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**Profit Neutrality in Licensing:
The Boundary Between Antitrust Law and Patent Law**

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Abstract

From the antitrust case law that governs restrictions on patent licenses, we derive three unifying principles: just reward, profit neutrality and minimalism. The just-reward principle holds that the patentholder's profits should be earned, if at all, from the social value created by his invention. Profit neutrality holds that patent rewards should not depend on the rightholder's ability to work the patent himself. Minimalism holds that licensing contracts should not use more restrictive terms than required for neutrality. We discuss how these principles determine which patent license restrictions should and should not be acceptable from an antitrust perspective. We also compare these principles and the per se rules that follow from them to the potential benefits and drawbacks likely to be encountered under a rule of reason approach.

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1. Introduction

Patent law and antitrust concerns were born side by side. The Statute of Monopolies (1623) banned any monopoly or letters patent “for the sole Buying, Selling, Making, Working or Using of any Thing within this Realm,” but made an explicit exception for patents on inventions. Modern antitrust policy follows the general prohibition of monopolies while modern patent law descends from the exception. For most of the 20th century, the dividing line between these two bodies of law has been controversial. The basic problem is that having the exclusive right to make, use, or sell an invention may not be worth much unless the inventor can exercise it in concert with others through licenses and agreements. When, if ever, should licensing run afoul of the antitrust laws?¹

Antitrust policy in the U.S. is largely governed by “rule of reason.” Under rule of reason, courts make a case-by-case determination of whether harm to competition is outweighed by the efficiency benefits of the business practice or transaction in question. Rule of reason balances different types of harm to consumers. In the patents context, harm to consumers can arise because the incentive to innovate is stifled *ex ante* or because prices are too high *ex post*. Courts currently follow a rule-of-reason approach for a wide variety of license restrictions (Weinschel 2000 at 2:90).

In contrast to the rule-of-reason approach, U.S. courts have sometimes exempted certain licensing restrictions from antitrust scrutiny altogether. Modern case law starts with the Supreme Court’s 1926 opinion in *U.S. v. General Electric*, which held that a patentholder can fix its licensee’s price, even if such price fixing would be illegal absent the patent. Courts have also upheld other restrictions, such as restricting the licensee to certain customers (*General Talking Pictures* 1938; Schlicher 2002, 11:193) or certain geographic markets (Hovenkamp, Janis & Lemley 2004, at

¹License restrictions can be challenged under several legal theories including (a) “restraint of trade” under the antitrust laws and/or (b) “misuse” amounting to a defense to infringement under the patent laws (*Morton Salt* 1942). Historically, some licenses have been acceptable under one standard but not the other. Nothing in the present paper turns on these distinctions and we ignore them in what follows.

33:18). On the other hand, the *General Electric* rule does not extend to all possible transactions. For example, the “first sale” doctrine says that the *General Electric* exemption is only available for the first transaction where the owner receives value for his patented good (*Malinckrodt* 1990). Similarly, the “tying” doctrine (*Morton Salt* 1942) says that *General Electric* immunity does not apply to contracts that restrict unpatented items, even where those items are inputs for using the patented technology. Finally, price-setting immunity does not apply where the real purpose of the restriction is to cartelize a separate market (*Ethyl* 1940).

The *General Electric* case has remained intensely controversial throughout its long history. The U.S. Supreme Court came within a single vote of overturning it in 1947 and again in 1964. Had it done so, all license restrictions would now be judged under rule of reason, as the U.S. Department of Justice and legal commentators have advocated more or less continuously since *General Electric* was adopted (Hovenkamp, et. al., 2004, at 31:22,29-31,35-36). While opposition has not yet caused *General Electric* to be overturned, courts have been reluctant to extend the price-fixing exception beyond its original facts.² Some commentators argue that these limitations have reduced *General Electric* to a “vestige” and advise practitioners that it is not “prudent” to rely on the case (Weinschel 2000, at 2:47).

We know of no legal or economic theory that unifies these disparate decisions about restrictive terms in licenses. To the contrary, a leading legal commentator, Chisum (2001), explains that “from the decisions, it is clear that the courts lack a clear and general theory for resolving this inquiry. Thus, individual problems are resolved in a piecemeal fashion, and it is difficult to harmonize decisions in one area (such as

²For example, *General Electric* may not apply to the unpatented product of a patented machine (Weinschel 2000 at 2:46, 2:95-96; Hovenkamp, et. al., 2004, at 31:27-29), to patentholders with multiple licensees (Weinschel 2000, 2:107 & n. 19; Hovenkamp, et. al., 2004, at 31:817-18), to patentholders who do not manufacture the patented item (Schlicher 2002 11:179; Hovenkamp, et. al., 2004, at 31:20; *Royal Industries* 1969), to licenses that are said to “predominantly benefit” licensees rather than the patentholder (Weinschel 2000, 2:107; *Ethyl* 1940), to licenses where the patent does not “completely cover” the product (Schlicher 2002 11:179; Hovenkamp, et. al., 2004, at 31:25), to patentholders who acquire their rights by purchase rather than internal R&D (Hovenkamp, et. al., 2004, at 31:19), or to intellectual property rights other than patents (Hovenkamp, et. al., 2004, at 31:30-35; *Interstate Circuit* 1939).

price restrictions) with another (such as field of use restrictions).” Blue ribbon panels have complained that the resulting uncertainty has produced “a reluctance by patent owners to license their inventions” since the 1950’s. (See *Hensley* 1967.)

Given this history of uncertainty and confusion, it is appropriate to ask whether the *General Electric* rule makes sense, or alternatively whether it should be abandoned in favor of rule of reason. It may seem tautological that rule of reason is better, since a case-by-case approach can be tailored to fit individual circumstances. However, that is too simplistic, since it is also difficult to apply rule of reason in a predictable and principled way. If different courts implement different principles,³ then rule of reason may have the deleterious effects of creating uncertainty for patentholders and rewriting the incentives that Congress thought it provided. We return to the advantages and disadvantages of rule of reason below.

Any attempt to delineate the boundary between antitrust law and patent law must address the fundamental tension between them. Antitrust law is normally hostile to restrictions that promote monopoly. However, from a patent law perspective, the Supreme Court has recognized that “[t]he very object of [the patent laws] is monopoly” and that “[t]he fact that the conditions of the contract keep up the monopoly does not render them illegal.” (*Bement* 1902) But this begs the question of which contract restrictions are needed to “keep up the monopoly.” Judges have opined that a license cannot be used to create a monopoly on any product other than the invention itself (*Id.* at 11:34); that “[t]he patentee is entitled to exact the full value of his invention but is not entitled to endanger competition in other areas by manipulating his patent monopoly” (*Bement* 1902); and that the patent monopoly should exclude “all that is not embraced in the invention.” (*Morton Salt* 1942). In fact, any other stance would be unconstitutional. Neither Congress nor the courts can give a patentee “more than the rewards of his discovery.” (*Hensley* 1967; *Line Material* 1948 (Douglas concurring))

We paraphrase these cases as embodying the principle that the patentholder

³For two very different visions of what rule of reason might look like, see *Line Material* (1948). Justice Douglas’ concurring opinion stresses *ex post* efficiency with little or no consideration of *ex ante* incentives. Justice Burton’s dissenting opinion stresses *ex ante* incentives over *ex post* inefficiency.

must earn her reward, if at all, from the social value of the invention. We call this the *just-reward* principle. For example, profit earned by cartelizing an existing market would not satisfy the just-reward principle, since the profit derives from the cartel, and not from the invention. In our view, the just-reward principle also explains why courts condemn sham licenses. In a sham license, the intellectual property right is an excuse to create a cartel that would be profitable even if the invention had no value. We say more about how to apply the just-reward principle when we discuss product enhancements below.

We also interpret the case law as suggesting two additional principles, *profit neutrality* and *minimalism*. Profit neutrality means that the patentee's opportunity to profit should not depend on his ability to work the patent. His ability to work the patent may depend on such accidents of history as whether he owns manufacturing facilities, is liquid, or has access to financing. Licensing may be the only way to overcome such circumstances.

Minimalism means that licenses should not contain more restrictions than required to achieve profit neutrality. The minimalist principle recognizes that superfluous restrictions increase the risk of collusion. *General Electric* immunity might invite conspirators to design sham transactions that implement ordinary collusion under the guise of legitimate licensing (*Ethyl* 1940; *Line Material* 1948). In that case, the returns from the transaction would not derive from the social value of the invention or implement the incentive intended by Congress. The Supreme Court has struck down licensing provisions when “[t]he licensing conditions are ... not used as a means of stimulating the commercial development and financial returns of the patented invention which is licensed, but for the commercial development [of defendants’ businesses].” (*Ethyl* 1940) Courts are famously and justifiably leery of letting licensors extend the patent monopoly granted by Congress to other products. At least one court has made the link between profit neutrality and minimalism explicit: “The patentee can obtain the full reward of the patent in the first sale; a right to restrict the goods in more remote channels of trade is not a traditional part of the patent grant *nor is it needed in order for the patentee to fully enjoy the monopoly of the patent.*” (*Shapiro*

1979, emphasis supplied) A key question is whether such an assertion is true. If so, the first-sale rule is both consistent with neutrality and required by minimalism. However, we argue below that there are circumstances in which the first-sale principle cannot be reconciled with profit neutrality.

We have already noted that some legal scholars think the *General Electric* exception has been reduced to a mere “vestige.” But the fact that *General Electric* immunizes only a few licensing restrictions does not necessarily imply that the doctrine is “vestigial.” The question is whether the boundaries are drawn in the right place. We argue below that the just-reward, neutrality, and minimalism principles go a long distance toward rationalizing the case law.

In section 2, we consider the licensing of a product patent, as in *General Electric*. In section 3 we consider product enhancements or additives as in *Ethyl Gasoline* and *Line Material*. In section 4 we comment on how our conclusions relate to the first-sale rule. In section 5 we return to rule of reason, and in section 6 we compare rule of reason with the *per se* approach embedded in our three principles. In section 7 we give some summary conclusions about what this analysis teaches us.

2. Licensing New Products

We first consider the licensing of product patents, as in *General Electric*. The pro-competitive reason for licensing would typically be productive efficiency – that is, distributing the manufacturing in a way that achieves lowest total cost. If the marginal cost of manufacturing the product is increasing, production costs are minimized by producing in several firms rather than one. Accounting also for the setup costs of the plants, we will assume without loss of generality that the efficient number of production facilities is two.

As a benchmark case, we first assume that the patentholder owns the two production facilities himself, and decides how much to supply. He earns all the revenue and bears all the costs. We view the resulting profit as that which was intended by

Congress, and evaluate the neutrality of various licensing schemes according to whether they generate the same profit.

There are many reasons that the patentholder may not be situated to serve the whole market, such as that he cannot raise the money to build production or distribution facilities. Our neutrality principle is that the patentholder's reward should not depend on who owns the plants that produce and distribute the output.

We first show that the minimal set of licensing instruments required for neutrality includes only royalties and fixed fees in the extreme case that the entire supply is contracted out. Courts routinely approve licenses with fixed fees and per-unit royalties (*Brulotte* 1964). However we show in the subsection after this that these simple and uncontroversial licensing tools do not lead to neutrality in the intermediate case where the patentholder supplies some of the market, and competes with licensees.

Suppose that the inverse demand curve (the willingness to pay for the marginal unit at quantity q) is defined by $p(q) = 1 - q$, where q is the total supply of all firms.⁴ When there are two firms supplying the market with quantities q_1, q_2 , the market price will therefore be $p(q_1 + q_2) = 1 - (q_1 + q_2)$.

The profit available using the two production facilities, as a function of total output, is

$$p(q)q - 2 \int_0^{q/2} \gamma(\hat{q})d\hat{q} \tag{2.1}$$

where $\gamma(\cdot)$ is the marginal cost curve in each facility. We ignore the fixed costs here, assuming that they justify the use of two and only two facilities.

The benchmark case is that the market is supplied by a single firm using two facilities. The profit-maximizing total supply q^* , which maximizes (2.1), satisfies the

⁴The easiest interpretation is that each agent buys a fixed amount of the good in each period, which we shall understand as one unit. The potential buyers are indexed by their willingness to pay $\theta \in (0, 1)$. If agent θ buys the good at price p , his utility is $\theta - p$. If θ is uniformly distributed on the interval $(0, 1)$, the number of agents for whom $\theta - p > 0$ is $1 - p$. If q units of the good are supplied, the market-clearing price is $1 - q$, since that is the price that provides nonnegative utility to the q buyers with $\theta > 1 - q$, but negative utility to the others.

condition that marginal revenue equals marginal cost:

$$1 - 2q^* = \gamma\left(\frac{q^*}{2}\right) \quad (2.2)$$

The profit-maximizing price satisfies

$$p(q^*) = 1 - q^* = \frac{1}{2}\left(1 + \gamma\left(\frac{q^*}{2}\right)\right) \quad (2.3)$$

We now turn to the case that, instead of producing in two production facilities himself, the patentholder has two licensees. The profit will be generated through production decisions of the two licensees, and will be shared with the licensor through royalties and fixed fees, (ρ, F) .

We will consider Cournot competition, where each licensee chooses its supply optimally, taking the other firm's supply as given. Our objective is to characterize the equilibrium such that neither firm has an incentive to change its supply. The equilibrium supplies will depend on the royalty rate ρ . We will show that the following royalty rate supports the profit-maximizing price, with each firm supplying $\frac{q^*}{2}$.

$$\rho = \frac{1}{2}q^* \quad (2.4)$$

Conditional on the royalty ρ , we will write profit of firm 1 as

$$(p(q_1 + q_2) - \rho) q_1 - \int_0^{q_1} \gamma(\hat{q})d\hat{q} \quad (2.5)$$

Firm 1 takes the supply of the other firm, q_2 , as fixed, and optimizes by choice of its own supply, q_1 . The optimum satisfies

$$q_1 = \frac{1}{2}(1 - q_2 - \rho - \gamma(q_1)) \quad (2.6)$$

Similarly, firm 2's profit as a function of q_2 , taking q_1 as fixed, is

$$(p(q_1 + q_2) - \rho) q_2 - \int_0^{q_2} \gamma(\hat{q})d\hat{q} \quad (2.7)$$

and the optimal q_2 satisfies

$$q_2 = \frac{1}{2}(1 - q_1 - \rho - \gamma(q_2)) \tag{2.8}$$

Since the conditions (2.6) and (2.8) are satisfied at $(q_1, q_2) = (\frac{q^*}{2}, \frac{q^*}{2})$ when ρ is defined by (2.4), the profit-maximizing supplies $(\frac{q^*}{2}, \frac{q^*}{2})$ are an equilibrium.

However, the licensor is not collecting all the profit in royalties. This can be seen directly from the above calculations, but it is always true that Cournot competitors (oligopolists) earn positive profit, regardless of whether part of their “marginal cost” is royalty. The licensor can collect the remainder of the profit through the fixed fees F . (If the setup costs are high enough, the fixed fees may be negative – payments from the patentholder to the licensee.)

The foregoing shows that, using only royalties and fixed fees, the patentholder can collect as much profit from two licensees as by producing himself. Although patentholders have the right to impose quantity restrictions on their licensees (Schlicher 2002; Hovenkamp, et. al., 2004, at 32:3), profit neutrality does not require such restrictions in the case where the entire supply is contracted out.

This changes when the patentholder operates one of the production facilities himself and licenses another firm to operate the other. In that case, royalties and fixed fees do not lead to profit neutrality. Additional licensing instruments we consider in the next section are

1. Fixing the licensee’s price.
2. Imposing a price-matching clause, as in *General Electric*.
3. Restricting the licensee’s output.
4. Restricting the licensor’s own output.
5. Allowing the royalty rate to decrease with the licensee’s supply.
6. Allowing the royalty rate to decrease with the licensor’s supply.

We argue that only instruments 2, 4 and 6 provide as much profit as the benchmark case.

2.1. Licensor Competes with Licensee: Nonneutrality

To see the nonneutrality of royalties and fixed fees, suppose that there is a single licensee at (constant) royalty ρ , and that the licensor, called firm 1, also supplies part of the market. Let the licensee be firm 2. The profit of the licensor, firm 1, is

$$p(q_1 + q_2)q_1 + \rho q_2 - \int_0^{q_1} \gamma(\hat{q})d\hat{q}$$

If the licensor takes the licensee's output q_2 as given, and optimizes with respect to q_1 , his optimal supply satisfies

$$q_1 = \frac{1}{2} (1 - q_2 - \gamma(q_1)) \tag{2.9}$$

The profit of the licensee, firm 2, is

$$(p(q_1 + q_2) - \rho) q_2 - \int_0^{q_2} \gamma(\hat{q})d\hat{q}$$

If firm 2 takes the licensor's output q_1 as given, and optimizes with respect to q_2 , his optimal supply satisfies

$$q_2 = \frac{1}{2} (1 - q_1 - \gamma(q_2) - \rho) \tag{2.10}$$

It follows from (2.9) and (2.10) that, in equilibrium,

$$q_1 + \gamma(q_1) = q_2 + \rho + \gamma(q_2) \tag{2.11}$$

Since the two firms will not produce the same quantities, the aggregate supply is not produced efficiently at any positive royalty rate. Conditional on (2.11), there may be a royalty rate that supports the price $p(q^*)$, but the licensor will still not receive the maximum profit, due to productive inefficiency. By productive inefficiency, we mean

that total costs, conditional on the output, are unnecessarily high. Since the licensor produces more than the licensee, the marginal cost of his last unit of supply is higher than the marginal cost of the licensee's last unit of supply. Costs could be saved if the licensee supplied more and the licensor supplied less. Moreover, this shows that if the licensee is induced to supply half the profit-maximizing quantity, as intended, the licensor will increase his own supply beyond half the monopoly quantity. He gets marginal revenue from each additional unit supplied, while losing only half the revenue that is lost due to the fall in price. The other half is a loss imposed on the licensee.

Intuitively, the problem that arises here is that the licensor will exploit the licensee after the royalty agreement is in place. Once the royalty agreement is in place, and the licensee makes the decision to supply half the monopoly output, $\frac{q^*}{2}$, as intended, the royalties and fixed fees that the licensor collects from the licensee are fixed. An increase in supply by the licensor will not change them. An increase in supply by the licensor will impose a loss on the licensee through the fall in price, but this is not his concern once the agreement is in place.

The problem is that the prospect of such *ex post* opportunism undermines the licensor's *ex ante* profit. The licensee will rationally predict that, after the license is signed, the licensor will supply more units than the profit-maximizing number of units $\frac{q^*}{2}$, and the market price will be lower than the profit-maximizing price. The licensee realizes that the licensor's *ex post* supply decision will erode his own profit. The terms that the licensee will accept at the outset will reflect this prediction. As a consequence, the licensor cannot charge the fixed fees that he could charge if he could commit to producing only half the monopoly output, $\frac{q^*}{2}$.

The easiest way to fix the problem is to allow the licensor to cap his own output at $\frac{q^*}{2}$, as part of the license. Such a commitment improves the terms of license that the licensee will agree to, since the licensee is then guaranteed that the market price will be the monopoly price. Since the resulting license would be profit neutral with respect to the benchmark, we see nothing wrong with such a commitment. Courts have held that restricting the licensee's output does not pose an antitrust problem

(*General Talking Pictures* 1938; Weinschel 2000, 2:91; Hovenkamp, et. al., 2004, at 32:1:3), but we are unaware of any case where restricting the licensor’s output has been challenged.

2.2. Competition with Price Restrictions

As we have already pointed out, a solution to the incentive problem is for the licensor not to produce at all, and to have two licensees. We now ask whether the *General Electric* rule can also be a solution when the patentholder has manufacturing capability. The *General Electric* price-fixing exception allows the licensor to set the price for both the licensor and the licensee.

We should say at the outset that competition is messy when prices can be fixed. The notion of competition used above was competition in supply. With the licensing terms in place, each firm made an independent choice of supply, and the market price then adjusted to ensure that all the units were sold. That notion must now be modified, since prices are not allowed to change endogenously in order to clear the market. For example, if the total supply exceeds demand at the fixed price, then firms will end up with excess supply. This should not happen in equilibrium, but in order to test whether the supply decisions are an equilibrium, we need some notion of what would happen if a firm changed its supply.

For the *General Electric* price-fixing rule, we will again assume that firms make their supply decisions after the licensing terms have been set. We interpret the price-matching rule to mean that the licensor can set the price at which both firms sell. In addition, the agreement may specify royalties and fixed fees. With this agreement in place, the firms choose their supplies.

We claim that the licensor can ensure the monopoly outcome by setting royalty

$$\rho = p(q^*) - \gamma\left(\frac{q^*}{2}\right) \tag{2.12}$$

and setting the fixed fee so that the licensee’s profit is zero if both firms produce $\frac{q^*}{2}$.

If neither firm wants to deviate from half the monopoly supply, $\frac{q^*}{2}$, then the licensor gets all the profit and production is efficient.

We will check whether either firm wants to deviate, conditional on the supply of the other. Consider first the licensee, and suppose that the licensor is supplying $\frac{q^*}{2}$. The licensee cannot benefit by reducing supply from $\frac{q^*}{2}$ to something less, because each of the inframarginal units provides him with revenue (price) higher than the royalty plus marginal cost. The licensee also cannot benefit by increasing supply above $\frac{q^*}{2}$. If he increases supply, the market will have an excess supply at price $p(q^*)$. If the licensee does not manage to sell his marginal units, then he has wasted the cost of producing them. If he does sell them, he cannot cover costs, since $p(q^*) - (\rho + \gamma(q)) < p(q^*) - (\rho + \gamma(\frac{q^*}{2}))$ for $q > \frac{q^*}{2}$.

What about the licensor? Will he also be content to supply $\frac{q^*}{2}$? He has no incentive to produce less, since the marginal units provide him profit in amount $p(q^*) - \gamma(q)$, which is positive for $q \leq \frac{q^*}{2}$. If he produces more, then either the marginal unit crowds out a unit that would otherwise be sold by the licensee, or the marginal unit is not sold at all. If not sold, it wastes the costs of production. If it crowds out a unit sold by the licensee, then the licensor loses the royalty ρ on that unit. But using (2.12) and the fact that $\gamma(\cdot)$ is increasing, it follows that $\rho > p(q^*) - \gamma(q)$ for $q > \frac{q^*}{2}$; hence the licensor prefers to collect the royalty from the licensee than to crowd out that unit and produce it himself.

This proves that with the license terms specified – a royalty that satisfies (2.12) and price fixing – there is an equilibrium with profit-maximizing production, even though the licensor competes with the licensee. The licensor can collect all the profit through fixed fees and royalties.⁵

⁵A slight embarrassment, however, is that, depending on how excess supply is rationed, there can be other equilibria with the property that $q_1 + q_2 = q^*$ (where q_1, q_2 are respectively the supplied quantities of the licensor and licensee), and $q_2 < \frac{q^*}{2}$. Even if such an equilibrium exists, it will not be preferred by either party to the equilibrium in which the firms supply $q_1 = q_2 = \frac{q^*}{2}$. By moving to the equilibrium with equal outputs, the licensee benefits because the price he receives on the additional units is larger than the royalty plus marginal cost. The licensor benefits because the royalty he receives on the units transferred to the licensee is larger than the price net of costs of his own supply. In economic games with two equilibria, where both parties prefer one equilibrium to the other, it is

Thus, the General Electric Company chose a rule that implements profit neutrality. Its solution was also “minimalist.” We argue in section 8.1 that General Electric could not have achieved the same result by fixing the price of the licensee without fixing his own.

2.3. Nonlinear Royalties

Our final scheme is to consider nonlinear royalties. Of course constant royalties and fixed fees are a form of nonlinear royalty, but payments of this form will not guarantee profit neutrality when the licensor and licensee compete.

As we showed above, the licensor can profit by committing himself not to expand output beyond $q_1 = \frac{q^*}{2}$ once the license is in place. His incentive to expand output follows from the fact that he earns royalties on the licensee’s output in any case, and can earn even more profit by expanding the market. Even though his expansion reduces the market price, the licensee bears half of that loss, while the licensor continues to collect royalties, and also sells the additional units. The problem is that, since the licensee can predict this outcome, he will not sign a license agreement in the first place that provides monopoly profit to the licensor. Thus, the licensor can do better by committing not to expand output once the license is in place.

Suppose that instead of imposing a fixed royalty, the licensor imposes a royalty rate ρ that falls with his own output. The fall in royalty rate will punish the licensor for expanding output, and thus creates a commitment not to do so. This will solve the problem. In particular, let ρ be the following decreasing function of q_1 :

$$\rho(q_1) = q^* - q_1.$$

Then $\rho(\frac{q^*}{2}) = \frac{q^*}{2}$ and $\rho'(\cdot) = -1$. The higher the licensor’s output, the less royalty he gets, and this will commit him not to increase output beyond $\frac{q^*}{2}$.

easy to ensure that the better equilibrium is played. One of the players can simply announce that he intends to play his strategy in the preferred equilibrium, and the other player will follow. No commitments or license terms are required to implement this outcome. It is self-enforcing.

Firm 1's profit is

$$p(q_1 + q_2)q_1 + \rho(q_1)q_2 - \int_0^{q_1} \gamma(\hat{q})d\hat{q}$$

and the optimal supply q_1 , conditional on firm 2's supply q_2 , satisfies

$$q_1 = \frac{1}{2} (1 - q_2 + \rho'(q_1)q_2 - \gamma(q_1))$$

Firm 2's profit is

$$(p(q_1 + q_2) - \rho(q_1)) q_2 - \int_0^{q_2} \gamma(\hat{q})d\hat{q}$$

and firm 2's optimal supply q_2 , conditional on firm 1's supply q_1 , satisfies

$$q_2 = \frac{1}{2} (1 - q_1 - \gamma(q_2) - \rho(q_1))$$

At $(q_1, q_2) = (\frac{q^*}{2}, \frac{q^*}{2})$, neither firm has an incentive to deviate.

Of course this scheme requires that the licensor send a royalty bill to the licensee based on the licensor's own output. It might create an enforcement nightmare for the licensee. The licensor will always want to argue that his supply was lower than it was, and the licensee will want to argue that it was higher.

Nonlinear royalties based on the licensee's supply are common and at least two courts have said that such agreements do not violate the antitrust laws (*Stockham Valves* 1966; *DuPont* 1953). However, in the model presented here, royalties that increase or decrease with the licensee's supply will not lead to profit neutrality because they do not punish the licensor for trying to exploit the licensee once the terms of license are fixed. To punish the licensor for increasing supply beyond that to which he would like to commit, the royalty must depend on the licensor's supply, not the licensee's supply.

This is a good place to return to our inquiry about minimalism. The point of stipulating royalties that decline with the licensor's output is to soften the competition

that the licensor provides to the licensee. It is even more direct to write license terms that restrict the licensor's supply. Many commentators believe, on somewhat slender case law, that U.S. law permits patentholders to impose minimum output levels on their licensees (Weinschel 2000, 2-91; Hovenkamp, et. al., 2004, at 32:9), but we know of no cases in which a licensor's commitment to self-restraint has been at issue.

3. Licensing Patents on Enhancements

A different economic context in which the price-fixing exception was considered was a patented enhancement to an existing product. In *Ethyl Gasoline*, the patentholder had the rights to a gasoline additive (tetraethyl lead) that raised the gasoline's octane rating. Licensed refiners were not allowed to sell gasoline containing the additive to unlicensed middlemen ("jobbers") and jobbers who failed to observe the major refiners' posted prices were regularly terminated for displaying poor "business ethics." The net effect was to set the price at which licensed jobbers could sell high performance gasoline. The court struck down the jobbers' licenses on the ground that they violated the antitrust laws.

In considering proprietary enhancements to existing goods, we will assume that each consumer's willingness to pay for the enhanced product is larger than for the original product by amount Δ . Applying the just-reward principle, the inventor should not receive more than Δ per unit sold.

As before, we will suppose that the demand for the underlying good, say, unenhanced gasoline, is given by a function $1 - p$, where p is the price, and that the inverse demand curve is therefore given by $1 - q$. Suppose that the marginal cost of a unit of unenhanced gasoline is $c \leq 1$ and that the additive increases the willingness to pay for each unit of gasoline by $\Delta \leq 1$. Then the demand for enhanced gasoline at price p is $1 + \Delta - p$, and the willingness to pay for the q^{th} unit (the inverse demand curve) becomes $p(q) = 1 + \Delta - q$.

We will not yet make a distinction between selling the additive at a proprietary

price or licensing the right to produce gasoline that includes the additive. In both cases, we will refer to the price or royalty as ρ .

3.1. Patented Enhancements to Nonproprietary Goods

Assume for simplicity that the resource cost of producing the additive is zero, and the unit cost of producing gasoline (enhanced or unenhanced) is c . In a competitive market, the cost of enhanced gasoline will then be $p = c + \rho$ if ρ is the wholesale price of the additive or the royalty for adding it to the gasoline. If the licensor charges the entire value as royalty, $\rho = \Delta$, the price of gasoline will go up by Δ , so that sales of the enhanced gasoline are the same as without the additive. During the life of the patent, it is the patentholder rather than user who collects the social value. This is consistent with the just-reward principle that the profit must derive from the social value.

Further, provided the total demand for gasoline is relatively large, the licensor's profit is maximized by charging $\rho = \Delta$ in a competitive market. No distributor would buy the additive at a price greater than $\rho = \Delta$, so $0 < \rho \leq \Delta$. In addition, it cannot generally be more profitable to charge a royalty less than Δ . The licensor's profit is $\rho(1 + \Delta - \rho - c)$. This profit increases in ρ whenever $1 + \Delta - c > 2\rho$. But since $\Delta \geq \rho$ it is enough that $1 - c > \Delta$. Since $1 - c$ is the demand for unenhanced gasoline at the competitive price, this condition can be interpreted to mean that the licensor will charge a royalty equal to the full value of the additive whenever the demand for gasoline is large relative to the value of the additive.

It seems clear under the just-reward principle that the licensor should be allowed to profit in amount Δ per unit of gasoline sold, but not more. This is true even if gasoline suppliers operate as oligopolists in the distribution of gasoline, rather than as perfect competitors. Suppose, in particular, that there are only two gasoline sellers, firms 1 and 2. Neither will take a license on the additive at a royalty or wholesale price greater than Δ , since a refiner can sell the same amount of unenhanced gasoline at price $p - \Delta$ as enhanced gasoline at price p . If the royalty is greater than Δ , it is

more profitable to sell unenhanced gasoline.

If both firms license at royalty ρ and sell the enhanced gasoline, firm 1 chooses the supply q_1 that maximizes profit, defined as follows, assuming that the supply q_2 of the other firm is fixed:

$$(1 + \Delta - q_1 - q_2)q_1 - (c + \rho)q_1$$

The optimal q_1 solves

$$q_1 = \frac{1}{2}(1 + \Delta - q_2 - (c + \rho))$$

and at the symmetric solution where $q_1 = q_2 = q(\rho)$, each firm supplies the $q(\rho)$ that solves

$$q(\rho) = \frac{1}{3}(1 + \Delta - c - \rho) \tag{3.1}$$

Thus, the licensor's profit is

$$2 \rho q(\rho) = \frac{2}{3}\rho(1 + \Delta - c - \rho)$$

Exactly as for the competitive case, the optimum is to set $\rho = \Delta$ provided demand is large relative to Δ .

The oligopolist refiners (gasoline suppliers) earn profit in the oligopoly, regardless of the royalty they pay; that is the nature of oligopoly. Although the licensor would like to get its hands on that profit, the licensor is not entitled to it under the just-reward principle. The oligopolists earn profit regardless of whether there is a product enhancement; the profit earned by the oligopolists was not created by the proprietor of the enhancement.

Further, there is no reason that the oligopolists would give up their profit by licensing the enhancement. However this does not nullify the threat of “sham licensing.” The three firms together could profit from cartelizing the market so that

they jointly earn monopoly profit instead of oligopoly profit. It is this threat that the minimalist principle seeks to curb.

To reiterate, by sham licensing we mean that the licensor can use the intellectual property right to cartelize the market, and earn profit from the cartelization rather than from the value of the invention. The most profitable arrangement is to keep unenhanced gasoline off the market and to sell the monopoly output of enhanced gasoline, namely, the q that maximizes

$$(1 + \Delta - q - c)q$$

The parenthetic term is the sales price when q units of enhanced gasoline are supplied. The profit-maximizing quantity of enhanced gasoline satisfies

$$q^*(\Delta) = \frac{1}{2}(1 + \Delta - c) \tag{3.2}$$

and the corresponding market-clearing price is

$$p(q^*(\Delta)) = 1 + \Delta - q^*(\Delta) = \frac{1}{2}(1 + \Delta + c) \tag{3.3}$$

In order to see the potential for sham licensing, it is useful to think of Δ as close to zero. By the just-reward principle, the patentholder's reward should also be close to zero. Instead, with sham licensing, the patentholder's reward will include profit made available through cartelization.

The following license terms will support the monopoly price, provided both gasoline distributors take the license. One can see from (3.1) and (3.2) (and analogously to our discussion in section 2.1) that a royalty of $\rho = \frac{1}{2}q^*(\Delta)$ supports the monopoly output.

1. Charge a royalty $\rho = \frac{1}{2}q^*(\Delta)$ for producing and using the additive, stipulating that licensees cannot avoid the royalty by reverting to unenhanced gasoline. Share the profit through fixed fees.

2. Charge a fixed fee for producing and using the additive, stipulating that the price of enhanced gasoline must be $p(q^*(\Delta))$, and stipulating that the licensees cannot sell unenhanced gasoline. Share the profit through fixed fees.

A cartel cannot generally be supported unless the license stipulates either that the licensee will pay royalties on unenhanced gasoline as well as enhanced gasoline, as in (1), or that the licensee will sell only enhanced gasoline, as in (2). Without being bound in one of those ways, a licensee can profit by selling unenhanced gasoline at a price between the marginal cost c and the monopoly price $p(q^*(\Delta)) - \Delta$. That will break the cartel. Because the license terms (1) and (2) will support a cartel, they should not be allowed.

Of course, entry will also break the cartel. If there is always a threat of entry by an unlicensed entrant, the market price for unenhanced gasoline must be $p = c$, and the price of enhanced gasoline can be no greater than $c + \Delta$. Higher prices will elicit entry.

The reader will have no trouble seeing that cost reductions can be analyzed in the same way as product enhancements. Instead of adding to the product's value, suppose the innovation reduces the cost of manufacturing it. Whether Δ is conceived as a boost to the consumer's willingness to pay for the product or a reduction in the cost of manufacturing it, the innovation would increase the consumers' surplus available in a competitive market by Δ per unit. For reasons analogous to the ones given here, allowing the licensor to fix prices would allow him to profit from cartelization rather than profiting from the social value he created, in violation of the just-reward principle. Instruments to fix the monopoly price will take the same forms as above, *e.g.*, binding the licensees to pay royalties regardless of whether they use the patented innovation, and specifying the price they must charge while preventing them from reverting to the inferior product.

We conclude that in the case of patented enhancements to unpatented goods, and also in the case of cost reductions, royalties are a rich enough licensing instrument to collect the profit that Congress intended. Price-setting power is not only

unnecessary, but allows the licensor to cartelize the market, thus earning profit from a source (the cartel) not created by the invention. This would violate the just-rewards principle.

3.2. Patented Enhancements to Patented Goods

In the previous section we supposed that the original good, say gasoline, was supplied in an unprotected market. We shall now assume that the previous good is itself proprietary. In this section we assume that the enhanced good does not infringe the previous patent, and in the next section we assume that it does.

If the two proprietary goods are noninfringing, is there any reason to allow licensing at all? Given that licensing is not required for productive efficiency as defined above, and not required to bring either of the products to market, is licensing a *prima facie* sham?

The problem here is that efficiency means more than productive efficiency. Without licensing, one of the proprietors would supply an inferior product, presumably at a lower price, and some of the consumers would buy it. Depending on prices, consumers may be better off if both firms supply the better product. What licensing terms, if any, should be allowed in order to achieve this result, without undermining the competition between the patentholders that Congress apparently intended?

Suppose, for example, that the two firms write a licensing agreement that commits the proprietor of the inferior product, whom we shall call firm 1, to stay out of the market. Then the proprietor of the enhanced product, whom we shall call firm 2, becomes a monopolist. This is presumably the most profitable arrangement for the two firms, and the proprietor of the better good should be willing to pay his potential competitor to stay out. Most commentators would agree that such an arrangement would be collusive, but how does that follow from the principles we have articulated? What licensing terms are consistent with our principles? Can the allowable licensing terms ensure that only the better product is supplied, while at the same time avoiding the collusive outcome?

We claim that the only licensing arrangement consistent with the just-reward principle is a license from firm 1 to firm 2, giving the right to produce the enhanced product in return for royalties and perhaps other fees. A license from firm 2 to firm 1 is not consistent with that principle, since firm 1 has nothing of value to offer firm 2. Cross-licensing is not consistent with the just-reward principle. Further, we show that the one-way license will not allow the firms to cartelize the market. Despite the license, the price of the enhanced product will be constrained by potential competition from the inferior product.

To make our case, we need to characterize the outcomes of three market arrangements: that the patentholders compete without a license, that firm 2 licenses to firm 1 with royalties and perhaps fixed fees, and that the firms find a way to support the collusive outcome. We will show that the first two arrangements are equivalent for consumers, but the second arrangement, one-way licensing, is more profitable for the firms. The collusive outcome is more profitable still, but imposes the monopoly price on consumers. Thus, one-way licensing achieves the objective of economic efficiency (all consumers consume the better good), while avoiding the collusive outcome.

Let p^I be the price of the original, inferior good, and let p be the price of the enhanced good. Then, since each user has willingness to pay Δ for the enhancement, prices must satisfy

$$p^I = \max\{0, p - \Delta\} \tag{3.4}$$

With these prices, the demand for units of both products is the same as if both firms supplied the enhanced product at price p . That is, the number of units demanded is $1 + \Delta - p$, but some of the units will be the inferior product, which provide less utility in amount Δ and sell at a price p^I that is lower by Δ . For simpler calculations, and because our focus is not on productive efficiency, we will now assume that the marginal cost of production is zero.

We will first characterize the equilibrium prices without licensing. In evaluating its profit opportunities, firm 1 takes as given firm 2's supply of the enhanced

good, q_2 . Firm 1's profit as a function of its own supply of the inferior good, q , is

$$(1 - q - q_2) q \tag{3.5}$$

and the profit-maximizing quantity satisfies

$$q = \frac{1}{2}(1 - q_2) \tag{3.6}$$

Similarly, firm 2's profit is

$$(1 + \Delta - q - q_2) q_2 \tag{3.7}$$

and its profit-maximizing supply satisfies

$$q_2 = \frac{1}{2}(1 + \Delta - q) \tag{3.8}$$

The equilibrium quantities (q, q_2) solve (3.6) and (3.8), namely,

$$\begin{aligned} q &= \frac{1}{3}(1 - \Delta) \\ q_2 &= \frac{1}{3}(1 + 2\Delta) \end{aligned}$$

and therefore the prices are

$$\begin{aligned} p^I &= \frac{1}{3}(1 - \Delta) \\ p &= \frac{1}{3}(1 + 2\Delta) \end{aligned}$$

We will now show that the second market arrangement, licensing from firm 2 to firm 1, is equivalent for consumers to competition without licensing, and better for the patentholders. The largest royalty, ρ , that would be offered or accepted is $\rho = \Delta$. At a larger royalty, firm 1 would supply the inferior good rather than the enhanced good under license. The constraint $\rho \leq \Delta$ is the key ingredient to our conclusion that licensing creates benefits patentholders without harming consumers.

In evaluating its profit opportunities, the licensee, firm 1, again takes as given firm 2's supply of the enhanced good, q_2 . Firm 1's profit as a function of its own supply of the enhanced good, q_1 , is

$$(1 + \Delta - q_1 - q_2 - \rho) q_1 \tag{3.9}$$

and the profit-maximizing quantity satisfies

$$q_1 = \frac{1}{2}(1 + \Delta - q_2 - \rho) \tag{3.10}$$

Similarly, firm 2's profit-maximizing supply satisfies

$$q_2 = \frac{1}{2}(1 + \Delta - q_1) \tag{3.11}$$

The equilibrium quantities (q_1, q_2) solve (3.10) and (3.11), namely,

$$\begin{aligned} q_1 &= \frac{1}{3}(1 + \Delta - 2\rho) \\ q_2 &= \frac{1}{3}(1 + \Delta + \rho) \end{aligned}$$

Therefore the price will be

$$\frac{1}{3}(1 + \Delta + \rho). \tag{3.12}$$

Total output of the enhanced good will be

$$\frac{1}{3}(2(1 + \Delta) - \rho)$$

The sum of the two firms' profit is

$$\begin{aligned} \frac{1}{9}(1 + \Delta + \rho)(1 + \Delta + \rho + 1 + \Delta - 2\rho) &= \frac{1}{9}(1 + \Delta + \rho)(2(1 + \Delta) - \rho) \\ &= \frac{1}{9}(2(1 + \Delta)^2 + \rho(1 + \Delta) - \rho^2) \end{aligned}$$

The two firms' total profit is increasing in ρ , and is greatest at $\rho = \Delta$. Therefore the price of the enhanced good is the same with and without licensing, namely $\frac{1}{3}(1 + 2\Delta)$. This accounts for our claim that consumers are as well off with licensing as without. However, the firms' joint profit with licensing is

$$\frac{1}{9}(2(1 + \Delta)^2 + \Delta) \tag{3.13}$$

which is larger than their profit in competition with each other, in the absence of a license.

We now compare to the collusive outcome, namely, the outcome if firm 1 renounces its right to supply the inferior product. The monopoly price and quantity of the enhanced good satisfy (3.3) and (3.2) with $c = 0$, and the maximum profit is

$$\frac{1}{4}((1 + \Delta)^2) \tag{3.14}$$

The collusive profit (3.14) is larger than the profit (3.13) available with one-way licensing, and the price of the enhanced good is also higher, $\frac{1}{2}(1 + \Delta) > \frac{1}{3}(1 + 2\Delta)$, in the case ($\Delta < 1$) where the possibility of supplying the inferior good is actually a constraint in the market.

We conclude that the one-way license allows the proprietor to profit from the social value of the enhancement without profiting from cartelizing the market. This is the only type of license that should be allowed under our principles. In contrast, a cross-license of the type discussed in the next section would allow the two firms to earn monopoly profits as if the proprietor of the enhancement created the whole market.

3.3. Blocking Patents on Enhancements

We continue our discussion of the same model, but now assume that the enhanced product infringes the patent on the original product, so the patentholders have blocking patents. This was the situation in *Line Material* (1948). Since the enhanced product infringes the patent on the inferior product, the knowledge created by the

first innovator was presumptively required to develop it. In this sense, the net value of the enhanced product is presumptively part of the social value created by the first innovator, even though the second innovator bore the incremental costs. By the just-reward principle, the first innovator is entitled to profit from it.

There are not many possibilities for how to resolve the blocking patents so that the enhanced product can come to market. They include:

1. Consolidate ownership of the patents (one patentholder sells to the other).
2. Allow the patentholders to cross license the enhanced product, each paying royalties to the other.
3. Allow the patentholders to cross license with royalties, fixing the price of the enhanced good, and stipulating that the inferior good will not compete in the market.
4. Force the patentholders to cross license without royalties.

We assume that (4) is not what Congress had in mind, as it leads to the same market outcome as if the patents were not blocking, discussed in section 3.2. We now show that (2) and (3) are equivalent to (1), provided that the cost of manufacturing the enhanced good is the same regardless of how the manufacturing is divided between the firms. However, echoing our discussion of section 1, (2) is not equivalent to (1) or (3) if the manufacturing must be divided in a particular way to achieve cost efficiencies.

Since the enhancement adds Δ to every user's willingness to pay, the inverse demand curve can again be written as $p(q) = 1 + \Delta - q$, where q is the quantity supplied of the enhanced good, and the inferior good is not supplied. The most profitable arrangement is for only the better product to be produced.⁶ We will first assume that the marginal cost of producing both goods is the same, and for simplicity,

⁶If users value the enhancement differently, it could be more profitable to sell both products as a form of price discrimination.

that the marginal cost is zero. Then any manufacturing arrangement is equally cost-efficient.

Clearly the maximum profit can be achieved if both patented goods are owned by a single firm (solution (1)). What we will now show is that it can also be achieved by cross licensing with royalties (solution (2)), but only if the previous patentholder, whom we again call firm 1, can either renounce his right to supply the inferior product, or pays a low enough royalty that he has no incentive to supply it.

Assume that the cross license on the enhanced good provides for royalties in amounts (ρ_1, ρ_2) , with each firm paying the other. We will show that in order to sustain the profit maximizing price, these royalties must satisfy

$$\rho_1 + \rho_2 = \frac{1}{2}(1 + \Delta) \tag{3.15}$$

Further, in order to dissuade firm 1 from undercutting the market by supplying the inferior product as well, it must hold that $\rho_1 \leq \Delta$. However this constraint imposes no harm provided the cost of aggregate supply does not depend on how the supply is divided between the firms. That is, it imposes no harm if there is no issue of productive efficiency.

With the royalties in place, and assuming that firm 1 does not supply the inferior good, the firms will choose their most profitable supplies, (q_1, q_2) , realizing that the price in the market will satisfy

$$p(q_1 + q_2) = 1 + \Delta - q_1 - q_2.$$

Taking as given the royalties (ρ_1, ρ_2) and the supply q_2 of firm 2, firm 1's profit function is

$$(p(q_1 + q_2) - \rho_1) q_1 = (1 + \Delta - q_1 - q_2 - \rho_1) q_1 \tag{3.16}$$

and the profit-maximizing quantity satisfies

$$q_1 = \frac{1}{2}(1 + \Delta - q_2 - \rho_1) \tag{3.17}$$

Similarly, firm 2's profit-maximizing quantity satisfies

$$q_2 = \frac{1}{2}(1 + \Delta - q_1 - \rho_2) \quad (3.18)$$

Adding (3.17) and (3.18), it follows that the aggregate equilibrium supply $q_1 + q_2$ satisfies

$$q_1 + q_2 = \frac{2}{3}(1 + \Delta) - \frac{1}{3}(\rho_1 + \rho_2)$$

But since the objective is to choose the royalties such that the equilibrium quantities satisfy

$$q_1 + q_2 = q^*(\Delta) = \frac{1}{2}(1 + \Delta), \quad (3.19)$$

the condition (3.15) must be satisfied.

Further, by (3.17), (3.18), and solving ρ_1 from (3.15), we can write the equilibrium supplies as

$$\begin{aligned} q_2 &= \rho_1 \\ q_1 &= \frac{1}{2}(1 + \Delta) - \rho_1 \end{aligned} \quad (3.20)$$

These are the firms' respective supplies if the royalties satisfy (3.15) and the inferior product is not supplied.

In equilibrium, firm 1's profit from selling the enhanced product and collecting royalties is

$$\frac{1}{2}(1 + \Delta)\left(\frac{1}{2}(1 + \Delta) - 2\rho_1\right) + \rho_1\left(\frac{1}{2}(1 + \Delta) - \rho_1\right)$$

which is decreasing with the royalty rate it pays, ρ_1 . At $\rho_1 = 0$ (and $\rho_2 = \frac{1}{2}(1 + \Delta)$), firm 1 supplies the whole market and earns all the profit. Thus, by choosing the royalties within the range $\rho_1 \in (0, \Delta)$, there is scope for dividing profit even without using fixed fees.

Thus, if the two firms have the same constant marginal cost of supply, we can conclude that there is a cross licensing arrangement that sustains the maximum profit. In this arrangement,

- each firm pays a royalty to the other on the units of the enhanced products it sells;
- the royalty paid by the previous patentholder is positive, but possibly smaller than the royalty paid by the improver;
- the previous patentholder has no incentive to undermine the monopoly on the enhanced product by selling the inferior product;
- the profits can be divided arbitrarily by using fixed fees as well as royalties.

We thus conclude that when manufacturing costs are the same regardless of which firm supplies the market, a cross-licensing agreement is profit neutral with respect to the benchmark solution (1) of allowing the patentholders to consolidate their patent rights. By the minimalist principle, there is no need to allow price fixing in addition to royalties, and the decision against price-fixing in *Line Material* is therefore consistent with our principles.

This may change, however, if each firm's marginal cost of production is increasing, or if the firms have different marginal costs of production. In that case, royalties and fixed fees may not be profit neutral. Profits may be higher under solution (1) than (2).

If, for example, the enhancer has lower (constant) marginal costs of production, the only efficient arrangement is for firm 2 to supply the whole market. The royalties that would induce firm 2 to supply the whole market would have to be low (zero) for firm 2 and high for firm 1. But if $\rho_1 > \Delta$, firm 1 has an incentive to enter the market with the inferior product, competing against firm 2, and depressing its price. Cross-licensing to manufacture and produce the enhanced product does not prevent this, even though both firms would be better off preventing it.

When productive efficiency is at issue, royalties and fixed fees may not be enough instruments to ensure (i) that the output is manufactured efficiently, (ii) that the market price is profit-maximizing, and (iii) that the inferior product stays off the market. In fact, for relatively large values of Δ , cross licensing will result in one of the following problems.

1. Manufacturing costs are unnecessarily high due to unequal production in the firms, and therefore the firms earn less than the maximum profit.
2. Manufacturing is efficient, but the firms earn less than the maximum profit because the royalties are too low.
3. The firms earn less than the maximum profit because the inferior product is also on the market.

To see this more formally, modify the above model so that the marginal costs of manufacturing are given by a function $\gamma(\cdot)$, as in section 2 above, and for simplicity, assume that these are the costs in each firm. Then the maximum profit is

$$p(q^*(\Delta)) q^*(\Delta) - 2 \int_0^{q^*(\Delta)/2} \gamma(z) dz$$

where the optimal quantity and price satisfy

$$\begin{aligned} q^*(\Delta) &= \frac{1}{2}(1 + \Delta - \gamma(\frac{q^*(\Delta)}{2})) \\ p(q^*(\Delta)) &= 1 + \Delta - q^*(\Delta) \end{aligned} \tag{3.21}$$

The optimum clearly requires equal production in the two firms. To support equal production, the royalties must be equal, $\rho_1 = \rho_2$. However, to prevent the first patentholder from supplying the inferior product, the royalties must satisfy $\rho_1 \leq \Delta$. In the appendix, we show that the royalties required to support the profit maximizing price are

$$\rho_1 = \rho_2 = \frac{1}{4}(1 + \Delta) - \frac{1}{4}\gamma(\frac{q^*(\Delta)}{2}) \tag{3.22}$$

However, if $\rho_2 = \rho_1 > \Delta$, these will not sustain the profit maximum, since firm 1 will supply the inferior product instead of the enhanced product, thus depriving firm 2 of royalties. The condition (3.22) may be inconsistent with $\rho_2 = \rho_1 \leq \Delta$ if $\Delta > \frac{1}{3}$ and costs γ are relatively low. There are several ways to solve these problems, but they may require terms of license beyond cross licensing the enhanced product. Two possibilities are

1. (Exclusive dealing) Write into the terms of license that firm 1 will not supply the inferior product, and write royalty rates that satisfy (3.22). Distribute the profit with fixed fees.
2. (Price Fixing) Set the royalty for the enhanced good at $\rho_2 = p(q^*(\Delta)) - \gamma\left(\frac{q^*(\Delta)}{2}\right)$ and fix the price for both firms at $p(q^*(\Delta))$.

Exclusive dealing is generally treated under rule of reason (see the 1995 *Antitrust Guidelines for Licensing Intellectual Property*, section 5.4). Our suggestion is that, by the neutrality principle, exclusive dealing of this type should be *per se* legal, especially if the second solution remains *per se* illegal (*Line Material*). In any case, whether the second solution will keep the inferior good off the market depends on the costs of producing the inferior good. Any unit of the inferior good that is supplied will either remain unsold due to rationing at the fixed price, or will crowd out a sale of the enhanced good by one of the firms. If the unit remains unsold, then producing it is clearly unprofitable, so suppose that it crowds out a sale of the enhanced good. The marginal unit can provide no more than $[p(q^*(\Delta)) - \Delta] - \tilde{\gamma}(0)$ as profit, where $\tilde{\gamma}(0)$ is the marginal cost of the first unit of the inferior good. The profit provided by the crowded-out unit is $p(q^*(\Delta)) - \gamma\left(\frac{q^*(\Delta)}{2}\right)$, whether it would have been sold by firm 1 or firm 2. (If it would have been sold by firm 2, the lost profit is lost royalty.) Provided that the cost $\tilde{\gamma}(0)$ is greater than $\gamma\left(\frac{q^*(\Delta)}{2}\right) - \Delta$, the unit is less profitable than the enhanced good it crowded out.

4. The First-Sale Rule

The “first sale” or “exhaustion” principle holds that patentees and their licensees lose the ability to control how an invention is used once they have sold it. This means, among other things, that the *General Electric* price-fixing exception cannot apply after the first sale has occurred. Because courts have held that transactions called “licenses” may in fact be “sales,” the first-sale rule is subject to some ambiguity. The issue is whether the patentee has surrendered ownership and transferred risk. Under the risk interpretation, patentees and licensees can avoid triggering the first-sale rule by transferring goods to one or more middlemen under consignment (*Mallinckrodt, Inc.* 1990).

Here we are not discussing risk, but the first-sale rule is of interest because patented products such as a gasoline additive can either be sold or licensed. The reader can verify that, in those cases above where royalties and fixed fees lead to profit neutrality, wholesale prices and fixed fees also lead to profit neutrality. If the patented object can be sold rather than licensed, then the wholesale price serves the role of a (constant) royalty.

Conversely, where royalties and fixed fees do not suffice for profit neutrality, we would suspect that the first-sale rule also obstructs profit neutrality. Indeed, we have uncovered one such case, that of blocking patents. One possible solution is to cross-license. Another is for firm 2 to sell the enhancement (the gasoline additive) to firm 1 (proprietor of the inferior product), while firm 1 grants a license to firm 2 in return for royalties. As we discussed in section 3.3, cross licensing may not support the same profit as consolidated ownership of the patents, and neither will selling the enhancement under the first-sale rule.

We hasten to add, however, that this is a special case, and the proprietor of the additive has the option to license instead of sell. If the licensing rule could remedy the nonneutrality, there would be no need to tamper with the first-sale rule.

5. Rule of Reason

Rule of reason permits the court to treat a given license term differently in different circumstances. In general, rule of reason and *per se* rules like the one stated in *General Electric* lead to different outcomes.

In order to have content, a rule-of-reason approach must specify what facts the court can consider and how should it analyze them. Otherwise, saying that courts should follow a rule-of-reason approach is not prescriptive enough to be useful. In this section we discuss two interpretations of what rule of reason might mean in the patent-antitrust context, and in the next section compare those approaches to the one suggested in this paper.

The first approach is the one suggested by the U.S. Department of Justice and Federal Trade Commission who say that the benefits of allowing the licensor “to exploit its [intellectual] property as efficiently and effectively as possible,” must outweigh the harm to competition (1995 *Antitrust Guidelines*). As we pointed out in the introduction, harm can arise in the innovation context either because innovations are stifled in the first place, or because the innovator receives too extensive a monopoly, leading to unnecessary market power after the fact. If the harm to competition is narrowly concerned with the *ex post* market for the patented product, then rule of reason would proscribe all restrictive terms of license, including royalties as well as price fixing. That is obviously an unworkable conclusion. In devising the concept of “innovation markets,” the antitrust agencies also recognized the importance of supporting competition for innovations themselves.

This approach does very little to clarify the boundary between Congress’ responsibility in policy making, and the responsibility of the courts in preserving competition. In balancing *ex post* deadweight loss against incentives to innovate, rule of reason becomes a factual inquiry into the appropriate reward. In this factual inquiry, should the court naively assume that the costs of the patentholder determine the necessary reward? Or should the factual inquiry about costs consider that some

other inventor could have achieved the patent more cheaply, and that too much reward only encourages waste? Should the inquiry consider that research is risky, and that a discoverer would only have invested if he expected a super-reward if successful? Given that the research endeavor was eventually successful, what evidence could be adduced to show that it might not have been, and with what probability? The considerations seem endless and extend far beyond evidence before the court.

Another, related interpretation of rule of reason was proposed by Kaplow (1984), who suggested the principle that a given restrictive practice should be allowed if it increases the (per-unit-time) ratio of profit to deadweight loss. Congress could then adjust the life of the right to adjust the overall reward. This is an economically sensible idea, but it makes no clear separation between policy-setting with respect to rewards and the antitrust treatment of licensing. Tellingly, the same principle was resuscitated in the 1990's as a principle about patent design, rather than antitrust rules (see Klemperer 1990, Gilbert and Shapiro 1990, Gallini 1992, Maurer and Scotchmer 2002). In our view, patent design is the context to which it is best suited.

In short, the most troubling aspect of rule of reason is that it does not draw a boundary between policy-setting and antitrust jurisprudence at all. The two are almost completely conflated. This paper retreats from that conflation. We adopt the conceit that Congress has been clear on its policies, particularly as to length and breadth of an intellectual property right. Within that policy context, courts should then conduct an antitrust inquiry governed by the three principles we have suggested.

6. Deriving *Per Se* Rules from the Three Principles

The virtue of our three principles is that they can be applied in many different contexts to arrive at sensible and unambiguous *per se* rules. We have investigated two such contexts above. This is not to suggest that the principles will be useful in all circumstances, or that they will resolve all controversies, but that is not a reason to discard them in cases where they are useful. In this section we elaborate more on the

meanings of the principles, and how they might be used.

Our just-reward principle does not mean that Congress has in mind a certain size for the inventor's reward, and wants to give that reward in the least onerous way. That point of view would transform the problem into an optimal-tax problem, in which the tax needn't bear any relationship to the invention. Such a transformation would undermine the incentive purpose of the patent system. Instead, our just-reward principle assumes only that the length and breadth (and perhaps other policy levers such as the right to reverse engineer) have been fixed, and within that framework, that the inventor must earn her profit from the value she has contributed. If the social value of the invention is high, her profit will typically be high, regardless of the costs of invention. Our just-reward principle is not about the *size* of the reward, but rather about its *source*. The innovator may or may not be entitled to \$100,000, but if she is, she had better earn it by taxing the beneficiaries of her invention, and not, for example, by cartelizing a market she did not create. If the intellectual property right is being exercised appropriately, it cannot make any user worse off than he would be, absent the invention. We have argued that this principle is embodied in both the constitution and case law. Sham licensing is the usual name applied when a licensing practice goes beyond the just-reward principle.

Some licensing practices, such as those considered in section 3.2, generate a Pareto improvement. That is, the license makes the rightholder better off without making users worse off. Such licenses are clearly in the public interest. However, many practices – the controversial ones – seem to make users worse off while making inventors better off, at least from an *ex post* point of view. This is where our profit-neutrality principle enters. To know whether the licensing practice makes users worse off, one must answer “compared to what.” Our profit-neutrality principle provides the comparison. We assume that the rightholder is entitled to as much profit as would be available if he could work the patent efficiently without licensees. He should not be penalized because, for example, he cannot build manufacturing plants, and users should not receive a corresponding windfall.

Finally, the minimalism principle says that licensing practices should not be tolerated unless required for profit neutrality. Minimalism is a tie-breaking rule that removes much of the potential for sham licenses. In much of the analysis above, licensors could not increase their profit by stipulating prices even if they were allowed to do so. Allowing price-setting should therefore have no beneficial effect. In those cases, there is no harm in proscribing it.

The difficulty, as we have pointed out, is that when there is an issue of productive efficiency (when both the licensee and licensor are manufacturers), price setting may be necessary for profit neutrality. A *per se* rule would subsume those circumstances as factors that legitimate price-fixing.

We admit that our *per se* rules eliminate the court's ability to fine-tune patent rewards after the fact, as might seem desirable based on the costs of development. However, although the incentives needed in some industries may be higher than in others, and it would be socially beneficial to distinguish those cases, rule-of-reason analysis at the antitrust level may not be the place to do it. We think it wiser to grant Congress its one-size-fits-all patent law, perhaps cleaving off some subject matters for *sui generis* treatment, and to use the three principles to determine which license restrictions are acceptable.

7. Conclusion

The *General Electric* price-setting exception, as limited by subsequent courts, is for the most part consistent with the just-reward, profit-neutrality and minimalist principles. The main situation where profit neutrality requires price setting is when licensors and licensees compete with each other, including cross licensing of blocking patents. The minimalist principle should restrict it to those circumstances.

If this set of rules were abandoned in favor of rule of reason, Congress would lose control over patent incentives. Of course, rule of reason also creates flexibility, and allows rewards to be tailored to circumstances. However we are not confident

that this flexibility will be exercised in a way that is an improvement.

The various restrictions on patent licensing that have evolved in the case law have long been criticized as *ad hoc* and incoherent. The absence of a unifying principle has made patentholders reluctant to write creative license terms, since it has been difficult to predict their legality. Such uncertainty can chill the licensor's ability to exploit the patent right. Our three principles provide a coherent framework for deciding when a particular license term should receive antitrust immunity, and provides a language in which lawyers can argue their case.

8. Appendix:

8.1. Fixing a Licensee's Price, but not the Licensor's Price

We showed in section 2.1 that *General Electric* restores profit neutrality by fixing the licensee's price to match the licensor's price. Here we show that it is not enough simply to specify a price for the licensee, without committing the licensor to the same price.

To support the monopoly profit, the stipulated price will have to be $p(q^*)$, and the equilibrium supplies will have to be $q_1 = q_2 = \frac{q^*}{2}$. Supposing that $q_2 = \frac{q^*}{2}$ the royalty must be (2.12) in order to ensure that $q_1 = \frac{q^*}{2}$. Then, since the licensee cannot charge a price higher than $p(q^*)$, he has no incentive to cut supply in order to raise the market price. And he has no incentive to increase supply, since he would then pay more in royalties and costs than the price of the marginal unit.

Thus, the price-fix will ensure that the licensee supplies the optimal quantity, $\frac{q^*}{2}$. However, it is still not easy to control the licensor's incentive to be opportunistic. With a fixed price for the licensee, the licensor wants to increase supply beyond $\frac{q^*}{2}$, and thus profit at the licensee's expense.

Defining the licensor's profit function will now be a little trickier because of the out-of-equilibrium rationing problem. To test whether $q_1 = q_2 = \frac{q^*}{2}$ is an equilibrium,

the licensor must hypothesize what will happen if he increases or decreases his own supply. If he deviates in supply, there will be two prices in the market. If the licensor cuts supply, so that aggregate supply is less than q^* , the licensor's supply price will be higher than $p(q^*)$, while the licensee's price is fixed at $p(q^*)$. If the licensor increases supply, his supply will be sold at a price lower than $p(q^*)$, while the licensee sells at $p(q^*)$.

Regardless of a buyer's willingness to pay, he would rather buy a cheaper unit than a more expensive unit, and therefore the cheaper units will have to be rationed among buyers. We assume that all of the cheaper units are sold, but that some of the higher-priced supply might remain unsold. A customer might buy from the higher-priced firm if he cannot get a lower-priced unit, but only if his willingness to pay is above the higher price. But if most of the customers with relatively high willingness to pay manage to buy from the lower-priced firm, then the only remaining customers for the higher-priced firm are those with lower willingness to pay, who may choose instead to stay out of the market. Thus, the number of units that the higher-priced firm sells depends on the rationing rule.

It is clear that the licensor will not want to cut his supply below $\frac{q^*}{2}$, because he would not want to do this even if he could sell all his units at the higher price required to clear the market, $p(q_1 + q_2) = p(q_1 + \frac{q^*}{2})$. Using (2.2), profit is increasing with q_1 at $q_1 = \frac{q^*}{2}$. Thus, for reducing the supply instead of increasing it ($dq_1 < 0$ instead of $dq_1 > 0$), profit will decrease. The worry, as in the previous section, is not that the licensor will want to cut supply, but that he will want to increase it.

If the licensor increases supply, he will be the lower-priced firm selling all his units. However, the licensee may not sell all his units. We will describe the rationing rule by a decreasing (or nonincreasing) differentiable function $\hat{q}_2: [\frac{q^*}{2}, \infty) \rightarrow [0, \frac{q^*}{2}]$ where $\hat{q}_2(q_1)$ is the number of units that the licensee can sell if he produces $\frac{q^*}{2}$ units and the licensor produces q_1 units, $q_1 > \frac{q^*}{2}$. We assume that $\hat{q}_2(\frac{q^*}{2}) = \frac{q^*}{2}$, which means that demand is exactly met if both firms produce $\frac{q^*}{2}$, selling at the market-clearing price $p(q^*)$. Since \hat{q}_2 is decreasing with q_1 , $\hat{q}_2(q_1) \leq \frac{q^*}{2}$, as is logically necessary, since

the licensee cannot sell more than he produces. The assumption that the licensees' sales, \hat{q}_2 , are decreasing with q_1 reflects rationing. If there are more lower-priced units, there will be more consumers with high willingness to pay finding them, and that cuts into the licensee's sales. By increasing supply and selling lower-priced units, the licensor crowds out sales by the licensee.

Two special cases are complete crowding out, so that $\frac{d\hat{q}_2(q_1)}{dq_1} = -1$, and no crowding out, so that $\frac{d\hat{q}_2(q_1)}{dq_1} = 0$.

Then the licensor's profit function is the following.

$$\hat{\pi}^1(q_1, q_2) = p(q_1 + \hat{q}_2(q_1))q_1 + \rho\hat{q}_2(q_1) - \int_0^{q_1} \gamma(\hat{q})d\hat{q} \quad (8.1)$$

$$= (1 - q_1 - \hat{q}_2(q_1))q_1 + \rho\hat{q}_2(q_1) - \int_0^{q_1} \gamma(\hat{q})d\hat{q} \quad (8.2)$$

$$= (1 - q_1)q_1 - (q_1 - \rho)\hat{q}_2(q_1) - \int_0^{q_1} \gamma(\hat{q})d\hat{q} \quad (8.3)$$

Taking the derivative with respect to q_1 ,

$$\frac{\partial \hat{\pi}^1(q_1, q_2)}{\partial q_1} = (1 - 2q_1) - \hat{q}_2(q_1) + (\rho - q_1)\frac{d\hat{q}_2(q_1)}{dq_1} - \gamma(q_1)$$

Evaluating at $q_1 = q_2 = \frac{q^*}{2}$, and using (2.12) and (2.2), the derivative is zero in the extreme case of complete crowding out, $\frac{d\hat{q}_2(q_1)}{dq_1} = -1$, but otherwise positive. Even with the fixed price, the licensor will behave opportunistically in increasing supply. The problem cannot be solved by making the royalty ρ larger, since the licensee would not then be willing to produce $\frac{q^*}{2}$ units.

In the special case of complete crowding out, the fixed-price license can support the profit maximum. With complete crowding out, the licensor is punished for his supply deviation by losing a lot of royalty revenue. However complete crowding will be unlikely. It essentially means that all the customers with lower willingness to pay who could have been brought into the market by the licensor's increased supply have found themselves at the higher-priced firm, and therefore decide not to purchase. This would not happen with random assignment of customers to firms.

8.2. Cross Licensing when firms have increasing marginal cost

We augment section 3.3, showing why royalties must satisfy (??) in order for the cross license to support the monopoly price for the enhanced good, assuming that the inferior product is not supplied. Taking as given the royalties (ρ_1, ρ_2) and firm 2's supply, q_2 , firm 1's profit, as a function of its own supply q_1 , is

$$\left(p(q_1 + q_2) - \rho_1 - \int_0^{q_1} \gamma(z) dz \right) q_1$$

and the profit-maximizing quantity satisfies

$$q_1 = \frac{1}{2} (1 + \Delta - q_2 - \rho_1 - \gamma(q_1)) \quad (8.4)$$

Similarly, firm 2's profit-maximizing quantity satisfies

$$q_2 = \frac{1}{2} (1 + \Delta - q_1 - \rho_2 - \gamma(q_2)) \quad (8.5)$$

By adding (3.17) and (3.18), setting $q_1 = q_2 = \frac{1}{2}q^*(\Delta)$, it follows that

$$q_1 + q_2 = \frac{2}{3}(1 + \Delta) - \frac{1}{3}(\rho_1 + \rho_2) - \frac{1}{3}(\gamma(q_1) + \gamma(q_2)) \quad \text{and}$$

$$(\rho_1 + \rho_2) = \frac{1}{2}(1 + \Delta) - \frac{1}{2}\gamma\left(\frac{q^*(\Delta)}{2}\right)$$

instead of (3.15). Since the royalty rates must be equal in order to sustain equal output, (3.22) follows.

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