The Inverse Cournot Effect in Royalty Negotiations with Complementary Patents

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Introduction: Patents and SSOs

- Patent licensing is a primary source of revenue from innovation.
- Most modern products embed multiple technologies covered by patents owned by many different innovators (e.g. thousands of patents in the case of smartphones).
- Standard-Setting Organizations (SSOs) are forums in which firms discuss compatibility standards for products and the technologies that enable them (e.g. UMTS, WI-FI, RFID, etc).
- Some patents have no alternative and need to be licensed. They are denoted Standard Essential Patents (SEPs).
- Participating firms often commit to license their patents under Fair, Reasonable, and Non-Discriminatory or (F)RAND terms.
- Both SEPs and the meaning of FRAND have been subject to frequent litigation and antitrust scrutiny in recent years.
- Other contentious issues involve *Patent Assertion Entities* (PAEs), also denoted as patent trolls and *privateers*.

Royalty Stacking

- The licensing of complementary technologies generates the classical **Cournot-complements problem**: Each firm chooses a royalty without internalizing the effect of the higher price on the profits of other firms.
- It is argued that this effect creates a "Royalty Stack" (Lemley and Shapiro, 2007) that induces excessive downstream prices and undermines the incentives to innovate in upstream markets.
- However, anecdotal evidence in the mobile phone industry suggests a hectic pace of innovation in spite of the dozens of (essential) patent holders involved (Galetovic and Gupta, 2016).
- The US Court of Appeals for the Federal Circuit in Ericsson v D-Link stated: "The best word to describe [the] royalty stacking argument is theoretical."

The Case of the Mobile Telecommunications Industry

- In 1998, the Third Generation Partnership Project (3GPP) was created to develop a common wireless cellular system.
- We have collected data on the patents applying to three consecutive telecommunication standards.
- The data shows that from 2G to 3G and from 3G to 4G the number of *declared* SEPs and the number of firms owning them has increased substantially.

	2G	3G	4G
Number of Firms Owning SEPs	67	80	83
Number of SEPs	22,934	62,592	76,949
Mean Portfolio Size (No. of SEPs)	342	782	927
Std. Deviation (No. of SEPs)	977	2205	2409

Table: Descriptive Statistics of Company Level SEP Ownership.

Distribution of SEP Ownership

- Of a total of 489 members of 3GPPs during the period, about 85% do not declare any SEPs to any given standard.

- Only 130 firms declare patents essential to at least one standard.

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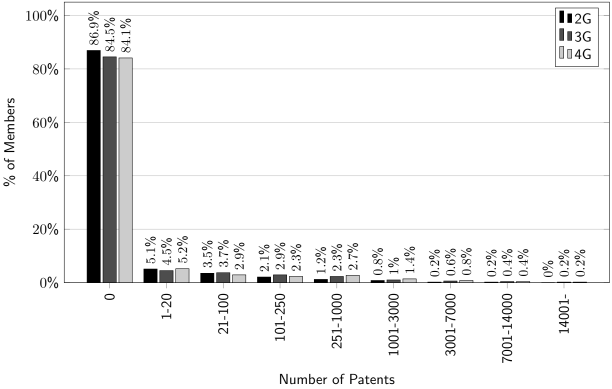

- Only 130 firms declare patents essential to at least one standard.

- Ten firms own between 72% and 84% of the essential patents.
- Twenty firms own more than 90% of the essential patents.

SEP Owning Entities	No. (%) of 2G Inventions	No. (%) of 3G Inventions	No. (%) of 4G Inventions
Top 2	1,208 (42%)	2,188 (30%)	2,424 (23%)
Top 5	1,951 (69%)	4,197 (58%)	5,125 (48%)
Top 10	2,385 (84%)	5,616 (78%)	7,664 (72%)
Top 20	2,648 (93%)	6,524 (90%)	9,708 (91%)
Top 40	2,802 (99%)	7,088 (98%)	10,476 (99%)

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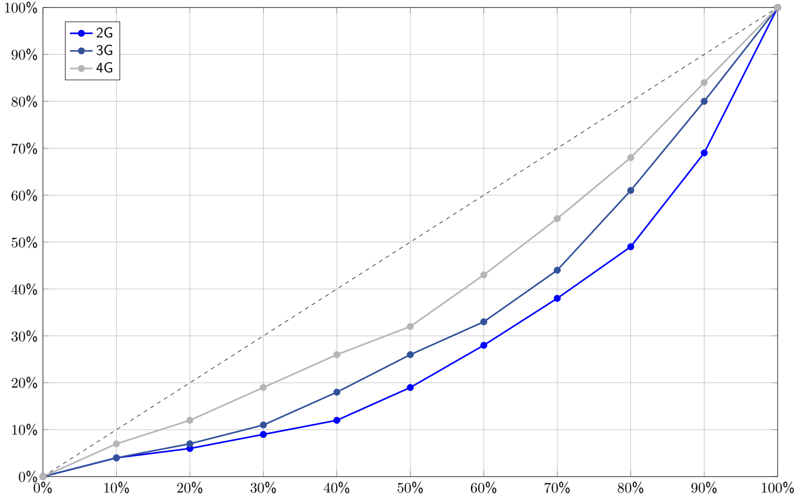

Figure: Top 10 SEP Patent Owners by Standard - Lorenz Curve

This Paper

- We aim to reconcile the theoretical argument on Royalty Stacking with the seemingly broad perception that in practice it does not seem to constitute such a large hurdle.
- Our model "only" departs from the literature by assuming that
  - Innovators have heterogeneous patent holdings, and
  - they might need to defend the validity of their IP in court.
- We show that compared to a situation without litigation:
  1. Small patent holders license their IP for less (obvious!), and
  2. this decrease is larger the lower the aggregate royalty rate.
  3. Large patent holders that would not be litigated in any case, also lower their royalty rate.
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- Keeping constant the total number of patents, more homogeneous patent holdings might make royalty stacking worse.
- These effects also have implications for mergers and patent pools.

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Related Literature

- Royalty stacking: Shapiro (2001), Spulber (2014), Galetovic and Gupta (2016).
- Patent litigation and probabilistic patents: Llobet (2003), Farrell and Shapiro (2008), Choi and Gerlach (2015).
- Acquisition of patent portfolios in SSOs: Bourreau et al. (2015), Choi and Gerlach (2016).
- Patent Pools: Lerner and Tirole (2004), Boutin (2015).

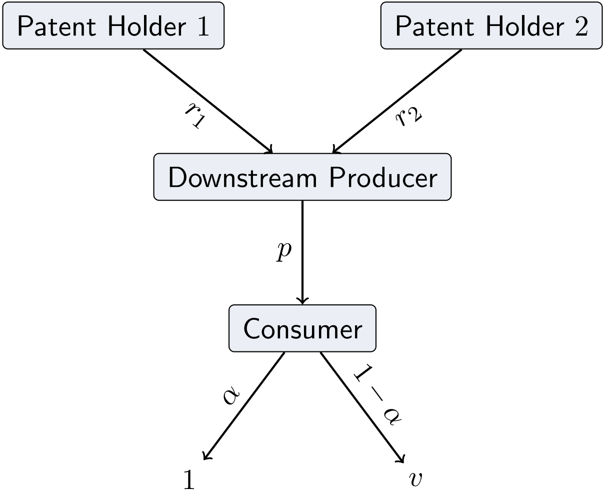
The Model

The Downstream Market

- A downstream monopolist, D, sells (at most) one unit of a good to a unique consumer.
- The consumer has valuation 1 with probability α and $v < 1$ with probability $1 - \alpha$.

Upstream Patent holders

- Production requires the usage of two technologies. Technology i is owned by patent holder i.
- Patent holder i charges a royalty rate r_i, with $R = r_1 + r_2$.
- Patent holder i owns a portfolio of size x_i covering the technology, with $x_1 \geq x_2$.


Patent Holder 1
Patent Holder 2
r_1
r_2
Downstream Producer
p
Consumer
α
$1-\alpha$
1
v

The Litigation Technology

- The royalty rate is set as a take-it-or-leave-it offer.
- D can challenge the patent portfolio of firm i in court.
  - Patent holder i wins with probability $g(x_i)$, increasing in i and the royalty stays at r_i.
  - D wins with probability $1 - g(x_i)$ and the royalty goes to 0.
  - $g(x_i)$ is non-decreasing in x_i.
  - Litigation costs are L_D and L_U for D and the upstream patent holders, respectively.
- Patent holders are litigated in an **endogenous sequence** and the decision might depend on the outcome of the previous trial.

Timing

1. Upstream patent holders simultaneously choose their royalty rate r_i, for $i = 1, 2$.
2. D chooses whether to litigate patent holder 1, 2 or none.
   - After the first trial D chooses whether to litigate the other patent holder or not.

   The resulting R is determined.
3. The demand is realized.
4. D chooses the price p in the final market.

We analyze three scenarios depending on the strength of the patent holders' portfolios.

1. Large Patent Portfolios: $g(x_1) = g(x_2) = 1$.
2. One large Patent Portfolio: $g(x_1) = 1$ and $g(x_2)$ small.
3. Two small Patent Portfolios: $g(x_1) = g(x_2)$ small.

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The Optimal Price

- The previous timing implies that the price is chosen after the demand is realized. There is no distortion due to double marginalization.
- Hence, the price will be equal to the observed valuation, $p^M \in \{v, 1\}$, as long as the marginal cost R is lower than the realized valuation.
- Profits become

$$\Pi_D(R) = \begin{cases} \alpha + (1-\alpha)v - R & \text{if } R \leq v, \\ \alpha(1-R) & \text{if } R \in (v, 1], \\ 0 & \text{otherwise.} \end{cases}$$

  That is, if $R > v$, D will decide not to sell when the valuation is low.
- $\Pi_D(R)$ is decreasing and convex in R.

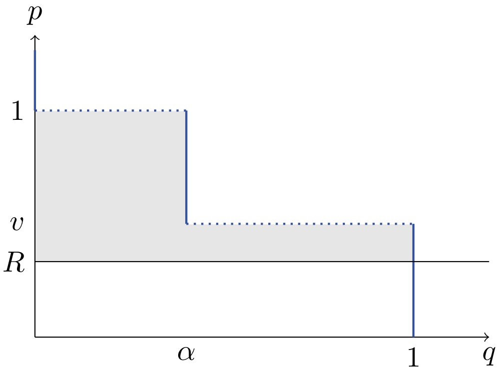


Figure: Downstream profits when $R < v$.

- You can think of D as a final consumer.
- The algebra would become more involved if we allow for Double marginalization.

Large Patent Portfolios

The Benchmark Case

- Assume that $g(x_1) = g(x_2) = 1$.
- The litigation stage is irrelevant.
- First, suppose the patent holders chose their royalty rates together.

Lemma (Profit Maximizing Royalty)

The aggregate royalty rate that maximizes total patent holder profits is $R^M = v$ if $v \geq \alpha$ and $R^M = 1$ otherwise.

- When $v \geq \alpha$ it is also socially efficient.

The Equilibrium

- Patent holders choose r_i independently and simultaneously.

Proposition

There is a continuum of (undominated) pure strategy equilibria. The corresponding royalty rates can be characterized as follows

1. *If* $v \geq \frac{2\alpha}{1+\alpha}$, $R^u = r_1^u + r_2^u = v$ *with* $r_i^u \leq \frac{v-\alpha}{1-\alpha}$ *for* $i = 1, 2$.
2. *If* $v \leq \frac{1+\alpha}{2}$, $R^u = r_1^u + r_2^u = 1$ *with* $r_i^u \geq \frac{v-\alpha}{1-\alpha}$ *for* $i = 1, 2$.

Both kinds of equilibria co-exist when $\frac{2\alpha}{1+\alpha} \leq v \leq \frac{1+\alpha}{2}$.

- As before, when v is high $R^u = v$ and, otherwise, $R^u = 1$.
- Not all royalty rates that lead to the same R are an equilibrium:
  - If $R = v$ and r_1 is high, patent holder 2 has incentives to deviate and increase r_2, cater the high demand and increase profits.
  - If $R = 1$ and r_1 is low, patent holder 2 has incentives to deviate and lower r_2, cater all the demand and increase profits.

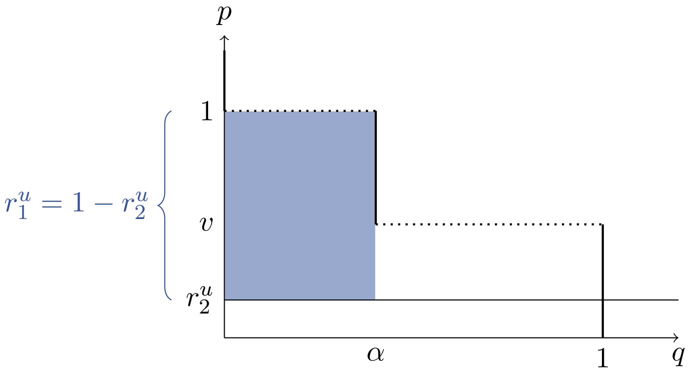
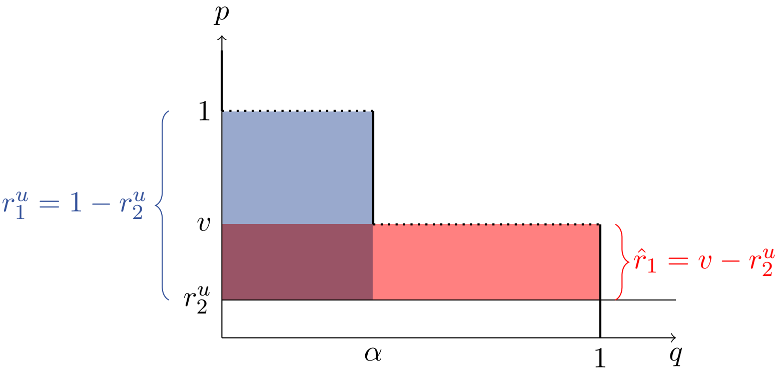


Figure: Deviation by patent holder 1 from $r_1^u + r_2^u = 1$.



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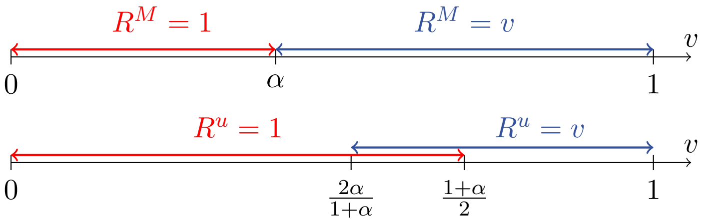
Royalty Stacking

Corollary

When $\alpha < v \leq \frac{1+\alpha}{2}$ *inefficient equilibria with* $r_1^u + r_2^u = R^u = 1$ *exist even though total profits are maximized when the total royalty is equal to* v*. When* $\alpha \leq v < \frac{2\alpha}{1+\alpha}$*, all equilibria lead to* $R^u = 1$*. However, there are no parameter values for which* $R^M = 1$ *but* $R^u = v$*.*



- The total royalty rate is too high.

Implications

- The idea of royalty stacking has been discussed in this context by Lemley and Shapiro (2007).
- As in the standard complementary-goods problem, firms do not internalize the fact that by raising their royalty rate they are decreasing final sales for them and for the competitors.
- It implies that
  1. For a given total IP, the royalty-stacking problem is worse the more patent holders there are and
  2. All patent holders are essential. Thus, they should receive the same royalty in equilibrium, regardless of the size and strength of their patent portfolio.
- These implications are not robust to the introduction of imperfect patent enforcement.

One Constrained Patent Holder

- Suppose that $g(x_1) = 1$ and $g(x_2) < 1$. Only patent holder 2 might be litigated.
- Focus on the case in which, without litigation, royalty stacking might arise in equilibrium, $v \in \left(\alpha, \frac{1+\alpha}{2}\right]$.
- Take a candidate $r_1^* + r_2^* = 1$. A **necessary** condition for litigation to be irrelevant is

$$(1 - g(x_2)) \left[\Pi_D \left(r_1^*\right) - \Pi_D(1)\right] \leq L_D, \tag{1}$$

- Thus, litigation against patent holder 2 is profitable for D if r_1^* is low or, alternatively, if

$$r_2^* > \bar{r}_2 = \begin{cases} \frac{L_D}{\alpha(1-g(x_2))} & \text{if } \frac{L_D}{1-g(x_2)} < \alpha(1-v), \\ (1-\alpha)(1-v) + \frac{L_D}{1-g(x_2)} & \text{otherwise.} \end{cases} \tag{2}$$

In that case, (r_1^*, r_2^*) will not be an equilibrium.

- Suppose now that $r_2^* \leq \bar{r}_2$. Will (r_1^*, r_2^*) be an equilibrium? Patent holder 1 obtains profits

$$\Pi_1(r_1^*, r_2^*) = \alpha r_1^*.$$

- A profitable deviation must induce litigation on patent holder 2.
- Given any r_2, litigation occurs if $r_1 \leq \bar{r}_1$, where

$$(1 - g(x_2)) \left[\Pi_D\left(\bar{r}_1\right) - \Pi_D(\bar{r}_1 + r_2)\right] = L_D, \tag{3}$$

or

$$\bar{r}_1(r_2) = v + \frac{\alpha}{1-\alpha} r_2 - \frac{L_D}{(1-\alpha)(1-g(x_2))} \text{ if } \underline{r}_2 < r_2 \leq \bar{r}_2, \tag{4}$$

where if $r_2 < \underline{r}_2 \leq \frac{L_D}{1-g(x_2)}$ even a royalty $r_1 = 0$ will not induce litigation.

The Inverse-Cournot Effect

- $\bar{r}_1(r_2)$ is weakly increasing in r_2 and weakly decreasing in L_D.
- We call the positive relation between r_2 and $\bar{r}_1(r_2)$ the **Inverse-Cournot Effect**.
- This relationship is in contrast with the negative relation between r_1^* and r_2^* associated to the **Cournot Effect**.
- As a result, if $r_1^* > \bar{r}_1(r_2^*)$, a deviation must involve a decrease in r_1.
- Notice also that the optimal deviation is $\hat{r}_1 = \min\{\bar{r}_1(r_2^*), v\}$, which insures that
  1. The portfolio of patent holder 2 is litigated and,
  2. when it is invalidated the quantity sold increases from α to 1.
- Profits become

$$\hat{\Pi}_1 = [\alpha + (1-\alpha)(1-g(x_2))]\,\hat{r}_1. \quad (5)$$

Proposition (One Constrained Patent Holder)

Suppose that $v \geq \alpha$. *If* $\frac{L_D}{1-g(x_2)} < \frac{v-\alpha}{1-\alpha}$ *there is no pure strategy equilibrium with royalty stacking. However, if* L_U *is sufficiently high the efficient equilibrium always exists and it involves* $r_2^* \leq \frac{L_D}{1-g(x_2)}$ *and* $r_1^* = v - r_2^*$.

- If litigation is a sufficiently relevant threat (L_D and $g(x_2)$ are low) royalty stacking will not arise.
- Remember that
  - without litigation an equilibrium with $R = 1$ existed if $r_i \geq \frac{v-\alpha}{1-\alpha}$, and
  - patent holder 1 cannot induce litigation on 2 if $r_2^* < \underline{r}_2 \leq \frac{L_D}{1-g(x_2)}$.

  Thus, only when both conditions are met at the same time royalty stacking can emerge.
- This result implies that it is optimal for patent holder 1 to induce litigation on the other firm whenever possible.

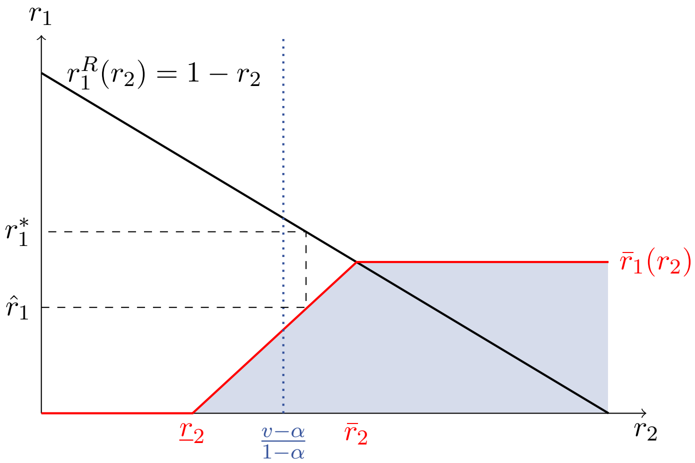


Figure: The power of the Inverse Cournot Effect.

- The intuition for the result is that patent holder 1 always wants to induce litigation because it expects to appropriate all the increase in surplus.
- What kind of equilibria can emerge in this case?
  1. When L_U is low, an equilibrium where patent holder 2 might be litigated exists.
  2. When L_U is large, patent holder 2 chooses a low r_2 and patent holder 1 internalizes the cost of royalty stacking.
- When L_U is large patent holder 2 gets a royalty which is increasing in x_2.

Two Constrained Patent Holders

- Assume now that $g(x_1) = g(x_2) = g(x) < 1$.
- Now, both patent holders might be litigated in equilibrium.
- The order is chosen by the downstream producer.
- We start by assuming that the downstream producer litigates first the patent holder with the highest royalty rate.
- Again, we study when an equilibrium with royalty stacking $(r_1^* + r_2^* = 1)$ may exist.
- We focus on the symmetric equilibrium, $r_1^* = r_2^* = \frac{1}{2}$. In fact, since litigation and potential deviations are going to impose bounds, this is the equilibrium that will persist for more parameter values.

Litigation Cascades

- Since $\Pi_D(R)$ is convex,

$$\Pi_D\left(1/2\right) - \Pi_D(1) \leq \Pi_D(0) - \Pi_D\left(1/2\right).$$

- Suppose that the litigation against patent holder 2 was profitable. Then, litigating patent holder 1 after victory against 2 would be even more profitable.
- Thus, if $r_1^* = r_2^*$ the litigation of only one patent holder is not optimal.
- Litigation will occur if

$$(1-g(x))\left\{\left[\Pi_D\left(1/2\right) - \Pi_D(1)\right] + (1-g(x))[\Pi_D(0) - \Pi_D(1)] - L_D\right\} > L_D$$

- Compared to the previous case, litigation is more profitable as it might initiate a cascade.
- Litigation might occur even if $(1-g(x))\left[\Pi_D\left(1/2\right) - \Pi_D(1)\right] < L_D$.

Strategic Royalty Choice

- The previous expressions suggest that due to the weaker patent portfolio of patent holder 1 the incentives to litigate **both** patent holders increase $\Rightarrow$ A moderating effect that reduces royalty stacking?

  Not necessarily, since this argument does not take into account strategic considerations.
- Start with a situation in which $r_1^* = r_2^* = \frac{1}{2}$ and D does not want to initiate a litigation cascade.
- Consider patentee 1's incentives to deviate. By choosing $\hat{r}_1 < r_1^*$ the Inverse Cournot Effect might induce litigation on patent holder 2.
- But if litigation against patent holder 2 occurs and D prevails, patent holder 1 might be litigated next.
- We can characterize the following result:

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Lemma (Litigation Cascade Effect)

Suppose that under $r_1^* = r_2^* = \frac{1}{2}$ it is not profitable for the downstream producer to engage in litigation. If by deviating to $\hat{r}_1 < r_1^*$ patent holder 2 is litigated, patent holder 1 will also be litigated if and only if patent holder 2 lost in court and $\hat{r}_1 > \frac{L_D}{1-g(x)}$.

- As a result, two forces go in opposite directions
  - The weaker portfolio forces 1 to lower the royalty rate. And the Inverse-Cournot Effect reduces the royalty rate of 2.
  - But the Litigation Cascade Effect weakens the strategic incentives to lower the royalty rate.

Example

Consider parameter values $\alpha = 0.1$, $v = 0.3$, $L_D = 0.035$ and L_U is sufficiently high.

- Case 1: $g(x_1) = g(x_2) = 1$.
  - It would be (jointly) profit maximizing to choose $R^M = v$,
  - but if royalties are chosen independently, $R^u = 1$.
- Case 2: $g(x_1) = 1$ and $g(x_2) = 0.7$. By construction $\frac{L_D}{1-g(x_2)} < \frac{v-\alpha}{1-\alpha}$ so only an equilibrium with $R^* = v$ will exist.
- Case 3: $g(x_1) = g(x_2) = 0.7$,
  - Under $r_1^* = r_2^* = 1/2$, D does not want to litigate, and
  - Due to the high L_U, the optimal deviation is $\hat{r}_1 \leq \frac{L_D}{1-g(x_2)}$, implying that

$$[\alpha + (1-\alpha)(1-g(x_2))]\,\frac{L_D}{1-g(x_2)} \leq \frac{\alpha}{2}.$$

  - Thus, $R^* = 1$ is an equilibrium.

Royalty Stacking II

- We have shown that the equilibrium royalty rate is not monotonic in the size of the patent portfolio. That is,
  - If both patent portfolios are stronger, royalty stacking is more likely, but
  - If only one patent portfolio becomes stronger the Inverse-Cournot effect operates in the opposite direction.
- This result suggests that royalty stacking might be less problematic in standards, such as 2G, in which patent holdings are very skewed and more so in 4G.

Royalty Stacking II

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Implications for Patent Pools and Mergers

- A standard implication of the royalty-stacking problem is that mergers and patent pools are always socially optimal.
- This paper suggests that this is not always the case.
- Consider a case where $N = 3$, with $g(x_1) = 1$ and $g(x_2) = g(x_3) < 1$. Assume also that $g(x_2 + x_3) = 1$.
- If firms are kept separate and L_D is small, the royalty-stacking problem should be minor due to the (now stronger) Inverse-Cournot Effect.
- Consider two kinds of consolidation.
  - If 2 and 3 form a patent pool, their portfolios are perfectly (joinly) enforced and royalty stacking always emerges.
  - A patent pool between 1 and 2 (or 3) generates a moderating effect
    - The strength of the portfolio does not increase, and
    - Eliminating 2 reduces $r_1 + r_2$ which due to the Inverse-Cournot Effect reduces also r_3.
- Consolidation towards more homogeneous patent holdings might decrease welfare.

A More General Model

- Consider a general demand function $D(p)$ strictly decreasing in p and continuously differentiable.
- Given r_1 and r_2, D's profits become

$$\Pi_D(R) = \max_p \, (p - R)D(p),$$

with $\Pi'_D(R) = -D(p^M) < 0$ and $\Pi''_D(R) = -D'(p^M)\frac{dp^M}{dR}(R) > 0$.

Assumption

$D(p^M(R))$ is log-concave in R.

- Then, the profits of patent holder i defined as

$$\Pi_i(r_j) = \max_{r_i} \; r_i D(p^M(r_1 + r_2)) \text{ for } j \neq i$$

are convex in r_i.
- Royalty stacking arises when $g(x_1) = g(x_2) = 1$.

Proposition (Royalty Stacking)

If litigation is sufficiently costly for the downstream producer, in the unique equilibrium of the game, all patent holders choose $r_i^u = r^u$, *defined by*

$$D(p^M(R^u)) + r^u D'(p^M(R^u))\frac{dp^M}{dR} = 0, \tag{6}$$

independently of the size of their portfolio. In this equilibrium $r^u(N)$ *is decreasing in* N *but* $R^u(N)$ *and* $p^M(R^u(N))$ *are increasing in* N*.*

The Inverse Cournot Effect

- Go back to $g(x_2) < g(x_1) = 1$.

Lemma

The downstream producer will litigate patent holder 2 if $r_1 < \bar{r}_1(L_D, x_2, r_2)$, as defined by

$$(1 - g(x_2)) \left[\Pi_D \left(\bar{r}_1\right) - \Pi_D(\bar{r}_1 + r_2)\right] = L_D,$$

This threshold royalty $\bar{r}_1$ is strictly increasing in r_2 and strictly decreasing in L_D and x_2.

- This result only depends on the convexity of $\Pi_D(R)$.
- The effect immediately generalizes to N patent holders since only R_{-2} matters.

FRAND

No Nash Equilibrium in Pure Strategies

- In the general model there is no Nash Equilibrium in pure strategies if litigation is a relevant concern.
- A royalty rate that makes the downstream producer indifferent between litigating or not is not optimal because patent holder 1 would slightly lower r_1 and obtain a discrete gain.
- If the royalty rates are different from the unconstrained ones and D strictly prefers not to litigate, patent holder 2 would prefer to increase r_2.

Litigation Cascades

- Assume again that $g(x_1) = g(x_2) = g(x) < 1$.
- For a given r_1 and r_2 the litigation order is determined as follows.

Lemma

If the two patent holders have a portfolio of the same strength, the downstream producer always prefers to litigate first the one that has set the highest royalty.

- Suppose that $r_2 > r_1$. This result is due to two effects:
  1. Consider the case in which the second trial only arises after a first victory. In that case the royalty r_2 is eliminated with probability $1 - g(x)$ and r_1 is eliminated with probability $(1 - g(x))^2$.
  2. It is optimal to litigate first the patent holder for which this decision is optimal in more states of the world.

- Similar calculations to the ones in the original example, allow us to compute D's gains from the second stage of a litigation cascade as

$$\Phi(r_1, r_2) \equiv \begin{cases} g(x)\Pi_D(r_2) + (1 - g(x))\Pi_D(0) - \Pi_D(r_1 + r_2) & \text{if } r_1 > r_2, \\ g(x)\Pi_D(r) + (1 - g(x))\Pi_D(0) - \Pi_D(2r) & \text{if } r_1 = r_2 = r \\ g(x)\Pi_D(r_1) + (1 - g(x))\Pi_D(0) - \Pi_D(r_1 + r_2) & \text{otherwise.} \end{cases}$$

  Litigation is profitable if $(1 - g(x)\left[\Phi(r_1, r_2) - L_D\right] > L_D$.
- Consider how these profits change with r_1

$$\frac{\partial \Phi}{\partial r_1} = \begin{cases} -\Pi_D'(r_1 + r_2) & \text{if } r_1 \geq r_2, \\ g(x)\Pi_D'(r_1) - \Pi_D'(r_1 + r_2) & \text{otherwise.} \end{cases}$$

- Increases in r_1 lead to
  - increases in the incentives to litigate if $r_1 \geq r_2$ and 1 was already litigated first.
  - ambiguous incentives to litigate otherwise. Patent holder 2 is litigated first and the bigger royalty stack makes this decision less profitable.

Example

Under a linear demand function, $D(p) = 1 - p$ and in a symmetric situation, the Inverse Cournot effect dominates the litigation cascade and, hence, a decrease in the royalty rate lowers the returns from litigation of the downstream producer if and only if $r_1 = r_2 > \frac{1-g(x)}{2-g(x)}$.

- This negative effect of decreasing the royalty rate makes possible the existence of a pure-strategy Nash Equilibrium.

Proposition

With identical patent holders and a linear demand function, in a symmetric equilibrium in pure strategies, $r_1^* = r_2^* = r^*$*, where either* $r^* = r^u$ *or* $r^* < r^u$*. In this latter case*

$$g(x)\Pi_D(r^*) + (1 - g(x))\Pi_D(0) - \Pi_D(2r^*) = \frac{L_D}{1 - g(x)} + L_D.$$

This equilibrium arises when $g(x)$ *and* L_D *are sufficiently small and* $L_U \geq 0$*. The equilibrium royalty is increasing in* $g(x)$ *and* L_D*.*

- Lowering the royalty rate to induce litigation on the other patent holder might not be optimal if that initiates a litigation cascade.

Concluding Remarks

- This paper questions the received wisdom about royalty stacking.
- When litigation is a relevant concern this problem might be mitigated (or might disappear) for two reasons:
  - The obvious one is that weaker patent holders ask for lower royalties.
  - Through the new Inverse Cournot Effect, we show that strong patent holders may also choose to lower their royalty rate to force litigation on weaker competitors.
- Patent portfolio heterogeneity matters:
  - When portfolios are weak and quite homogeneous the Inverse Cournot Effect is also weaker because patent holders are concerned about litigation cascades.
- The results of the paper challenge the standard recommendation to always promote patent pools: If they lead to a more homogeneous distribution of portfolios royalty stacking might become more relevant.

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Additional Slides

SEPs and FRAND

- In the basic model firms only litigate over the validity of the patents.
- However, most SSOs require SEPs to be licensed according to Fair, Reasonable and Non-discriminatory or (F)RAND terms.
- As a result, downstream producers can argue in court that the portfolio of firm i is invalid and, if it is not, that these patents are SEP and should be bound to FRAND commitments.
- We can capture this effect in the model by assuming that the court can rule that the portfolio contains SEP patents with a probability $h(x_i, r_i)$, increasing in x_i and r_i.
- Suppose that if considered SEP, a court will determine a FRAND royalty rate $\rho(x_i, r_i)$ which is a non-decreasing function of its arguments.

- The producer is indifferent between litigating or accepting $\bar{r}_i$ if

$$(1 - g(x_i)) \left[\Pi_D(R_{-i}) - \Pi_D(R_{-i} + \bar{r}_i)\right] \\ + g(x_i)h(x_i, r_i) \left[\Pi_D(R_{-i} + \rho(x_i, \bar{r}_i)) - \Pi_D(R_{-i} + \bar{r}_i)\right] = L_D.$$

- In this case, as long as the incentives of D to litigate are increasing in r_i, it is still true that $\bar{r}_i$ is increasing in R_{-i}.
- Notice that it is not guaranteed that patent holders with higher x_i are less constrained: a patent is more likely to be valid but it is also more likely that the court regulates the royalty rate.
  However, we should expect $\rho(x_i, r_i)$ to be sufficiently increasing in x_i so that stronger patent holders are always better off. Otherwise, they would reduce the number of patents they choose to enforce (free disposal).

Adding FRAND commitments reduces even further the royalty rate that small patent holders can charge, making the Inverse Cournot effect even more relevant.

- The Inverse Cournot Effect is weakened if the FRAND Royalty is decreasing in R_{-i}, $\rho(x_i, r_i, R_{-i})$ as discussed by Judge Robart in his decision in the Microsoft vs Motorola Case of 2013 suggests:

  > *A proper methodology for determining a RAND royalty should address the risk of royalty stacking by considering the aggregate royalties that would apply if other SEP holders made royalty demands of the implementer.*

- In that case, trying to prevent royalty stacking would actually have a self-defeating effect.

Return

Double Marginalization

- Suppose that demand is realized after p is chosen. The downstream producer would choose a price of 1 (as opposed to v) if

$$\alpha(1-R) \geq v - R \Rightarrow R \geq \bar{R} \equiv \frac{v-\alpha}{1-\alpha}.$$

- All the results of the paper would be based on $R \lesseqgtr \bar{R}$ as opposed to $R \lesseqgtr v$.

Return