconductors, Qualcomm, Samsung, Sanyo, Sharp, Symbol Technologies, and Texas Instruments.[81]

In addition to these companies, Speedus Corp. claims an essential patent (No. 5,949,793) relating to MIMO (multiple in, multiple out), a technology central to 802.11n.[82] According to Speedus: "We believe that it would be difficult for any wireless communications company to construct a system without using one or more of our patented technologies."[83]

Reportedly, there are 634 U.S. patent applications and 255 patents granted by the U.S. PTO regarding MIMO.[84]

There has been at least one concluded lawsuit involving the technology. In that case, Symbol Technologies was awarded a 6% royalty rate in a jury verdict on a single patent relating to the 802.11 standard.[85]

In an attempt to deal with the problem of patent stacking for 802.11 products, Via Licensing, a subsidiary of Dolby Laboratories, has been working to build a patent pool containing a number of patents that are essential to the 802.11 family of standards. In April 2005, Via Licensing announced that availability of a joint license essential patents held by France Telecom, Fujitsu, Japan Radio Company, LG Electronics, Philips Electronics, and Sony. The royalties for this license begin at $0.55 per licensed product for the first 500,000 units and step down steadily to $0.20 per unit for 10m to 20m units and $0.05 per unit for units above 40m per year.[86]

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[80] See http://standards.ieee.org/db/patents/pat802_11.html. Some of the patent assurance letters relate to 802.11 generally, but others are specific to parts 802.11a through 802.11w.

[81] We do not know how many patents, if any, these companies may assert as essential to the 802.11 standard. There are also more than a dozen smaller companies in this same category.

[82] See http://www.speedus.com/patents/.

[83] See http://www.speedus.com/business_activity.php.

[84] See WiMax, 802.11n Renew Patent Debate," http://www.wi-fiplanet.com/columns/article.php/3495951.

[85] Symbol Technologies v. Proxim, cite.

[86] See www.vialicensing.com/products/IEEE80211/standard.html for details. Via Licensing has created similar patent pools for Advanced Audio Coding, part of the MPEG-2 standard, and for the MPEG-4 Audio Standard. Via

C. Other Examples

These examples, while extreme, are by no means atypical of the multi-component nature of products, particularly in the information technology industries. To cite just two other examples, seven different companies hold 177 patents covering recordable DVD media.[87] And there may be as many as 4,000 patents covering aspects of radio-frequency identification devices (RFID chips).[88] In both cases there are efforts to build patent pools to aggregate the rights to produce these devices, as there has been in the WiFi case, though the RFID pool in particular has rights to only a small subset of the necessary patents. And because there is no requirement that a patent owner participate in such an organization, there is no way to guarantee that a pool will actually find and include all or even most of the patents covering a new technology.

The problem is even worse than these examples suggest. Each of the case studies we have identified in this paper involve technologies that are not themselves sold as products to customers. Rather, the technology at issue is itself but one component of a larger product. People don't buy WiFi capability or RFID chips; they buy computers or products with those features embedded in them. The true measure of the stacking problem must take all of these patents and add in all the other patents covering other components of the end product.

D. Empirical Analysis of Court-Ordered Royalties

Our second empirical study is an analysis of all the court decisions setting reasonable royalty rates. Our goal here is to determine the extent to which rates differ by industry or depending on whether the invention is part of a multi-component product. We use these data to get at least some sense of the extent to which the reasonable royalty rules in patent cases succeed in solving the component patenting problem by reducing the royalty rate granted to account for the contribution of other components of the product. We try to get at this question in two ways: directly, by classifying certain patents as covering a component rather than an entire system, and indirectly, by classifying patents by area of technology and noting that certain industries are much more likely to have component-based products than others.

We collected all the cases reported in Westlaw from 1982 through mid-2005 that actually awarded reasonable royalties to patentees.[89] The result is a surprisingly small number of cases – only 60. There are several reasons for this. First, while patent litigation has been growing in significance, relatively few patent cases go to trial every year – only about 100.[90] About 80% of

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Licensing studies a patent to confirm that it is essential to implementing the standard before including it in Via's licensing package.

[87] See http://www.dvd6cla.com.

[88] See Doug Lichtman, *Defensive Suspension in Standard-Setting Organizations* [draft at 8] (working paper 2006); Barnaby J. Feder, *Consortium to Pool Radio-Tag Patents*, **N.Y. Times**, Aug. 10, 2005, at C3.

[89] A description of the case research methodology is attached as Appendix B.

[90] Moore, *supra* note __, at 25.

patent cases settle,[91] and another 10-15% are resolved without trial, usually by finding non-infringement or invalidity.[92] Those settlements and pre-trial rejections of the patentee's claim are of course not included in our dataset. Second, in many of the cases that do go to trial, the patentee loses, either because the patent is held invalid[93] or unenforceable or because it is not infringed.[94] Third, many of the cases that the patentee wins are settled without a damages award, particularly if (as commonly happens) the judge bifurcates the damages trial from the liability trial. Fourth, in those cases that do result in a damages award, the damages award is frequently based on lost profits rather than a reasonable royalty, and is therefore excluded from our dataset. Indeed, lost-profits cases are overrepresented in the subset of cases that actually go to trial, because those cases involve a patent owner seeking to exclude a competitor from the market, a type of case that is significantly less likely to settle than cases in which a patentee seeks only a royalty. Significantly, in order to avoid biasing our dataset we also exclude from our dataset decisions that do not make it clear whether the basis for decision was lost profits or reasonable royalty. This further reduces the number of cases. Finally, we do not have any way of evaluating pure verdicts. Instead, our dataset is limited to the subset of cases in which a court has written an opinion disclosing the royalty awarded, either as part of a verdict in a bench trial, a JMOL ruling after a jury trial, or an appeals court decision reviewing a damages verdict. This last fact in particular creates an unavoidable bias away from jury verdicts and towards court opinions,[95] as well as causing cases that survive to appeal to be overrepresented in our database. It also results in some written decisions from which it is impossible to determine the royalty percentage, either because it is not mentioned or because it is awarded in dollars per unit and it is impossible to determine the price of the unit.[96] We exclude those cases as well.

The results are presented in Table 1.

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[91] Jay P. Kesan & Gwendolyn G. Ball, *How Are Patent Cases Resolved? An Empirical Examination of the Adjudication and Settlement of Patent Disputes*, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=808347 (working paper 2006). Kesan and Ball find approximately 80 cases a year that reflect judgments of infringement. *Id.* at 35. Many of those are preliminary rulings, however, with validity or enforceability still to be considered. Only between 30 and 50 cases a year resulted in damage awards. *Id*. at 36.

[92] *Id.* at __; William M. Landes, *An Empirical Analysis of Intellectual Property Litigation: Some Preliminary Results*, 41 **Hous. L. Rev.** 749, 761 (2004) (5.38% of patent cases go to trial).

[93] 46% of all patents litigated to judgment are held invalid. John R. Allison & Mark A. Lemley, *Empirical Evidence on the Validity of Litigated Patents*, 26 **AIPLA Q.J.** 185, 205 (1998). At trial the numbers are somewhat smaller, but still significant. *Id.* at __.

[94] For cases that go to trial, Kimberly Moore finds that 33% of those where validity is at issue are held invalid, 27% of those where enforceability is an issue are held unenforceable, and 35% of those where infringement is at issue are held not infringed. Moore, *supra* note __, at 390. Moore's numbers differ from Allison & Lemley's because Allison & Lemley tested all reported dispositions, including summary judgments and JMOLs, while Moore tested only trials, both reported and unreported.

[95] Indeed, only 8 of the 60 opinions in our dataset involve jury verdicts, a rate far less than the percentage of cases ultimately decided by the jury. Among those jury verdicts, the average royalty rate was 13.7%, virtually indistinguishable from the total average royalty rate across all cases. This provides at least some evidence that the skew away from jury awards may not significantly affect the findings in the paper.

Table 1

Summary Statistics for Royalty Rates

					Confidence Intervals for Mean					
	N	Mean	Median	Standard Deviation	90%		95%		99%	
All Cases	47	13.13	10.00	10.63	10.59	15.68	10.09	16.17	9.15	17.12
Product Category	29	14.71	10.00	12.17	11.00	18.41	10.28	19.14	8.90	20.52
Process Category	7	11.57	11.20	5.05	8.44	14.70	7.83	15.32	6.66	16.48
Component Category	11	9.98	10.00	8.32	5.86	14.09	5.06	14.90	3.53	16.43
Mechanics group ARR	29	15.55	15.00	11.39	12.08	19.01	11.40	19.69	10.11	20.98
Electronics/IT group ARR	8	6.49	6.47	4.65	3.79	9.19	3.27	9.72	2.26	10.72
Chem/bio group ARR	15	11.30	8.00	9.09	7.45	15.15	6.70	15.90	5.27	17.33
Acoustic ARR	1	15.00	15.00							
Automotive ARR	3	17.50	20.00							

[96] Where it is possible to calculate a royalty rate based on the contemporary sales price of the unit, we have done so and noted that fact in Appendix A.

Biotechnology ARR	2	9.60	9.60
Chemistry ARR	13	11.98	8.00
Communications ARR	1	5.94	5.94
Computer-Related ARR	2	5.50	5.50
Electronics ARR	2	7.50	7.50
Energy ARR	0		
Mechanical ARR	17	16.55	10.00
Medical Devices ARR	7	11.36	10.00
Optics ARR	2	10.00	10.00
Semiconductors ARR	2	8.25	8.25
Software ARR	1	1.00	1.00

The average royalty rate, granted in all reasonable royalty cases is 13.13% of the price of the infringing product. This number will strike many patent lawyers is surprisingly high; very few patent licenses negotiated without litigation (or even in settlement of it) result in royalty rates anywhere near that high.[97] We think this is an empirical verification of the probabilistic nature of patent rights we have discussed elsewhere.[98] The disparity in royalty rates it reflects the economic phenomena we discussed earlier, and particularly the operation of the assumption, when computing reasonable royalties, that the patent is valid and infringed.[99]

To get at the question of whether courts successfully discount royalty rates in percentage cases, we evaluated each patent to see whether the invention was directed to an entire product sold separately or to a single component of a larger integrated product. This exercise required substantial judgment. Relatively few patent claims expressly identify themselves as covering only a component of a larger product. Some are silent on the issue. Others are drafted as patents

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[97] Unfortunately, licenses are generally confidential, and there is no reliable source for average royalty rates. *See supra* notes __-__ and accompanying text. One estimate from the Licensing Economics Review found an average royalty rate of 6.7%, less than half the litigation rate. *Industry Royalty Rate Data Summary*, **Lic. Econ. Rev.**, Dec. 2005, at 6. Because that data was based on calculations from publicly available license agreements, it is likely significantly higher than the actual royalty averages, for reasons we have explained.

[98] Mark A. Lemley & Carl Shapiro, *Probabilistic Patents*, 19 **J. Econ. Perspectives** 75 (2005).

[99] It also demonstrates that the circularity we identified above is not complete, just as our model predicts.

covering an entire system, but the point of novelty is limited to a particular component in an otherwise old system. We have classed these claims as component inventions, to avoid the artificial distinctions that would otherwise be drawn based on the way a claim is drafted.[100] And we have included as components only those products whose royalty base was calculated as a part of the larger product, excluding those that were sold separately, since many of the royalty problems we discuss in this paper shouldn't come up if the product is sold separately.

As Table 1 indicates, fact finders do in fact grant somewhat lower royalty rates for component inventions. The royalty rate for components is approximately 10%, compared with 13.1% for all inventions and 14.7% for integrated product claims. But the difference is fairly modest. To see just how modest, consider that the reduction in royalty rate for component inventions is equivalent to a conclusion that there are on average less than 1.5 components in a multi-component invention. Obviously, this does not reflect commercial reality, at least in the telecommunications and computer industries. Even if each of the litigated component inventions was part of a simple two-component product, we should expect to see a more significant reduction in the royalty rate if the system were working as intended.[101] And since we know that many of the component cases involve many different inventive contributions to the product in the royalty base, it is reasonable to conclude that the legal doctrines designed to make the reasonable royalty track the actual value of the patented contribution are not working, at least not fully.

We also divided our dataset by industry category, on the theory that this might provide another way to analyze the problem. If, as commonly believed, component inventions are ubiquitous in the electronics and information technology industries and uncommon in chemistry and the life sciences, royalty rates should be significantly greater in the latter industries if the damages system were equilibrating well.

We first categorized the royalty awards into the fourteen industry categories created by Allison and Lemley.[102] Those categories are more useful than industry divisions based on the PTO

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[100] This issue has proven controversial in patent reform. In the fall of 2005, two competing drafts of a bill designed to deal with the problem of component inventions were circulated. Substitute HR 2795 addressed the problem by requiring courts to determine the value of the "inventive component" of the product. An alternative print offered by the life sciences industries made a seemingly small change, from "inventive component" to "component of the claimed invention." Unfortunately, this change could have the unfortunate consequence of allowing patentees to manipulate their damages by changing the way they claim their invention. For example, the inventor of the intermittent windshield wiper could claim the wiper alone, or alternatively could choose to claim a car including an intermittent windshield wiper. The invention is the same, and the patentee shouldn't be able to capture more money by phrasing the claim in the second way than the first. But the pharmaceutical draft may produce just such an effect, since the "claimed invention" is literally the whole car and not just the windshield wiper. To avoid this formalism, we have evaluated each claim in order to identify the inventive component.

[101] While it is conceivable that this modest reduction reflects a considered conclusion that the patented component is the most significant contributor to patent value in each case, overwhelming the contribution of all other components, we are skeptical that this is in fact true. That result seems particularly implausible given that in many cases several different components of the same product are patented.

[102] John R. Allison & Mark A. Lemley, *Who's Patenting What? An Empirical Exploration of Patent Prosecution*, 53 **Vand. L. Rev.** 2099 (2000).

classification system, since Allison and Lemley have shown that that classification system contains significant errors. Unfortunately, the small number of cases in our study makes it impossible to draw any statistically significant conclusions once we've divided the patents this finely. As an alternative, we also categorized the royalty decisions into the broad PTO categories of mechanical, chemical, and electrical inventions. We do find statistically significant differences in the royalty rates granted in those industries. Electronics (including information technology) inventions have the lowest average royalty rate (6.5%), less than half of the overall average. Interestingly, chemical and biotechnological inventions are also below the mean, with an average royalty rate of only 11.3%. It is mechanical inventions that are awarded the highest royalty rate, 15.6% on average. While we urge some caution in interpreting these data – the large-scale PTO categories concatenate a number of very different industries – they do suggest that the industries in which the multi-component products are most common also have the lowest average royalty rate. As with the direct analysis of component technologies, the differences are somewhat modest, here representing an average of only two components in any given product.

The litigation data, then, suggest that the reasonable royalty rules do in fact accommodate component products, but only to a limited extent. It seems highly unlikely that this accommodation fully solves the problems we identified earlier both theoretically and empirically. In particular, the high absolute royalty rates and the modest differences between component and non-component inventions suggest that problems associated with hold-up and royalty stacking have not been completely solved by existing legal rules. Indeed, to put some perspective on this issue, consider that the average profit margin across all industries for the past 25 years is 8.3%.[103] Even the "low" royalty rates on components or in the electronics industries are sufficiently high that paying royalties for one patent can capture essentially all the expected profit from the product.[104]

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[103] Vitaliy Katsenelson, *The Profit Margin Paradigm,* **The Motley Fool**, Mar. 1, 2006 (available at http://www.fool.com).

[104] While it is of course the case that profit margins vary by industry, there is no reason to believe they are systematically higher in the IT or other component industries. To take just one example, from 2002, see http://www.industryweek.com/ReadArticle.aspx?ArticleID=1086&SectionID=40:

> **Electronics/electrical equipment.** GE, the industry's revenue leader, also was among the best in profit margin with 11.3%. The industry's next revenue leader, Siemens AG, No. 13 in the **IW 1000**, had a profit margin of 2.4%. Hitachi Ltd., No. 16, had 1.2%. The industry's best profit margin was posted by United Microelectronics Corp. of Taiwan. The company, No. 551 in the **IW 1000**, showed a profit margin of 44.7% on revenues of $3.2 billion. United Microelectronics is a leading contract manufacturer of semiconductors, and has alliances and joint ventures with such other **IW 1000** stalwarts as IBM Corp. and Infineon Technologies AG.

One shouldn't take this too far. Other subsets of the IT industry, notably software, may have substantially higher profit margins. And profits on individual products aren't the same as overall corporate profits, but of course corporate profits are simply the aggregate of profits on individual products less general expenses.

V. Policy Recommendations

A. Limiting Injunctive Relief

We have emphasized the hold-up power that patent owners enjoy because of the threat that they will obtain injunctions. While we strongly believe that the threat of hold-up gives excessive bargaining power to patent holders, especially in component industries, we agree that the presumptive right to injunctive relief is an important part of the patent law, and that in most cases there will be no question as to the patentee's entitlement to such relief.

To begin, equity warrants an injunction absent extraordinary circumstances if the patentee practices the patent in competition with the accused infringer. Even if the patentee doesn't sell the patented product, if it sells a different product in the same market, equity should entitle it to an injunction to prevent an infringer from competing with the product it does sell. Similarly, if patentees assign or exclusively license the patent to someone who competes in the marketplace, they should also be entitled to injunctive relief under normal circumstances. And even if the patentee hasn't done these things in the past, if it is actively engaged in research and development and preparing to do so in the future equity might well support injunctive relief. Patentees also ought to be entitled to an injunction in cases where the defendant copies the idea from the patentee, even if the patentee is not participating in the market and has no plans to do so. Infringers shouldn't be able to copy an invention from the patentee, knowing that if they are caught they will still only have to pay a royalty. Even if none of these things are true, some injunctions won't lead to a risk of holdup, and so even patentees who don't meet any of the criteria listed above will often be entitled to an injunction. This is the virtue of equitable discretion – courts can grant injunctions when they are warranted, without being bound to grant them when they create more problems than they solve.

To date, the Federal Circuit has effectively mandated injunctive relief for patent infringement, without consideration of whether the patentee needs an injunction or the hardship that an injunction against a base product might impose on a defendant. But the Supreme Court has recently held in *eBay, Inc. v. MercExchange LLC* that district courts have the power to deny injunctions in appropriate cases,[105] and Congress is also considering emphasizing the discretion the statute gives to district courts to deny injunctive relief. We think that one circumstance in which courts should consider denying injunctive relief – or at a minimum delaying it – is when the product that would be enjoined contains multiple components, of which only one is the subject of the patent suit.

An additional prerequisite for denying injunctive relief should be that the defendant developed the technology independently rather than copying it from the plaintiff. While the goal of patent remedies should be to align the plaintiff's recovery with the actual value of its technical contribution, there is some risk that limiting damages and injunctive relief could encourage unscrupulous companies to steal another's technology, reasoning that if they are caught they will only have to pay ex post what they would have had to pay ex ante for a license (plus

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[105] eBay, Inc. v. MercExchange LLC, __ U.S. __ (May 15, 2006).

considerable litigation costs).[106] Under current law the willfulness doctrine serves to deter such conduct, but it has sufficient problems that patent reformers may well modify or even eliminate it.[107] Most notably, an infringement can be deemed willful under current law even if the defendant developed it independently and without knowledge of the plaintiff's patent.

Our preferred solution to hold-up in cases where the patent holders claims are based on reasonable royalties is for the courts to issue stays of their permanent injunctions. The infringing party would, of course, be required to pay reasonable royalties to the patent holder for any sales made during the period of the stay. In most cases, the reasonable royalty rate would need to be determined in any event to calculate the damages owed by the infringing firm to the patent holder, so this would not impose any extra burden on the court or the parties. The stay should only be long enough to enable the infringing party a reasonable opportunity to design its product to remove the patented feature, assuming they are able to do so.

With such stays, hold-up based on the disparity between the relatively large value of the patented product and the relatively small value associated with the patented feature is eliminated.[108] Hold-up based on the need for the downstream firm to redesign its product early, and thus incur the redesign costs even if the patent would be proven invalid, is also eliminated. The net result is that the gap between the negotiated royalty rate and the benchmark level reflecting the true value contributed by the patent holder is reduced. This is efficient, favorable for consumers, and still gives the patent holder a return at least as large as is warranted based on the patent holder's actual contributions to the product.

We recognize that issuing such stays will reduce the incentives of patent defendants to redesign their products while patent litigation is pending. We consider this a plus. Such redesign costs will prove entirely wasteful in the patent is later proven invalid, so avoid them is socially desirable, especially in cases involving weak patents, where the likelihood is high that these redesign costs will indeed prove to be wasteful. It is true that stays will allow the infringing party to keep infringing for some period of time after the patent is found valid and infringed, but we do not see this as terribly unfair to the patent holder, since the infringing party will owe reasonable royalties for those infringing sales, so any adverse impact on the patent holder is no greater than the impact caused by the infringement during the pendency of litigation.

As we emphasized above, a patentee's ability to obtain an injunction against an entire product on the basis of infringement of a single component in that product tends to drive negotiated royalty rates higher than would be warranted by the inventive contribution of the patent. As long as that hold-up problem remains, changing the damages calculation rules will be at best only a partial

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[106] *See* Fromson v. Western Litho Plate & Suply Co., 853 F.2d 1568, 1574-76 (Fed. Cir. 1988) (stating this objection in detail, but seeming to draw from it the conclusion that reasonable royalty rates should themselves be enhanced); Panduit Corp. v. Stahlin Bros. Fibre Works, 575 F.2d 1152 (6th Cir. 1978) (same).

[107] *See, e.g.*, H.R. 2795 (proposing to impose significant limits on the use of the doctrine); Mark A. Lemley & Ragesh K. Tangri, *Ending Patent Law's Willfulness Game*, 18 **Berkeley Tech. L.J.** 1085 (2003) (discussing these problems and proposing limits on the willfulness doctrine short of abolition).

[108] Shapiro explores this impact of stays in the formal model.

solution to the royalty stacking problem. Limiting patentees in component industries to recovery based on the value of their contribution will require not just damages reform, but vesting in the courts at least some power to deny or limit injunctive relief in component cases.

B. Design-Around Alternatives

The danger that reasonable royalties will be set too high in component cases will be sharply reduced if the courts base their estimates of "reasonable royalties" on an assessment the value of the patented component *in comparison with the next best, non-infringing alternative way to create that component*. After all, even if the component in question is valued highly by consumers, the patent holder's contribution may still be very modest if there are other, non-infringing ways to make a non-infringing version of the product that are equally good or nearly as good. The benchmark rate for reasonable royalties depends predominantly on the value of the patented component compared with the next best alternative.[109]

In our analysis above, the price and margin earned on the product as a whole were irrelevant to valuing the patented feature. In theory, the price and margin earned on the product as a whole could be relevant in valuing the patented feature, but only to the extent that the patented feature (compared with the best non-infringing alternative) adds to the unit sales of the product as a whole. This is presumably a second-order effect for all minor components of a complex product, and even for major components if there exists a nearly equivalent non-infringing way of making that component.

In lost profits cases, patent damages have long been constrained by the availability of non-infringing alternatives.[110] Surprisingly, however, the use of non-infringing design-arounds to set royalty rates is less clearly established in the reasonable royalty context.[111] But the existence of such a non-infringing alternative should absolutely constrain a reasonable royalty for a patented feature of component, just as it does in a lost profits award. Indeed, if the courts do not permit the use of design-arounds in reasonable royalty cases, they risk creating the anomalous result that the reasonable royalty "floor" is higher than the actual lost profits from infringement. We strongly encourage the courts to consider non-infringing design-around solutions when valuing patented features or components for the purpose of establishing reasonable royalties. In particular, the Federal Circuit should make it clear that a significant factor influencing the royalty rate a plaintiff could charge is the presence or absence of non-infringing alternatives.

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[109] Of course, the next-best alternative may be patented too. The proper comparison is between the cost and value of the patentee's component and the cost and value of the alternative.

[110] Grain Processing Corp. v. American Maize Prods. Co., 185 F.3d 1341 (Fed. Cir. 1999).

[111] One case that seems to permit such a use is Riles v. Shell Exploration & Prod. Co., 298 F.3d 1302, 1313 (Fed. Cir. 2002). The court there held: "Shell also urges that a reasonable royalty may not exceed the cost savings between its proposed non-infringing alternative installation and the patented method. . . . Upon remand, the district court is free to entertain additional evidence by the parties on this fact issue in its re-determination of the damages award. The trial court may also consider any other evidence about non-infringing alternatives." *Id.*

C. Consideration of Unpatented Components

A key step in solving the royalty stacking problem in patent damages is to ensure that the fact finder has the information necessary to assess the contribution of a component invention in the context of the value of the entire product claimed in the royalty base. In theory, *Georgia Pacific* permits this assessment now in its factor 13, though it does not expressly require it.[112] Congress is considering amending the patent damages statute to expressly require courts faced with component inventions to consider the importance of other components of the product sold that are not covered by the patent at issue.[113] We support such an amendment because it will emphasize to judges and juries that the royalty rate must be based not just on the value of the invention in the abstract, but what it contributes in the context of the other elements of the accused product. Even if it does not pass, courts have and should exercise the power to consider those components under existing law.

Cementing in the law the obligation to consider other parts of a multi-component invention is only the first step, however. Courts must also figure out ways to consider the value of those other contributions without unduly disrupting the trial, or else it will remain a "meaningless inquiry."[114] As an initial matter, we think that defendants in such cases should be entitled to introduce evidence about prior judgments or licenses covering other attributes of the same product. If a product has a profit margin of 10%, a jury deciding the royalty rate to award on one component of that product is entitled to know that another court has already required the same defendant to pay 6% of the sales price (that is, 60% of the profits) to license another component of the product. Similarly, if the defendant has taken royalty-bearing licenses to other components without litigation, it should be entitled to introduce that evidence as well.

But prior judgments involving the same product will show up only rarely, since most cases settle.[115] Even prior licensing deals outside of litigation won't provide a complete picture of the total economic costs a defendant faces or the actual contribution of the patented invention. First, and most obviously, it will work perfectly only for the *last* patent to be asserted against a product. The first time someone asserts a patent against a particular product, there will be no such prior record. Second, licensing deals often involve terms other than pure royalty payments. They may require a lump-sum payment instead of or in addition to a royalty rate. They may involve a business transaction in which products change hands, or even mergers or acquisitions. And many patent licenses involve multiple patents licensed for different products, and often running in both directions (a "cross-license"). All of these licenses involve economic costs to the licensee, but they will not all be transparent to a jury. Finally, admitting evidence of payments to outside parties works only for the components of the base product that are actually acquired from

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[112] *See also* Paymaster Techs. v. United States, 61 Fed. Cl. 593, 913 (Ct. Cl. 2004) ("[w]hen considering the reasonable royalty of the accused device, the stacked royalty of other patents involved must also be considered.").

[113] Substitute HR 2795.

[114] Blair & Cotter, *supra* note __, at 215.

[115] *See* Landes, *supra* note __, at 769.

outside, and doesn't account for the large portion of the technology that is likely to have been contributed by the defendant itself.

An alternative to a focus on the costs of non-covered components is to focus on the value of those components to buyers. This is clearly correct in principle; the benchmark we advocate above was determine entirely by the value to buyers of the patented component and did not depend at all upon the value contributed by other components or by the firm selling the infringing product. Focusing on the value of the patented component or feature is consistent with the goal of *Georgia Pacific* and with the entire market value rule, which allows patentees to capture royalties on a full product only where the patented component is the driving force behind the larger product. But actually implementing that rule requires courts to employ metrics for determining the share of value attributable to the patent. At a minimum, courts should consider technical expert testimony on the contribution the patented component makes to the product. But we think courts should go further, permitting survey evidence of customers about the reason they purchase the product and the attributes of that product they find useful.[116] Courts have significant experience with evaluating such survey evidence in the trademark context, and have done a good job of weeding out biased or misleading surveys.[117]

D. Facilitating Private Aggregation of Royalty Rates

While it is possible to change legal rules in ways that reduce the royalty stacking problem in court, doing so only indirectly addresses the vast majority of royalty stacking problems that come up outside the trial context.[118] One way to address those issues is to permit or even facilitate private aggregation of royalty rates for component products. Parties negotiating royalty rates for a patent covering a component of a product rationally ought to take into account of the value of the patented contribution, the value of other contributions (both from within the company and from other patent owners), and the cost of manufacturing the product. The resulting royalty agreement might be complex. Perhaps the producer could set a total cap on the rates patent licensors could charge, with the result that the royalty rate paid to each one would actually decline as other patent owners asserted rights in the product, reducing the relative contribution of each patentee. Or if that were implausible, producers might negotiate a "step-down" royalty, paying each new claimant a declining percentage to reflect the claims already made against the product.[119]

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[116] At least one court has admitted such evidence. *See* Applera Corp. v. MJ Research, 2004 WL 914253 (D. Conn. Mar. 11, 2004).

[117] On the sophistication of surveys in trademark law, see J. Thomas McCarthy, **Trademarks and Unfair Competition** §__ (5th ed. 2003).

[118] That is not to say damages reform would have no effect on cases not litigated to judgment. As we noted *supra* notes __-__ and accompanying text, the royalties set in private licensing negotiations are driven in significant part by the results a patentee could obtain if they went to trial. So changing those remedies will affect negotiated royalty rates.

[119] For a brief discussion of how such a step-down system might work, as well as other alternatives, see Mark A. Lemley, *Ten Things To Do About Patent Holdup of Standards (and One Not To)*, __ **B.C. L. Rev.** __ (forthcoming 2006).

Individual companies are free to negotiate something of this sort today. But they rarely do. One problem is that private solutions only affect those who choose to participate in the private ordering scheme, and patent owners have incentives not to do so. In some cases, cross-licenses and patent pools will help, but the private solutions are unlikely to be very valuable in dealing with patent owners who are not producers. Those patent owners naturally want more. This reflects the underlying tensions and externalities associated with the problem of Cournot Complements. And since as we have seen the law gives patent holders a shot at a share of profits from the product out of proportion to their contribution, there is no reason they would agree to such an arrangement under the current law. But if we solve that problem – if we align patent remedies with the contribution of the patented invention, rather than permitting patentees to capture more – the bargaining power will at least shift in a direction that reduces the inherent Cournot Complements problem that arises in the presence of multiple patents.

Patents that cover industry standards pose an even more difficult problem. When competitors in an industry get together to discuss the products they will produce, for example in a standard-setting organization (SSO), antitrust concerns naturally arise.[120] Those concerns are only heightened when participants in the organization must discuss the price of a patent license. Indeed, many SSOs refuse even to permit discussions of royalty rates for fear of antitrust concerns, relying instead on a vague promise to license under "reasonable and nondiscriminatory" terms.[121] And no SSO we are aware of has tried to implement a royalty cap or a step-down royalty system, which raise even more antitrust flags since they involve not only discussion of but agreement on price.

Obviously, SSOs cannot make an informed decision as to the costs and benefits of a patented technology if they do not know how much it costs to implement. And unless everyone who owns a patent covering a particular technology is a participant in the SSO, even disclosures of license prices by SSO members will not suffice to give a true picture of the cost of licensing all the rights needed for that technology. Antitrust law should permit SSOs at a minimum to determine what participants own patents covering a standard and what licensing terms they are offering for those patents. And in some circumstances, antitrust law it should go further, permitting groups to collectively negotiate royalty rates. Such negotiations are very likely to be pro-competitive if the technology would otherwise be so encumbered by patent rights and blocking positions that the standard would have difficulty moving forward in the market.

E. Patent Quality and Post-Grant Opposition

Our analysis is a reminder of the economic costs associated with improperly issued patents. Improving patent quality will reduce many of the costs identified here that are associated with weak patents, hold-up, and the threat of injunctions, simply because it will remove some of the patents that impose those costs. Improved post-grant opposition procedures will help as well, at

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[120] For a general discussion of antitrust issues in standard-setting, see 2 **Herbert Hovenkamp et al., IP and Antitrust** ch. 35 (2006 ed); Mark A. Lemley, *Intellectual Property Rights and Standard-Setting Organizations*, 90 **Calif. L. Rev.** 1889 (2002).

[121] Lemley, *supra* note __, at 1965 & n.320 (citing the example of IEEE).

least to the extent that they prevent weak patents covering commercially important technologies from remaining in force to the point when they can be used to threaten downstream firms with the risk of an injunction. But it is important to recognize that no contemplated patent quality reform will entirely eliminate the uncertainty associated with patent validity or the problem of royalty stacking, and therefore that patent quality reform alone cannot solve the holdup and stacking problems we have identified.

VI. Conclusion

Patents are important to innovation. But in industries that are overly clogged with patents, they can also impede it. The goal of patent policy should be to ensure that patentees can get paid for their technology, but that what they get paid bears some reasonable relationship to what they actually contributed. Both our bargaining model and our empirical investigation demonstrate that under current law patentees whose inventions are only one component of a larger product are systematically overcompensated.

The "reasonable royalty" floor for patent damages is designed to compensate a patent owner for losses it sustained as a result of infringement, not to punish or deter infringement or even to deprive an efficient infringer of all of the profits from that infringement.[122] But the way the reasonable royalty is calculated, particularly for component inventions, has made it into a tool for patentees to capture more than their fair share of a defendant's product. Realigning the reasonable royalty calculation with its intended purpose – compensation of patent owners – will go a long way towards reducing the incentives of patent plaintiffs to engage in opportunistic holdup.

To be effective, though, damages reform must be coupled with a solution to the holdup problems created by injunctive relief. Our model suggests that holdup problems in patent cases are quite significant, but that a relatively simple step – a stay of injunctive relief sufficient to allow the infringer to design around the patent if it can – would significantly reduce that problem as well. The Supreme Court's recent decision in *eBay, Inc. v. MercExchange* also promises to help solve holdup problems by making permanent injunctions less routine or automatic, but it is too soon to say just what its impact will be. These reforms will help to rebalance the patent system and ensure that it enhances rather than impedes innovation in component industries, including the information technology sector of the economy.

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[122] *See* Roger D. Blair & Thomas F. Cotter, **Intellectual Property: Economic and Legal Dimensions of Rights and Remedies** 12 (2005) (noting this fact, but questioning whether it makes sense).

Appendix

Royalty Stacking with Linear Demand

Suppose that the downstream firm faces demand $X = A+V-P$ where X is its output level and p is its price, which is set by the downstream firm. The parameter A reflects the value of the product if none of the patented features are included. The variable V represents the value added to the product by the patented features at issue. The downstream firm's marginal cost, before accounting for any patent royalties, equals C.

Patentee i owns patent i which covers a feature that adds value v_i to the product. There are N patent holders and $V = \sum_{i=1}^{N} v_i$. We assume that the product has already been designed to include all N features.

The analysis in this Appendix applies in situations where the binding constraint on the royalty rates set by the various patent owners arises from the reduction in output associated with higher royalty rates. The analysis here does *not* apply if the binding constraint on each patent holder arises from the downstream firm's threat to redesign its product or litigate the patent. In this important sense, the calculations here complement those in Shapiro (2006b).

One benchmark is the first-best outcome *ex post.* This involves a downstream price that equals marginal cost, C, which implies an output level of

$$X^F = A+V-C\,.$$

A second benchmark is the output that would be produced by an integrated firm controlling all N patents. This firm would have some market power, maximizing $(P-C)(A+V-P)$, which implies a price of $P^I = [A+V+C]/2$ and an output of

$$X^I = [A+V-C]/2 = X^F/2\,,$$

where the superscript "I" here stands for "integrated." As is well known, with linear demand and constant marginal cost, a monopolist produces half of the first-best output level.

Our third benchmark arises if a single firm controls all N patents but is *not* integrated downstream and instead sets a simple, uniform price, i.e., uses linear running royalties. If the single patent holder were to charge a combined royalty rate of R, and if the downstream firm were willing to pay this royalty rather than redesign its product or litigate, then the downstream firm would maximize $(P-C-R)(A+V-P)$, which would lead to a downstream price of $P(R) = [A+V+C+R]/2$ and a corresponding quantity of $X(R) = A+V-P(R) = [(A+V)-(C+R)]/2$. The patent holder in this circumstance sets R to

maximize $RX(R)$ which implies a combined royalty rate of $R^D = (A+V-C)/2$ and an output level of

$$X^D = X(R^D) = (A+V-C)/4 = X^I/2 = X^F/4,$$

where the superscript "D" here stands for "double marginalization." As is well known, with linear demand and constant marginal cost, double marginalization leads to an output level half as large as would be produced by the integrated monopolist.

We are now ready to consider the royalty-setting game among non-integrated patent holders. We model this game as a simultaneous-move royalty-setting game, which is the standard treatment of Cournot complements.[123] Call patentee *i*'s royalty rate r_i, and the aggregate, or "stacked" royalty rate $R \equiv \sum_{i=1}^{N} r_i$. As noted above, if the downstream firm pays an aggregate royalty rate of *R* rather than litigating, the downstream firm would then set price $P(R) = [A+V+C+R]/2$ and produce $X(R) = A+V-P(R) = [(A+V)-(C+R)]/2$ units of output.

Patentee *i* sets r_i to maximize $r_i X(R) = r_i[(A+V)-(C+R)]/2$. The first-order condition for r_i is given by $(A+V)-(C+R)-r_i = 0$. For simplicity, we now impose symmetry, so $v_i = v$ for all *i* and $V = Nv$. In a symmetric equilibrium, $r_i = r$ for all *i*, and we must have $R = Nr$. Therefore, so the first-order condition for r_i becomes $(A+V)-(C+Nr) = r$, which implies that $r = (A+V-C)/(N+1)$, so the combined or "stacked" royalty rate equals $R^S = N(A+V-C)/(N+1)$. The corresponding output level is

$$X^S = \frac{A+V-C}{2(N+1)} = \frac{2}{N+1} X^D.$$

Of course, if there is only one patent, $N=1$, then there is only one patent holder, and this output level is the same as arises under double marginalization. With more patents, however, output falls, and $X^S < X^D$. For example, with three patent holders, $N=3$, then $X^S = X^D/2$. In general, the theory of Cournot complements tells us that output falls as the number of patent holders rises, for a given level of *V*. In this particular model, output shrinks towards zero as the number of patent holders grows large. However, as noted in the text, for sufficiently large *N*, the downstream firm will not be able to recover the fixed costs it must incur to develop the product, so the entire market will be ruined if hold-up and royalty stacking are anticipated.

Readers may wonder how royalty stacking can cause such severe problems given that each patent holder, by assumption, contributes valuable technology: each individual patent adds value

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[123] See, for example, Carl Shapiro, "Theories of Oligopoly Behavior," p.339, in *Handbook of Industrial Organization*, R. Schmalensee and R. Willig, eds., Elsevier Science Publishers, 1989.

v to the product, for a combined value of *V*. Output cannot fall below the level that would arise without these contributions if each patent holder is limited to charging no more than the value of its technology, i.e., if $r_i \le v_i$ for all *i*.[124] However, in the presence of hold-up and opportunism, there is no reason that the constraint $r_i \le v_i$ must hold, if redesign costs are significant.

In fact, in the model used above, each patent holder sets a royalty rate of $r = R^S / N = (A+V-C)/(N+1)$. Substituting $V = Nv$, we get $r = (A+Nv-C)/(N+1)$, which can easily exceed *v*. Indeed, we will get $r > v$ if and only if $A-C > v$, a relatively weak condition, which only requires that the demand intercept for a non-infringing product, $A-C$, exceeds the value of each patent holder's contribution. This condition is easily met if there are many patents covering minor features of the product, so *v* is small.

[124] If the constraint $r_i \le v_i$ applies for all *i*, then the downstream firm must find it optimal to produce as least as much output as it would if it were simply producing a non-infringing product, for which demand is given by $X = A-P$. In that case, output must be at least $(A-C)/2$.