Screening for good patent pools
through price caps on individual licenses

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Intellectual Property Rights (IPRs) necessary to commercialize a product are normally controlled by many firms.

Uncoordinated pricing of **complementary** inputs leads to a higher price for the final product than if they were controlled by one entity.

Such multiple marginalization problem can be solved through patent pools where IPR owners sell their respective innovations as a bundle.

Pools made of **substitute** patents are paramount to cartels that eliminate competition and result in higher prices.

Regulators have **very limited information** necessary to assess pools.
Our contribution

- Lerner Tirole 2004 shows that independent licensing (IL) can destabilize welfare decreasing pools.
  - We characterise the set of (static Nash) equilibria where welfare decreasing pools can be stable to IL (for more than 2 IPR holders).
  - To avoid this, we propose to constrain royalties for individual licenses with a cap simply replicating the pool’s sharing rule.
  - We also generalize the LT framework.

- Our results also allow to reinterpret and generalize Rey and Tirole 2013 on unbundling as means of preventing tacit collusion in pools:
  - Even with very general form of asymmetries for n players, a bad pool cannot sell with IL and the cap;
    - Also when licensors are free to adjust the sharing rule in a way that may not reflect contributions, they can not counteract the effect of the cap.
  - As this true in any period, there is no scope for collusion.
A simple "existence" example

- 3 IPR holders, $A$, $B$ and $C$ (1 symmetric patent each)
- 1 customer with $V(1) = \epsilon$ and $V(2) = V(3) = \pi$ (needs 2 patents).
- In the absence of a pool $r_A^u = r_B^u = r_C^u = 0$.
- The pool sets a higher price $R = \pi$, each licensor gets $\frac{R}{3}$.
- If IL is allowed, it is immediate that IL at $r > \pi$ is an equilibrium which does not destabilize the pool.
- For any price between the competitive ($R = 0$) and the monopoly ($R = \pi$), there exist many equilibria in IL to which the pool is stable.
  - Suppose the pool offers the bundle at $R$, and firms offer IL at $r \geq R/2$.
  - To attract demand, deviator sets $\bar{r}$, such that $\bar{r} + r < R$ (also beats IL).
  - No profitable deviation as long as $\bar{r} = R - r < R/3$
  - Hence, with $R = \pi$, $r^* \geq \frac{2}{3}R$ is an equilibrium of the IL game, which does not prevent the pool from selling the bundle at a total price $R$.
    - Observe that by constraining IL we could destabilize the pool.
The model

- We assume there exist \( n \) IPR holders, bearing no marginal costs, each offering one patent (no symmetry) to a continuum of customers.
- \( \mathbf{x} = (x_i)_{i \in \{1, \ldots, n\}} \in \{0; 1\}^n \) is the vector such that \( x_i = 1 \) if a customer buys patent \( i \) and 0 otherwise.
- Buying the basket \( \mathbf{x} \) provides the customer of type \( \theta \) with utility \( V(\mathbf{x}) + \theta \) if the basket \( \mathbf{x} \) is not empty, and 0 otherwise.
  - Surplus function \( V \) is not user specific. Its shape reflects the complementarities between the different IPRs;
    - we assume that each IPR brings a positive (\( \epsilon \)) value to a basket, which rules out equilibria where an IPR holder cannot sell because the royalty for another perfectly complementary IPR is too high (full basket best)
  - Idiosyncratic parameter \( \theta \) represents heterogeneity in the benefits that licensees derive from the technology and in their costs to adopt it;
    - additive separability: customers have the same preferred basket
    - wide support: there are always customers who buy this optimal basket
    - strictly increasing hazard rate: unique maximum in all max. programs
The model

1. The vector corresponding to the full basket of patents
   - all patents together provide utility $V(1)$
2. $r$ is the vector of royalties and $\|r\| = \sum_{i \in \{1,\ldots,n\}} r_i$ is the total royalty for the full basket of $n$ patents.
3. The total royalty for a given basket $x$ is $x'.r$.
   - demand given by the distribution of $\theta : D(x'.r - V(x)) = P(V(x) + \theta \geq x'.r) = 1 - F(x'.r - V(x))$.
4. $1_{-i}$ the basket of all the IPR but IPR $i$ and $r_{-i}$ is the vector of all the royalties apart from the royalty of IPR $i$.
   - buying $1_{-i}$ costs $\|r_{-i}\|$.
5. $\delta_i$ is the basket including IPR $i$ only, which costs $r_i$.
6. The holder of IPR $i$ is assumed to be entitled to a share $\alpha_i$ of the pool’s profit, with the condition $\|\alpha\| = 1$. 
**Uncoordinated equilibria**

- Assume a candidate uncoordinated equilibrium $r^u$.
  - any equilibrium is such that each IPR holder sells (otherwise undercut)
  - therefore IPR holders have to price in such a way as to be included in the optimal, full, basket of patents (*competition margin CM*)

- Some IPR holders may be effectively constrained by their CM
  - they set $r^u_i$ that satisfy $V(1) - \|r^u\| = \max_{x|x_i=0, \|x\| \geq 1} \{ V(x) - x'.r^u \}$

- For other IPR holders, this could lead to royalty levels higher than what would maximize their profits.
  - they maximize: $r_i D (r^u_i + r_i - V(1))$ (demand margin DM binds).

These conditions characterize a Nash equilibrium

- it exists as the best response function is a continuous function from a compact space to the same compact space
- possibly not unique; the set of uncoordinated equilibria defined as:

$$\mathcal{R}^u = \left\{ r^u \in \mathbb{R}^n_+ \right\} \forall i \in \{1, \ldots, n\},$$
$$r^u_i = \min \left\{ V(1) - \max_{x|x_i=0, \|x\| \geq 1} \{ V(x) - x'.r^u \} - \|r^u_{-i}\|, \argmax \left\{ r^u_i D(\|r^u\| - V(1)) \right\} \right\}$$
We assume that the pool only sells the full bundle of patents

"no menus" is realistic in pools and consistent with additive seperability

The pool without IL sets \( \bar{R} = \arg\max_{R} R \cdot D (R - V(1)) \).

With IL, pools set \( R \in [0, \bar{R}] \).

As there can be several uncoordinated equilibria, a pool is:

- **strongly welfare reducing** if it effectively sells at a total royalty higher than the maximum total royalty of the uncoordinated equilibria \( \bar{R}^u \)

- **strongly welfare increasing** if it effectively sells at a total royalty lower (or equal) the minimum total royalty of the uncoordinated equilibria \( \bar{R}^u \)

- pools with no effect on price are assumed to be welfare increasing (note that in reality pools also reduce transaction costs)
General framework

Patent pool

- If IPR holders play an equilibrium where the demand margin binds for at least one IPR holder in the absence of the pool, then the pool without IL is welfare increasing.
- A strongly welfare decreasing pool can only occur if the CM would bind for all IPR holders in the absence of the pool.
  
  Then, the total uncoordinated price $Z = \|z\|$ is such that:

$$\forall i \in \{1, \ldots, n\}, \quad V(1) - Z = \max_{x|\|x\|\geq 1} \{V(x) - x'z\}$$

- $\mathcal{Z}$ is the set of Nash equilibria where the CM binds for everyone:

$$\mathcal{Z} = \left\{ z \in \mathbb{R}^n_+, \forall i \in \{1, \ldots, n\}, \quad V(1) - Z = \max_{x|\|x\|\geq 1} \{V(x) - x'z\} \right\}$$

Proposition 3.1

If a pool is strongly welfare decreasing then $\mathcal{R}^u = \mathcal{Z}$. 

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Pools and caps on individual licenses

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Definition 3.1

Stability

A patent pool \((R, \alpha)\) is stable to independent licensing if there exists an equilibrium of the continuation "independent licensing" game \(r^*\) such that customers buy from the pool at price \(R\).
Proposition 3.2

i) The set of stable pools \((R, \alpha)\) is non-empty.

ii) The aggregate price \(R\) of a stable pool satisfies:

\[
R \leq \min \left\{ \overline{R}, \min_{i \in \{1, \ldots, n\}} \left\{ \frac{V(1) - V(\delta_i)}{1 - \alpha_i} \right\} \right\}
\]

(3.2.1)

where \(\overline{R} = \arg\max_R R.D(R - V(1))\).

iii) The equilibrium independent royalties of the continuation game \(r^*\) that do not destabilize the pool satisfy:

\[
\forall i \in \{1, \ldots, n\}, \forall x \in \mathbb{R}^n | x_i = 1, \|x\| \geq 2,
\]

\[
x'.r^* - r^*_i \geq V(x) - V(1) + (1 - \alpha_i)R
\]

(3.2.2)

\[
\forall x \in \mathbb{R}^n | \|x\| \geq 1, \quad x'.r^* \geq V(x) - V(1) + R.
\]

(3.2.3)
Corollary 3.3

For a given sharing rule $\alpha$, the profit maximizing stable pool’s prices are given by:

i) $R_{\text{max}} = \overline{R}$ if $\forall i \in \{1, \ldots, n\}, V(\delta_j) < V(1) - (1 - \alpha_i)\overline{R}$,

ii) $R_{\text{max}} = \min_{i \in \{1, \ldots, n\}} \left\{ \frac{V(1) - V(\delta_i)}{1 - \alpha_i} \right\}$ otherwise.

Proposition 3.4

Optimal sharing rule

From the perspective of a stable pool, the optimal sharing rule is:

$$\alpha_i^* = 1 - (n - 1) \frac{V(1) - V(\delta_i)}{\sum_{j=1}^{n} V(1) - V(\delta_j)}$$ (3.4.1)
Consider a situation where a patent pool without IL would be strongly welfare reducing: $\bar{R} > \bar{R}^u$. Then, when IPR holders play a continuation equilibrium $r^*$ that does not destabilize the pool, the optimal stable pool $(R_{\text{max}}, \alpha^*)$ is either strongly welfare reducing or welfare neutral:

i) if $\forall i \in \{1, \ldots, n\}$, $V(\delta_i) < V(1) - (1 - \alpha_i^*)R$, with independent licensing, the pool can still effectively sell at $R_{\text{max}} = \bar{R} > \bar{R}^u$

ii) otherwise it can effectively sell at $R_{\text{max}} = \min_{i \in \{1, \ldots, n\}} \left\{ \frac{V(1) - V(\delta_i)}{1 - \alpha_i^*} \right\}$ and $R_{\text{max}} > \bar{R}^u$, unless

$$\forall z \in \mathcal{Z}, \|z\| = \min_{i \in \{1, \ldots, n\}} \left\{ \frac{V(1) - V(\delta_i)}{1 - \alpha_i^*} \right\}$$
Proposition 3.6

When patent pool members are under the obligation to offer individual licenses at royalties not exceeding $\alpha_i R$, where $R$ is the total royalty of the pool:

(i) if $R > \bar{R}^u$, then there exists no $\alpha$ such that the pool $(R, \alpha)$ is stable,
(ii) if $R \leq \bar{R}^u$, there exists $\alpha$ such that the pool $(R, \alpha)$ is always stable.

The proof is too long to be presented here, the idea being:

- With the cap there can be no strongly welfare reducing pool that sells because if it did, the pool’s total royalty could not be higher than the maximum total royalty of an uncoordinated equilibrium.
- The cap does not destabilize strongly welfare increasing pools because if the cap binds for every IPR holder, then $r^*$ is such that the pool sells, no one wants to undercut the pool, and the pool can always modify $\alpha$ such that the cap binds for everyone.
The cap would effectively screen pools;
  Giving firms legal certainty and facilitating formation of good pools.
The cap could give grounds to a safe harbor within Article 101(1);
  Securing lighter antitrust treatment for eligible firms.
Safe harbor dominates other available policy options for pools:
  minimizes type 1 and type 2 enforcement errors.
Our agenda for future research involves more general customer heterogeneity, downstream competition, coalition formation and incentives for innovation.