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An analysis of Article L. 615-7

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Damage rules and the patent hold-up problem : An analysis of Article L. 615-7[*]

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Abstract

This paper provides an analysis of two damage rules (Lost Profit *versus* Unjust Enrichment) introduced in the French *Code de la Propriété Intellectuelle* in 2007 (Loi du 27 Octobre 2007, Art. L. 615-7). We use a simple sequential game where both the decisions to infringe and to enforce the patent, as well as the decisions to accomodate, settle or litigate the case, and the outputs decisions (Cournot competition) are endogenous. We characterize the equilibria associated with each rule, and compare their properties. We show that: 1/ the Unjust Enrichment rule provides Patentees with higher damages compensation than the Lost Profit one; however, 2/ Lost Profit induces more deterrence of infringement, and is associated with less trials than Unjust Enrichment; 3/ Unjust Enrichment may deter the Patentee to enforce his right; 4/ when there is a positive probability that the case settles, Patentee's expected utility is higher under Lost Profit than under Unjust Enrichment.

Keywords: lost profit rule, unjust enrichment rule, intellectual property rights, patent litigations, pretrial negotiations.

JEL classification: 03, L1, L4, D8, K2, K4.

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1 Introduction

The reform of the French Code de la Propriété Intellectuelle passed in 2007 has provided Courts with a set of rules that may be used for assessing the value of damages awarded to plaintiffs, retaining a large definition for the loss of business:

"*Pour fixer les dommages et intérêts, la juridiction prend en considération les conséquences économiques négatives, dont le manque à gagner, subies par la partie lésée, les bénéfices réalisés par le contrefacteur et le préjudice moral causé au titulaire des droits du fait de l'atteinte [...].*" (Loi du 29 octobre 2007; for both industrial property (Art. L. 615-7, L.622-7, L.623-28 and L.716-4) and copyright (Art. L.331-1-3))"

French Jurisdictions have now the opportunity to consider the loss of business and profits borne by the patentee (Lost Profits rule), as well as the illegal benefits obtained by the infringer (Unjust Enrichment rule). The main motivation for such a reform was that the ancient code (Loi No 68-1 du 2 janv. 1968, art. 57) only considered that the damages paid by the infringer to the patentee must be set according to the value of forfeiting goods (*i.e.* the illegal profits obtained by the infringer if they have been successfully sold). The practical consequences were that the compensations obtained by plaintiffs were generally set at a very low level in France (Baudry and Dumont, 2005), and it may be suspected that this has prevented many patentee(s) to sue their infringer(s), given the high costs and delays associated with legal disputes in IPR infringement cases.

In this paper, we analyze some of the effects of Art. L. 615-7, in link with the use of both the Lost Profit and Unjust Enrichment rules[1]. In our model, we focus on the case of a Intellectual Property Rights that normally would be licensed. We will assume that IPR are *probabilistic*, i.e. there is a risk that the litigated IPR be found invalid; this is now the standard assumption adopted in the literature (see Anton and Yao, 2003, 2006; Choi, 2009; Crampes and Langinier, 2002; Farrell and Shapiro, 2008; Meurer, 1989; Schankerman and Scotchmer, 2001; Shapiro, 2010). It has strong empirical supports, since many studies have reported the dramatic increase in the number of patent litigation cases over the two last decades (Lanjouw and Lerner, 1998; Bessen and Meurer, 2005; Baudry and Dumont, 2005), and Allison and Lemley (1998) found a figure close to 50% for the plaintiffs' rate of success considering all litigated patents. On the other hand, our model departs

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[1]The 2007 reform also introduces a third possible rule, Ideal Royalties: "Toutefois, la juridiction peut, à titre d'alternative et sur demande de la partie lésée, allouer à titre de dommages et intérêts une somme forfaitaire qui ne peut être inférieure au montant des redevances ou droits qui auraient été dus si le contrefacteur avait demandé l'autorisation d'utiliser le droit auquel il a porté atteinte." (Loi du 29 octobre 2007; for both industrial property : Art. L. 615-7,. L.622-7; L.623-28 et L.716-4; and copyright : Art. L.331-1-3). We let it aside for further research.

in several respects with those existing in the literature: 1/ we consider for both players a richer set of strategies than usually considered: both the decision to enforce the patent, and the decision to infringe it, are endogenous here; 2/ we assume that pretrial negotiations operate under asymmetric information between litigants, the legal costs of the Infringer being private information. Such an assumption may be seen as an analytical short-cut (see also Chopard and ali, 2010) capturing that parties opposed in a litigation may initially be unequally endowed in terms of skill or ability to predict the verdict at trial.[2] This is consistent with the assumption that the occurrence of a trial is not certain, nor is certain the verdict in case of trial.

Section 2 introduces the basic framework. Section 3 discusses the properties of the equilibria when Lost Profit is awarded by Courts, and section 4 considers the same issues when Unjust Enrichment are applied. Section 5 compares the different effects of these damage rules at equilibrium: on 1/ the value of damages awarded to plaintiffs in case they prevail at trial, 2/ the level of deterrence of IPR infringement, 3/ the level of deterrence of IPR enforcement, 4/ the frequency of trials, and 5/ the level of plaintiffs' total expected profits associated with IPR litigations. Section 6 concludes.

2 Model and assumptions

We consider here that the Patentee holds an IPR on a drastic innovation. The game between the Infringer and the Patentee has four main stages. At stage 1, Nature chooses the legal cost (i.e. type) of the Infringer c_e which is a private information. The Patentee only knows that the value of the Infringer's cost is a random variable $c_e \in [\underline{c}_e, \bar{c}_e]$ distributed according to a cumulative function $G(c_e)$ and a density $g(c_e)$. In contrast, the Patentee's litigation costs, denoted c_h, are common knowledge. At stage 2, the Infringer has to decide whether he enters and imitates the patent without a license (chooses *Infringe*), and competes *à la* Cournot with the Patentee (the potential market is a duopoly); or he does not enter and earns 0 (chooses *Non Infringe*) such that the Patentee earns π^M (the potential market is a monopoly). In case of infringement, the game reaches the next to last stage. At stage 3, the Patentee chooses either *Accommodate* to adapt the entry of the Infringer (thus, they earn their duopoly profits, respectively π_e^A for the Infringer and π_h^A for the Patentee), or *Litigate* such that the Patentee earns at least the market profit π_h^L, while the Infringer earns at best π_e^L, knowing that the case may be defended at trial or be settled. When the case is litigated, the game reaches the last stage. At stage 4, the pretrial bargaining process takes place: the Patentee makes a (take-it-or-leave-it) *licensing price Offer* ℓ to

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[2] There is some empirical support for this assumption (Osborne, 1999).

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the Infringer, corresponding to a price for the patent agreement (or fees for the normal use of the patent). On the one hand, if the Infringer chooses *Accept*, they settle amicably their dispute - and they earn their duopoly profits, up to the cost and price of licensing, respectively $u_e(\ell) = \pi_e^L - \ell$ for the Infringer and $u_h(\ell) = \pi_h^L + \ell$ for the Patentee. On the other hand, if the Infringer chooses *Reject*, then a trial occurs. The Court sets for the Patentee/plaintiff with probability $\theta \in]0, 1[$, i.e. claims that the patent is valid. The verdict consists in a damage that the Infringer must pay to the Patentee, denoted as $D \in \{D_{LP} = \pi^M - \pi_h^L, D_{UE} = \pi_e^L\}$ depending on whether the Lost Profit rule or the Unjust Enrichment rule is applied; thus, the expected profit for each party is respectively $u_e(c_e) = \pi_e^L - \theta D - c_e$ for the Infringer, and $u_h(c_h) = \pi_h^L + \theta D - c_h$ for the Patentee (i.e. duopoly profits minus legal cost incurred at trial, up to the expected award θD).

The market demand is linear with a demand price given by: $P = a - b(y_h + y_e)$, where $a, b > 0$ and y_h, y_e denoting the quantity produced by the Patentee and the Infringer, respectively. The technology of production entails constant marginal costs of production, respectively: $k < a$ (after innovation occurs, for both firms). Note that when the patent is not infringed, the Patentee produces $y^M = \frac{a-k}{2b}$ and earns his monopoly profit $\pi^M = b\left(\frac{a-k}{2b}\right)^2$, while the Infringer produces nothing and earns 0. We will also make the following assumptions, in order to let aside technical difficulties (existence, uniqueness of equilibrium) which are not at the heart of our point here:

Assumption 1: the ratio $\frac{1-G}{g}$ is decreasing on $[\underline{c}_e, \bar{c}_e]$, and satisfies: $\left(\frac{1-G}{g}\right)_{|\underline{c}_e} > c_h + \bar{c}_e$ and $\left(\frac{1-G}{g}\right)_{|\bar{c}_e} < c_h + \underline{c}_e$.

The next assumption means that Plaintiff's claim is credible at trial:

Assumption 2: $\theta D - c_h > 0$.

Before proceeding to the analysis, let us discuss two assumptions of our model, that may be seen as restrictive. First, we consider a *screening* game. The reason is that when legal costs are private information, their signalling role typically does not exist under the *fee shifting* rule introduced here (see Chopard and ali, 2010); however, our objective was to analyse the pure effects of damages rules, and thus a complete analysis of fee shifting, or the study of policies substituting damages with legal costs, are beyond the scope of this paper. Second, we introduce a *one-shot* pretrial negotiations game; but this is wlog, since the *generality* of this set up for pretrial negotiations is well known in the *L&E* literature (see Daughety and Reinganum, 2012; Spier, 2007).

3   Equilibria under the Lost Profit rule

The two following propositions give the results for the Lost Profit rule, under which $D_{LP} = \pi^M - \pi_h^L$. By $\left(\pi_i^L\right)_{LP}$ for $i = h, e$ we will denote the value of firm i's profit at equilibrium under the Lost Profit rule.

Proposition 1 If $\theta \leq \frac{\left(\pi_e^L\right)_{LP} - c_e^*}{\pi^M - \left(\pi_h^L\right)_{LP}}$, where c_e^* satisfies $\left(\frac{1-G}{g}\right)_{|c_e^*} = c_e^* + c_h$, the next profile of strategies is an equilibrium:

- the Patentee produces $\left(y_h^L\right)_{LP} = \frac{a-k}{b(3-\theta)}$, chooses Litigate, and makes the licensing offer $\ell^* = \theta\left[\pi^M - \left(\pi_h^L\right)_{LP}\right] + c_e^* > 0$.

- the Infringer chooses Infringe, produces $\left(y_e^L\right)_{LP} = \frac{(1-\theta)(a-k)}{b(3-\theta)}$, and chooses Reject if $c_e \in [\underline{c}_e, c_e^*[$, or Accept if $c_e \in [c_e^*, \bar{c}_e]$.

Proof. The proof consists in three main stages.

- At stage 4, assume the Patentee believes that all types of Infringer have chosen *Infringe* (we will verify this is consistent). Hence, assume he offers a licensing price $\ell > 0$, associated with a cut-off value $c_\ell \in]\underline{c}_e, \bar{c}_e[$ satisfying $u_e(\ell) = u_e(c_\ell)$ with $D_{LP} = \pi^M - \pi_h^L$; thus any Infringer $c_e < c_\ell$ rejects ℓ (a trial occurs with probability $G(c_\ell)$), while any Infringer $c_e \geq c_\ell$ accepts ℓ (the case is settled with probability $1 - G(c_\ell)$). The maximization of:

$$U_h\left(\ell; c_\ell\right) = \left(1 - G(c_\ell)\right) u_h(\ell) + G(c_\ell) u_h(c_h) \quad s.t. \quad u_e(\ell) = u_e(c_\ell)$$

yields the solution (ℓ^*, c_e^*) corresponding to the best licensing price $\ell^* = \theta\left[\pi^M - \left(\pi_h^L\right)_{LP}\right] + c_e^* > 0$ (given by $u_e(c_e^*) = u_e(\ell^*)$) associated with the cut-off value c_e^* (which satisfies $\left(\frac{1-G}{g}\right)_{|c_e^*} = c_e^* + c_h$).

- At stage 3, if the Patentee chooses *Litigate* and the Infringer chooses *Infringe* whatever his type, Cournot competition between both firms yields the output levels $\left(\left(y_h^L\right)_{LP} = \frac{a-k}{b(3-\theta)}, \left(y_e^L\right)_{LP} = \frac{(1-\theta)(a-k)}{b(3-\theta)}\right)$ which solve the system[3]:

$$(1-\theta)\frac{\partial \pi_h^L}{\partial y_h} = 0 \tag{1}$$

$$\frac{\partial \pi_e^L}{\partial y_e} + \theta\frac{\partial \pi_h^L}{\partial y_e} = 0 \tag{2}$$

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[3]The best response functions are defined as:

$$y_h^L = \underset{y_h}{\arg\max}\left\{U_h\left(\ell^*; c_e^*\right) \text{ s.t. } P = a - b(y_h + y_e)\right\}$$

$$y_e^L = \underset{y_e}{\arg\max}\left\{u_e(c_e) \text{ s.t. } P = a - b(y_h + y_e)\right\}$$

On the other hand, if the Patentee chooses *Accommodate* and the Infringer chooses *Infringe*, the symmetric Cournot-Nash equilibrium at the market stage corresponds to the output level $y^A = \frac{a-k}{3b} \left(= y_h^A = y_e^A\right)$ which is the solution to the (usual) system[4]:

$$\frac{\partial \pi_h^L}{\partial y_h} = 0$$
$$\frac{\partial \pi_e^L}{\partial y_e} = 0$$

Thus, the Patentee chooses *Litigate* rather than *Accommodate* if $U_h\left(\ell^*; c_e^*\right) \equiv \left(\pi_h^L\right)_{LP} + \theta\left(\pi^M - \left(\pi_h^L\right)_{LP}\right) - G(c_e^*)c_h + \left(1 - G(c_e^*)\right)c_e^* \geq \pi_h^A$; this inequality holds under assumption 2, given that the Lost Profit rule implies $\pi^M > \left(\pi_h^L\right)_{LP} > \pi_h^A$.

- At stage 2, the Infringer knows that at the pretrial negotiation stage he will obtain at least $u_e(\ell^*) = \left(\pi_e^L\right)_{LP} - \ell^*$ (if *Infringe* is chosen) whatever his type, rather than 0 (if *Non Infringe* is chosen). Thus, *Infringe* is the best decision if $\left(\pi_e^L\right)_{LP} - \ell^* \geq 0 \Leftrightarrow \theta \leq \frac{\left(\pi_e^L\right)_{LP} - c_e^*}{\pi^M - \left(\pi_h^L\right)_{LP}}$. If this condition holds, then all Infringers' types choose *Infringe*, and thus Patentee's belief is also consistent. ∎

Proposition 1 illustrates[5] a situation with a strong strategic interaction between the litigants: when the patent is weak – in the sense that $\theta \leq \frac{\left(\pi_e^L\right)_{LP} - c_e^*}{\pi^M - \left(\pi_h^L\right)_{LP}}$ – the Patentee always enforces his property right since it is always infringed. As the Patentee litigates and settles, he has the opportunity to extract a licensing price ℓ^* and obtains a payoff larger than at trial, $\left(\pi_h^L\right)_{LP} + \ell^*$. The counterpart is that all Infringer's types have an incentive to chose *Infringe* rather than *Non Infringe*, and the highest types $c_e \in]c_e^*, \bar{c}_e]$ obtain an informational rent in settling the case $\left(\left(\pi_e^L\right)_{LP} - \ell^* > \left(\pi_e^L\right)_{LP} - \theta D_{LP} - c_e \text{ for all } c_e \in]c_e^*, \bar{c}_e] \right)$.

Remark that the threat of a trial introduces a distortion in the sharing of the market output between firms: the Patentee produces more than the Infringer $\left(y_h^L\right)_{LP} > \left(y_e^L\right)_{LP}$ under the Lost Profit rule, despite identical marginal costs. The first order conditions (1)-(2) illustrate the general property that along the equilibrium path where the Patentee chooses *Litigate* (hence, either the case is settled, or there is a trial), his best response function is not affected under Lost Profit by the occurrence of a trial as compared to the standard Cournot-Nash equilibrium (same FOC). In

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[4]The best response functions are defined as:

$$y_h^A = \arg\max_{y_h}\left\{\pi_h^A = (P - k)y_h \text{ s.t. } P = a - b(y_h + y_e)\right\}$$
$$y_e^A = \arg\max_{y_e}\left\{\pi_e^A = (P - k)y_e \text{ s.t. } P = a - b(y_h + y_e)\right\}$$

[5]In a sense, holding a strong patent is neither necessary nor sufficient for enforcing the patent.

contrast, the Infringer's best response function displays lower incentives to produce ($\frac{\partial \pi_e^L}{\partial y_e} + \theta \frac{\partial \pi_h^L}{\partial y_e} < \frac{\partial \pi_e^L}{\partial y_e}$). In word, the threat of a trial produces a negative externality at the market stage, and the Lost Profit rule posits this externality on the Infringer.

The following proposition considers cases associated with a strong patent:

Proposition 2 If $\theta > \frac{(\pi_e^L)_{LP} - c_e^*}{\pi^M - (\pi_h^L)_{LP}}$, and if it exists $\tilde{c}_e \in [\underline{c}_e, c_e^*[$ which satisfies $\tilde{c}_e = (\pi_e^L)_{LP} - \theta [\pi^M - (\pi_h^L)_{LP}]$, the next profile of strategies is an equilibrium:

- the Patentee produces $y^M = \frac{a-k}{2b}$ conditional on $c_e > \tilde{c}_e$; he chooses Litigate and produces $(y_h^L)_{LP} = \frac{a-k}{b(3-\theta)}$ conditional on $c_e \leq \tilde{c}_e$, and makes a licensing offer $\ell > \tilde{\ell} = \theta [\pi^M - (\pi_h^L)_{LP}] + \tilde{c}_e$.

- the Infringer chooses (Infringe, Reject) and produces $(y_e^L)_{LP}$ if $c_e \in [\underline{c}_e, \tilde{c}_e[$; while he chooses Non Infringe if $c_e \in [\tilde{c}_e, \bar{c}_e]$.

Proof. We only provide here a brief sketch of the proof. If $\theta > \frac{(\pi_e^L)_{LP} - c_e^*}{\pi^M - (\pi_h^L)_{LP}}$, then at stage 2 all Infringer's types cannot choose *Infringe* since $u_e(\ell^*) < 0$, and thus the equilibrium of proposition 1 breaks. Then, consider the threshold value $\tilde{c}_e$ for which $u_e(\tilde{c}_e) = 0 \Leftrightarrow (\pi_e^L)_{LP} - \theta [\pi^M - (\pi_h^L)_{LP}] = \tilde{c}_e$ (assuming that $\tilde{c}_e \in]\underline{c}_e, \bar{c}_e[$) and let us compare two alternative situations. **Case 1:** at stage 4, assume that the Patentee offers $\tilde{\ell}(< \ell^*)$ defined as $\tilde{\ell} = (\pi_e^L)_{LP} = \theta [\pi^M - (\pi_h^L)_{LP}] + \tilde{c}_e$; then the Infringer chooses either *(Infringe, Accept)* if his type satisfies $c_e \geq \tilde{c}_e$, or *(Infringe, Reject)* if his type satisfies $c_e < \tilde{c}_e$. When the Patentee chooses *Litigate* at stage 3, this yields him:

$$U_h(\tilde{\ell}; \tilde{c}_\ell) = (1 - G(\tilde{c}_e)) \left((\pi_h^L)_{LP} + \tilde{\ell} \right) + G(\tilde{c}_e) \left((\pi_h^L)_{LP} + \theta [\pi^M - (\pi_h^L)_{LP}] - c_h \right)$$

It is easy to see that $U_h(\tilde{\ell}; \tilde{c}_\ell) = (\pi_h^L)_{LP} + \theta [\pi^M - (\pi_h^L)_{LP}] - G(\tilde{c}_e)c_h + (1 - G(\tilde{c}_e))\tilde{c}_e > \pi_h^A$ (given assumption 2) since : $\pi^M > (\pi_h^L)_{LP} > \pi_h^A$. But this cannot be an equilibrium; to see why, let us investigate the second case. **Case 2:** assume that the Patentee makes a licensing offer $\ell > \tilde{\ell}$ at the pretrial stage. Then, the Infringer chooses *(Infringe)* if his type is $c_e \leq \tilde{c}_e$; otherwise, he chooses *Non Infringe*. Then, conditionally on the Infringer's type, the Patentee chooses *Litigate* (conditional on *Infringe*) and produces $(y_h^L)_{LP}$, or he produces his output y^M (conditional on *Non Infringe*). This yields him:

$$U_h(\ell; \tilde{c}_e) = (1 - G(\tilde{c}_e))\pi^M + G(\tilde{c}_e) \left((\pi_h^L)_{LP} + \theta [\pi^M - (\pi_h^L)_{LP}] - c_h \right)$$

Once more it is easy to see that $U_h(\ell; \tilde{c}_e) = (1 - G(\tilde{c}_e))\pi^M + G(\tilde{c}_e) (\pi_h^L)_{LP} + G(\tilde{c}_e) \left(\theta [\pi^M - (\pi_h^L)_{LP}] - c_h \right) > \pi_h^A$, given assumption 2 and given that $(1 - G(\tilde{c}_e))\pi^M + G(\tilde{c}_e) (\pi_h^L)_{LP} > \pi_h^A$. Then we have: $U_h(\tilde{\ell}; \tilde{c}_e) - U_h(\ell; \tilde{c}_e) = (1 - G(\tilde{c}_e)) \left((\pi_h^L + \pi_e^L)_{LP} - \pi^M \right)$. It is easy to verify that the sign of

$\pi^M - \left(\pi_h^L + \pi_e^L\right)_{LP}$ is the same as the sign of $f(\theta) = 1 + 2\theta - 3\theta^2$, with $f(0) = 1$ and $f(1) = 0$; moreover, $f(\theta)$ increases for $\theta \in [0, 1/3[$ and decreases for $\theta \in]1/3, 1]$. This implies $\pi^M - \left(\pi_h^L + \pi_e^L\right)_{LP} > 0$ for all $\theta \in [0, 1[$, and $\pi^M - \left(\pi_h^L + \pi_e^L\right)_{LP} = 0$ for $\theta = 1$. Hence, the result. ∎

Proposition 2 illustrates that when the patent is strong enough (i.e. $\theta > \frac{\left(\pi_e^L\right)_{LP} - c_e^*}{\pi^M - \left(\pi_h^L\right)_{LP}}$), infringement may be deterred at least when the Infringer has a high legal cost. Moreover, proposition 2 shows interestingly that the distortion in profits, that follows from the distortion in outputs levels due to the threat of a trial, is not monotonic in θ: it increases for $\theta \in]0, 1/3]$ (i.e. for θ small enough), and decreases for $\theta \in]1/3, 1]$ (i.e. for θ large enough). However, under Cournot competition where firms produce close substitutes, infringement always entails a dilution of monopoly profit, since at equilibrium we have: $\pi^M \geq \left(\pi_h^L + \pi_e^L\right)_{LP}$ (with a strict equality only for $\theta = 1$, for which $\left(\pi_h^L\right)_{LP} = \pi^M$ and $\left(\pi_e^L\right)_{LP} = 0$).

4   Equilibria under the Unjust Enrichment rule

The three next propositions focus on the Unjust Enrichment rule, for which $D_{UE} = \pi_e^L$. By $\left(\pi_i^L\right)_{UE}$ for $i = h, e$ we will denote the value of firm i's profit at equilibrium under the Unjust Enrichment rule.

Proposition 3 *If* $\frac{\pi_h^A - \left(\pi_h^L\right)_{UE} + G(c_e^*)(c_h + c_e^*)}{\left(\pi_e^L\right)_{UE}} - \frac{c_e^*}{\left(\pi_e^L\right)_{UE}} \leq \theta \leq 1 - \frac{c_e^*}{\left(\pi_e^L\right)_{UE}}$, *the next profile of strategies is an equilibrium:*

- the Patentee chooses Litigate, produces $\left(y_h^L\right)_{UE} = \left(y_e^L\right)_{LP}$, *and makes a licensing offer whose value is* $\ell^{**} = \theta \left(\pi_e^L\right)_{UE} + c_e^* > 0$.

- the Infringer chooses Infringe, produces $\left(y_e^L\right)_{UE} = \left(y_h^L\right)_{LP}$, *and chooses Reject if* $c_e \in [\underline{c}_e, c_e^*[$, *or Accept if* $c_e \in [c_e^*, \bar{c}_e]$.

Proof. We only give a sketch of the proof, since it is very close to the one of proposition 1.

- At stage 4, assume the Patentee expects that all types of Infringer have chosen *Infringe*. The maximization of:

$$U_h\left(\ell; c_\ell\right) = \left(1 - G(c_\ell)\right) u_h(\ell) + G(c_\ell) u_h(c_h) \quad s.t. \quad u_e(\ell) = u_e(c_\ell)$$

yields the solution $\left(\ell^{**}, c_e^*\right)$ corresponding to the best licensing price $\ell^{**} = \theta \left(\pi_e^L\right)_{UE} + c_e^* > 0$ (which solves $u_e(c_e^*) = u_e(\ell^{**})$) still associated with the cut-off value c_e^* (which satisfies $\left(\frac{1-G}{g}\right)_{|c_e^*} = c_e^* + c_h$).

- At stage 3, if the Patentee chooses *Litigate* and the Infringer chooses *Infringe*, Cournot competition between both firms yields the output levels $\left(\left(y_h^L\right)_{UE} = \frac{(1-\theta)(a-k)}{b(3-\theta)}, \left(y_e^L\right)_{UE} = \frac{a-k}{b(3-\theta)}\right)$ which solve the system[6]:

$$\frac{\partial \pi_h^L}{\partial y_h} + \theta \frac{\partial \pi_e^L}{\partial y_h} = 0 \tag{3}$$

$$(1-\theta)\frac{\partial \pi_e^L}{\partial y_e} = 0 \tag{4}$$

But the Patentee chooses *Litigate* rather than *Accommodate* only if $U_h\left(\ell^{**}; c_e^*\right) \equiv \left(\pi_h^L\right)_{UE} + \theta \left(\pi_e^L\right)_{UE} - G(c_e^*)c_h + (1 - G(c_e^*))\,c_e^* \geq \pi_h^A \Leftrightarrow \theta \geq \frac{\pi_h^A - \left(\pi_h^L\right)_{UE} + G(c_e^*)(c_h + c_e^*)}{\left(\pi_e^L\right)_{UE}} - \frac{c_e^*}{\left(\pi_e^L\right)_{UE}}$, which may not hold given assumption 2, since under the Unjust Enrichment rule we have now $\pi^M > \pi_h^A > \left(\pi_h^L\right)_{UE}$.

- At stage 2, the Infringer knows that if the Patentee enforces his right, then at the pretrial negotiation stage he will obtain at least $u_e(\ell^{**}) = \left(\pi_e^L\right)_{UE} - \ell^{**}$ (if *Infringe* is chosen) whatever his type, rather than 0 (if *Non Infringe* is chosen). Thus, *Infringe* is the dynamic consistent decision if $\left(\pi_e^L\right)_{UE} - \ell^{**} \geq 0 \Leftrightarrow \theta \leq 1 - \frac{c_e^*}{\left(\pi_e^L\right)_{UE}}$. If this condition holds, Patentee's belief is also consistent.
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Remark that according to the first order conditions (3)-(4), the negative externality of a trial is now shifted to the Patentee at the market stage, under the Unjust Enrichment rule: the threat of a trial introduces a distortion in the sharing of the output between firms, explaining that the Patentee now produces less than the Infringer: $\left(y_h^L\right)_{UE} < \left(y_e^L\right)_{UE}$.

Remark also that proposition 3 means that under the Unjust Enrichment rule, if the patent is weak enough but in a sense not too weak, it is always enforced since it is always infringed: the Patentee has always the opportunity to extract the licensing fees $\ell^{**} = \theta \left(\pi_e^L\right)_{UE} + c_e^* > 0$. Once more, all Infringer's types have thus an incentive to choose *Infringe* rather than *Non Infringe*.

The next proposition discusses the case with a strong patent.

Proposition 4 *If* $\theta > \max\left\{1 - \frac{c_e^*}{\left(\pi_e^L\right)_{UE}}, \frac{\pi^A - (1 - G(\hat{c}_e))\pi^M - G(\hat{c}_e)\left(\left(\pi_h^L\right)_{UE} - c_h\right)}{G(\hat{c}_e)\left(\pi_e^L\right)_{UE}}\right\}$, *where* $\hat{c}_e \in [\underline{c}_e, c_e^*[$ *satisfies* $\hat{c}_e = (1 - \theta)\left(\pi_e^L\right)_{UE}$, *the next profile of strategies is an equilibrium:*

- the Patentee produces $y^M = \frac{a-k}{2b}$ *conditional on* $c_e > \hat{c}_e$; *he chooses Litigate and produces* $\left(y_h^L\right)_{UE} = \left(y_e^L\right)_{LP}$ *conditional on* $c_e \leq \hat{c}_e$, *and makes a licensing offer* $\bar{\ell} > \hat{\ell} = \left(\pi_e^L\right)_{UE}$.

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[6]The best response functions are now:

$$y_h^L = \arg\max_{y_h}\left\{U_h\left(\ell^{**}; c_e^*\right) \text{ s.t. } P = a - b(y_h + y_e)\right\}$$
$$y_e^L = \arg\max_{y_e}\left\{u_e(c_e) \text{ s.t. } P = a - b(y_h + y_e)\right\}$$

- the Infringer chooses Infringe, produces $\left(y_e^L\right)_{UE} = \left(y_h^L\right)_{LP}$, *and then he chooses Reject if his type is* $c_e \in [\underline{c}_e, \hat{c}_e[$; *while he chooses Non Infringe if his type is* $c_e \in [\hat{c}_e, \bar{c}_e]$.

Proof. Let us simply highlight that at stage 2, it comes now that if $\left(\pi_e^L\right)_{UE} - \ell^{**} < 0 \Leftrightarrow \theta > 1 - \frac{c_e^*}{\left(\pi_e^L\right)_{UE}}$, *Non Infringe* is the dynamic consistent decision at least for the highest Infringer's types, conditional on the fact that the Patentee chooses *Litigate*. The end of the proof is very similar to the one of proposition 2, excepted that $\hat{c}_e = (1 - \theta)\left(\pi_e^L\right)_{UE}$ is the new cut-off value which allows to separate Infringer's types between the decisions *Infringe* (and *Reject*) and *Non Infringe*. Whether the Patentee proposes $\hat{\ell} = \left(\pi_e^L\right)_{UE}$ or $\bar{\ell} > \hat{\ell}$ depends on the sign of $U_h(\hat{\ell}; \hat{c}_e) - U_h\left(\bar{\ell}; \hat{c}_e\right) = (1 - G(\hat{c}_e))\left(\left(\pi_h^L + \pi_e^L\right)_{UE} - \pi^M\right)$, with once again $\left(\pi_h^L + \pi_e^L\right)_{UE} - \pi^M < 0$. Thus, the equilibrium is such that the Patentee offers $\bar{\ell}$ if $U_h\left(\bar{\ell}; \hat{c}_e\right) = (1 - G(\hat{c}_e))\pi^M + G(\hat{c}_e)\left(\left(\pi_h^L\right)_{UE} + \theta\left(\pi_e^L\right)_{UE} - c_h\right) \geq \pi^A \Leftrightarrow \theta \geq \frac{\pi^A - (1 - G(\hat{c}_e))\pi^M - G(\hat{c}_e)\left(\left(\pi_h^L\right)_{UE} - c_h\right)}{G(\hat{c}_e)\left(\pi_e^L\right)_{UE}}$. Under assumption 2 this condition may not hold since under the Unjust Enrichment rule we have now $\pi^M > \pi_h^A > \left(\pi_h^L\right)_{UE}$. Hence the result. ∎

The consequence of proposition 4 is that, when the patent is (too) strong, infringement may be deterred, under the Unjust Enrichment rule, at least in case where the Infringer pertains to the highest types. As shown in the next proposition, the counterpart of the two previous results is that the Patentee may prefer to accommodate the infringement of his right under the Unjust Enrichment rule. The proof is straightforward since at stage 3, the Patentee chooses *Accommodate* rather than *Litigate* if $U_h\left(\ell^{**}; c_e^*\right) \equiv \left(\pi_h^L\right)_{UE} + \theta\left(\pi_e^L\right)_{UE} - G(c_e^*)c_h + (1 - G(c_e^*))c_e^* < \pi_h^A \Leftrightarrow \theta < \frac{\pi_h^A - \left(\pi_h^L\right)_{UE} + G(c_e^*)(c_h + c_e^*)}{\left(\pi_e^L\right)_{UE}} - \frac{c_e^*}{\left(\pi_e^L\right)_{UE}}$. Hence, the result:
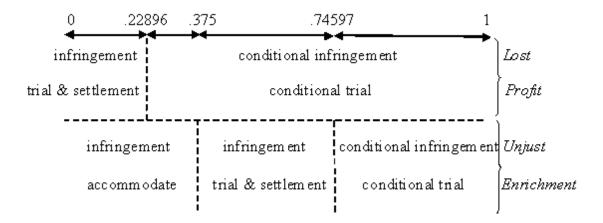
Proposition 5 *If* $\theta < \frac{\pi_h^A - \left(\pi_h^L\right)_{UE} + G(c_e^*)(c_h + c_e^*)}{\left(\pi_e^L\right)_{UE}} - \frac{c_e^*}{\left(\pi_e^L\right)_{UE}}$, *the next profile of strategies is an equilibrium: the Patentee chooses Accommodate, the Infringer chooses Infringe whatever his type, and both firms produce* $y^A = \frac{a - k}{3b}$.

Proposition 5 means that when the patent is too weak, enforcing his right may be a strategy too costly for the Patentee under the Unjust Enrichment rule, albeit it is always infringed; thus, it may be worth to accommodate the infringement. Note that this equilibrium occurs under the Unjust Enrichment rule (while it does not under the Lost Profit rule) despite the Patentee's claim is credible at trial.

5 Discussion

In the next graph, we report for each rule the outcome associated with the equilibrium strategies of the Infringer and of the Patentee[7], for different intervals of θ (patent strength):

<div align="center">

Graph 1

</div>

By *conditional infringement*, we mean that some Infringer's types do infringe (those having the smallest c_e) while others do not. By *conditional trial*, we mean that a trial occurs conditional on Infringer's types who infringe. Except for the highest values of θ where the outcome is the same under both rules, we observe that the features of equilibria associated with the different intervals is generally very different[8]. More generally, we obtain five main conclusions which allow to shed some lights on the consequences of the 2007 reform.

The first conclusion is that the Unjust Enrichment rule does not yield more deterrence than the Lost Profit – yet, we obtain the opposite result: the threshold of infringement under Lost Profit is smaller than under Unjust Enrichment, implying that the first rule is more effective in deterring infringement than the second.

The second conclusion is that the Unjust Enrichment rule has another unfortunate deterrent effect the Lost profit has not: the Patentee may be deterred from enforcing his right under the

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[7] We have numerically solved the inequalities (see proposition 1) $\left(\pi_e^L\right)_{LP} - \ell^* \geq 0 \Leftrightarrow 4(1-\theta)^2 - \left(\theta + \frac{c_e^*}{\pi^M}\right)(3-\theta)^2 + 4\theta \geq 0$ and (see proposition 3) $\left(\pi_e^L\right)_{UE} - \ell^{**} \geq 0 \Leftrightarrow 4(1-\theta) - \frac{c_e^*}{\pi^M}(3-\theta)^2 \geq 0$ for $\frac{c_e^*}{\pi^M} = 20\%$; the numerical resolution of the inequality (see proposition 3) $U_h\left(\ell^{**}; c_e^*\right) \geq \pi_h^A \Leftrightarrow 9(1-\theta)^2 + 9\theta + \left(\frac{(1-G(c_e^*))c_e^* - G(c_e^*)c_h}{\pi_h^A} - 1\right)(3-\theta)^2 \geq 0$ has been performed for $\frac{(1-G(c_e^*))c_e^* - G(c_e^*)c_h}{\pi_h^A} = 0$. As a matter of comparison, Lanjouw and Lerner (1998) found that the ratio of legal costs over R&D expenditures is close to 20%.

[8] It can be shown that this structure is also obtained for different values of the parameters.

Unjust Enrichment rule soon as the patent is weak enough. The driving force is that, despite the claim of the Patentee is credible at trial, his total expected profit (utility) associated with the enforcement strategy is smaller than his market profit when infringement is accommodated.

The third conclusion is that the frequency of trial is higher under the Unjust Enrichment rule; we give a general proof of this result in the next proposition.

Proposition 6 *The Unjust Enrichment rule yields a frequency of trials which is as least as large as the Lost Profit rule.*

Proof. Let us first compare the equilibria of propositions 1 and 3 (i.e. assume a solution where the case may be settled out of Court under both rules). In this case, a trial occurs with the same frequency under both rules: $G(c_e^*)$.

Now, let us compare the equilibria of propositions 2 and 4 (i.e. assume a solution where the Infringer may choose *Non Infringe* with some positive probability under both rules). By construction, we have:

$$\tilde{c}_e - \hat{c}_e = \left(\pi_e^L\right)_{LP} - \theta \left[\pi^M - \left(\pi_h^L\right)_{LP}\right] - (1-\theta)\left(\pi_e^L\right)_{UE}$$

and it can easily be verified that the sign of $\tilde{c}_e - \hat{c}_e$ is the same as the sign of $h(\theta) = \theta\left(-\theta^2 + 10\theta - 9\right)$. As $g(0) = 0$, $h(1) = 0$ and $h(\theta)$ is convex on $]0,1[$, we obtain that $\tilde{c}_e < \hat{c}_e \Rightarrow G(\tilde{c}_e) \leq G(\hat{c}_e)$ ($\tilde{c}_e < \hat{c}_e \Rightarrow G(\tilde{c}_e) < G(\hat{c}_e)$ for any $\theta \in [0,1[$, and $\tilde{c}_e = \hat{c}_e$ at $\theta = 1$). ∎

This result also implies that the Unjust Enrichment rule is associated with a larger (private) legal cost for IPR litigation cases, than the Lost Profit rule.

The fourth conclusion is focused on the size of the damages awarded to the plaintiff/Patentee when he prevails at trial: the Unjust Enrichment rule warrants higher damages than the Lost Profit[9]:

Proposition 7 *When a trial occurs at equilibrium, then $D_{LP} < D_{UE}$ for realistic values of* $\frac{(1-G(c_e^*))c_e^* - G(c_e^*)c_h}{\pi_h^A}$.

Proof. Given that $\left(\pi_e^L\right)_{UE} = \left(\pi_h^L\right)_{LP}$, we have $D_{LP} - D_{UE} = \pi^M - 2\left(\pi_h^L\right)_{LP}$. Thus it is easy to verify that the sign of $\pi^M - 2\left(\pi_h^L\right)_{LP}$ is the same as the sign of $g(\theta) = 1 - 6\theta + \theta^2$, with $g(0) = 1$ and $g(1) = -4$. Moreover $g'(\theta) = -6 + 2\theta < 0$, for any $\theta \in [0,1]$. Hence, it comes that

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[9]Note that this implies that $\ell^* < \ell^{**}$.

for any $\theta < 3 - 2\sqrt{2}(\simeq 0.17157)$, then $g(\theta) > 0 \Longrightarrow D_{LP} > D_{UE}$, while for any $\theta > 3 - 2\sqrt{2}$, then $g(\theta) < 0 \Longrightarrow D_{LP} < D_{UE}$.

On the other hand, the numerical resolution of the inequality $U_h\left(\ell^{**}; c_e^*\right) \geq \pi_h^A \Leftrightarrow 9(1 - \theta)^2 + 9\theta + \left(\frac{(1-G(c_e^*))c_e^* - G(c_e^*)c_h}{\pi_h^A} - 1\right)(3 - \theta)^2 \geq 0$, has been performed under different assumptions about the value of $\frac{(1-G(c_e^*))c_e^* - G(c_e^*)c_h}{\pi_h^A}$, making a distinction between cases with negative values as provided in the next table:

$\frac{(1-G(c_e^*))c_e^* - G(c_e^*)c_h}{\pi_h^A} =$	-20%	-10%	-3%	-2%	-1%
$\theta \geq$	.60943	.52203	.43221	.41523	.39638

and positive ones, as in the next table:

$\frac{(1-G(c_e^*))c_e^* - G(c_e^*)c_h}{\pi_h^A} =$	0%	1%	2%	3%	5%	9%
$\theta \geq$	.375	.37268	.37033	.36794	.36303	.35264

Note that Bessen and Meurer (2005) find that in around $1/4$ of IPR litigation cases both the infringer and the patentee are innovators (and thus $\frac{c_e^*}{\pi_h^A}$ is close to $\frac{c_h}{\pi_h^A}$), and that in a majority of cases, the plaintiff is a large firm (thus $\frac{(1-G(c_e^*))c_e^* - G(c_e^*)c_h}{\pi_h^A} < 0$). Thus, our simulations suggest that for values of $\frac{(1-G(c_e^*))c_e^* - G(c_e^*)c_h}{\pi_h^A}$ that are realistic (< 0), the probability threshold for which the Patentee litigates the case rather than accommodates it, is larger than 0.17157. Hence the result. ∎

The fifth conclusion is connected to Patentee's total expected gain in case of litigation (expected utility), and appears as less clear-cut.

Proposition 8 *i) When the case settles with a positive probability at equilibrium, Patentee's expected utility is larger under the Lost Profit rule than under the Unjust Enrichment rule. ii) When at least some Infringers' types do not infringe the patent at equilibrium, Patentee's expected utility under the Lost Profit rule may be larger or smaller than under the Unjust Enrichment rule.*

Proof. i) We have:

$$U_h\left(\ell^*; c_e^*\right) - U_h\left(\ell^{**}; c_e^*\right) = \left[\left(\pi_h^L\right)_{LP} - \left(\pi_h^L\right)_{UE}\right] + \theta\left(\pi^M - \left(\pi_h^L\right)_{LP} - \left(\pi_e^L\right)_{UE}\right) \tag{5}$$

The first bracketed term is positive, whereas the second (proposition 6) may be either positive or negative. However, it can be verified that:

$$U_h\left(\ell^*;c_e^*\right) - U_h\left(\ell^{**};c_e^*\right) = -(\tilde{c}_e - \hat{c}_e)$$

since $\left(\pi_h^L\right)_{LP} = \left(\pi_e^L\right)_{UE} > \left(\pi_e^L\right)_{LP} = \left(\pi_h^L\right)_{UE}$. Hence the result

ii) We have:

$$\begin{aligned}
U_h(\ell;\tilde{c}_e) - U_h\left(\bar{\ell};\hat{c}_e\right) &= (G(\hat{c}_e) - G(\tilde{c}_e))\left(\pi^M + c_h\right)\\
&\quad + G(\tilde{c}_e)\left(\pi_h^L\right)_{LP} - G(\hat{c}_e)\left(\pi_h^L\right)_{UE}\\
&\quad + \theta\left(G(\tilde{c}_e)\left[\pi^M - \left(\pi_h^L\right)_{LP}\right] - G(\hat{c}_e)\left(\pi_e^L\right)_{UE}\right)
\end{aligned} \tag{6}$$

still remembering that $\left(\pi_h^L\right)_{LP} = \left(\pi_e^L\right)_{UE} > \left(\pi_e^L\right)_{LP} = \left(\pi_h^L\right)_{UE}$. Thus, the term on the first line is always positive, while the term of the second line is positive only when $\frac{G(\hat{c}_e)}{G(\tilde{c}_e)}(> 1)$ is not too large. Finally, the term on the third line is negative given proposition 7 and $\frac{G(\hat{c}_e)}{G(\tilde{c}_e)} > 1$. ∎

Note that the comparison performed here requires that we focus on values of θ for which the same equilibrium outcome occurs whatever the rule; but this may have no sense for some values of $\frac{c_e^*}{\pi^M}$. To insist, it is clear that when $\frac{c_e^*}{\pi^M}$ is large (for example, $\frac{c_e^*}{\pi^M} = 20\%$) case ii) must only be considered for a consistent comparison – which means that only a large value for $\theta(\geq 0.74597)$ is relevant (see graph 1)[10].

Part i) of proposition 8 shows interestingly that focusing on the size of the damages awarded to the Patentee but ignoring the feedback effects at the market stage, is misleading when we turn to the comparison of Patentee's total expected utility (profits). The difference $U_h\left(\ell^*;c_e^*\right) - U_h\left(\ell^{**};c_e^*\right)$ is driven by two terms which have opposite signs (see (5)): on the one hand, we have $\left(\pi_h^L\right)_{LP} - \left(\pi_h^L\right)_{UE} > 0$; on the other hand, we found that $\theta\left(\pi^M - \left(\pi_h^L\right)_{LP} - \left(\pi_e^L\right)_{UE}\right) = \theta\left(D_{LP} - D_{UE}\right) < 0$. Thus, we have shown that despite $D_{LP} < D_{UE}$, the Lost Profit rule has a large and positive feedback effect at the market stage, which is beneficial to the Patentee, and detrimental to the Infringer. In a sense, the advantage of the Lost profit rule is explained by the market discipline it imposes to the Infringer, which prevents him from producing a large quantity despite he holds the same production costs as the Patentee. But note that case i) requires that there is a positive probability that the case settles amicably (and thus, infringement is never deterred).

In contrast, part ii) of proposition 8 means that the superiority of the Lost Profit rule may not hold soon as the probability that infringement is deterred is positive. Under conditional infringement, the choice/comparison between both rules reflects the existence of a trade-off[11]:

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[10]In contrast, case i) only occurs for small values of $\frac{c_e^*}{\pi^M}$ (for example at 1%). The result is available on request.

[11]This is a rough interpretation of the difference between the terms on the second and third lines in condition (6), which may be written as: $G(\tilde{c}_e)\left(\left(\pi_h^L\right)_{LP} + \theta\left[\pi^M - \left(\pi_h^L\right)_{LP}\right]\right) - G(\hat{c}_e)\left(\left(\pi_h^L\right)_{UE} + \theta\left(\pi_e^L\right)_{UE}\right)$.

roughly speaking, the Lost Profit rule is associated with a larger probability that the Patentee earns his monopoly profit, whereas the Unjust Enrichment rule yields a higher probability that higher damages are awarded in case of trial.

6   Conclusion

For practical purposes, French Jurisdictions may be prone to choose between one rule or the other just because of the available and quality of information regarding Infringers' profits or Patentees' profits. Indeed, as the reform of the French IPR law passed in 2007, a major argument that some legal commentators put in favor of the Unjust Enrichment rule was that it is consistent with the idea that "infringement must not pay". Moreover, the introduction of the Unjust Enrichment rule was seen as a substitute for *punitive damages* (despite the European Commission forbid their use) since it allows the disgorgement of the illegal benefits obtained by the infringer, thus creating the conditions to improve the deterrence of infringers[12]. However, our analysis shows that these ideas are not correct. The Unjust Enrichment rule entails *less* deterrence and at the same time, is associated with *more* trials, than the Lost Profit rule. Moreover, a main flaw of the Unjust Enrichment rule is that it may also deter the Patentee from enforcing his right (which we find not possible to occur under Lost Profit). Finally, regarding the preservation of Patentees total (expected) profit, the comparison is less obvious, no rule being better than the other.

Our paper has also shown the central role of the patent quality/strength, which was supposed to be exogenous here; but for a given level of θ, the features of the equilibrium are different between both rules most of the time, which makes harder their comparison. To overcome these problems, we will consider the issue of an endogenous patent strength in future research.

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[12]See the comments on Art. L. 615-7, L.622-7, L.623-28, L.716-4 and Art. L.331-1-3, in *Code de la Propriété Intellectuelle*, Code Rouge, online edition Ed. Dalloz.

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