INTELLECTUAL PROPERTY AND PUBLIC POLICY:
I. Addressing the patent thicket

GORMAN LECTURE I
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I. INTRODUCTION

IP (patents, copyright, trade secrets, trademarks)

- common feature = protection of market power
- subject to a large number of debates, including:

  *Recent extensions of IP protection*

  - scope of patents (software, biotechnology, business methods)
  - ridiculous patents (online Dutch auction, Amazon’s one click)
  - (retroactive) extension of copyright

*PTOs’ incentives and the patent thicket* (but 2011 America Invents Act)
Role of open source production process


Injunctions (e.g. preventing sale of infringing products)

LDCs: pharmaceuticals, plant breeders’ rights

Joint marketing agreements (patent pools)*

Standard essential patents & associated lawsuits*
Theory: the view from 10,000 feet

Principal (society)-Agent (innovator)
Principal provides a reward for socially valuable innovation.
Why does reward take the form of IP, i.e., market power?

*Long-standing debate about structure of this reward*

- Theory would suggest *prizes*: lump sum payment to the inventor and innovation put in public domain
  
  [17th century France: prize for a workable water turbine; 18th century England: Longitude Prize]

  *Ex-post efficient price* (MC, often nil)
  - facilitates diffusion
  - but creates no revenue adequacy/incentive for R&D.

Renewed interest in prize system/marginal cost pricing.
How does one measure innovation’s value?

*The tale of two projects*: *m* ("minor", "me-too") and *M* ("Major")

- *m* creates low surplus, is not worth the fixed cost*, unlike *M*;
- need to screen out *m*; cannot at low prices (*m* actually looks superior at low prices)

Screening in only socially beneficial innovations/projects/activities requires (potentially substantial) departures from ex-post efficient pricing.

*  [let alone fixed cost plus shadow cost of public funds used to reward innovation.]
Idea that exercise of market power is needed to screen out low-surplus activities/white elephants is old in public works context:

**proponents:** Smith 1776, Dupuit 1844, Mill 1848, Coase 1946, Vickrey 1948;

**opponents:** Marshall 1890, Pigou 1920, Hotelling 1938.

Adam Smith: the monopoly profit is “a pecuniary reward...precisely proportional to the merit of the invention”.
Formalized in Weyl-Tirole (QJE 2012)

Three-dimensional uncertainty: \((\sigma, m, c) = (\text{size, quality, cost of invention})\)

\[ q = \sigma Q \left( \frac{p}{m} \right) \]

Can normalize demand function so that \(m = \text{monopoly price}\).

Social planner
- does not observe \((\sigma, m, c)\)
- observes quantity \(q\) and price \(p\)

Optimal scheme \(t(q, p)\)?

Family includes
- patent \(t(q, p) = pq\)
- prize \(t(q, p) = t_0\)
Sorting condition: market power screens in high quality and out low quality innovations.

When does optimal incentive scheme involve $p$ close to monopoly price $m$ (at the optimum $0 \leq p \leq m$)?

- **High elasticity of innovation supply:** then high ratio

\[
\frac{\text{screening benefit (screen out marginal innovations)}}{\text{deadweight loss of high price on inframarginal innovations}}
\]

- **Large inequality in quality/ lots of me-too** (measure: $\text{var (log} (m/\sigma))$) conducive to IP, i.e. to prices that are close to monopoly prices.
Other application: 2-sided platforms

Laissez-faire \((p_i = m_i)\) vs bundling \((p_i = MC_i = 0, \text{ say})\)?

Analogy platform-social planner.

- Music (iTunes store): low elasticity of innovation supply
- Apps (Apple App store): high elasticity of innovation supply (rather exclusive apps).
Lecture I Joint Marketing Agreements (JMAs, e.g. patent pools)
Theme: designing information-free requirements that guarantee that JMAs improve welfare
- restoring competition (static environment)
- addressing tacit collusion (repeated game)

Lecture II Standardization
Themes:
- price regulation (standard essential patents)
- certification
A few relevant papers

(other authors will be cited along the way)

**Lecture I**


**Lecture II**

II. PATENT POOLS

Many mechanisms by which firms share technology

- Licensing proprietary technology,
- Cross-licensing and closed pools (generalization of cross-licensing arrangements to \( n > 2 \)),
- Patent pool: separate firms share patent rights to license to third parties (open pools),
- Licensing to a standards-setting body,
- Open source.
Why are patent pools interesting?

- Explosion in patent awards.
  - Especially problematic in emerging industries (e.g., biotechnology, software).

- Patent pools proposed as a possible solution to “patent thicket” problems
  

- More general co-marketing arrangements:
  - content carried by cable operators
  - payment systems used by merchants
  - providers included in health insurance network (Katz 2011)
  - music performance rights licensed by Pandora
  - product portfolios (e.g., alcoholic beverages in *GrandMet*)
  - producers’ organizations
BRIEF HISTORY OF PATENT POOLS (1)

[Excellent overviews: Gilbert 2002, Carlson 1999.]

1856: Sewing Machine Pool.

1902: **National Harrow**

[Supreme Court. “the general rule is absolute freedom in the use or sale of rights under the patent laws”.]

1945: **Hartford Empire**

[Supreme Court Justice Black: “the history of this country has perhaps never witnessed a more completely successful economic tyranny”].

1997: **DOJ’s first business review letter.**

[MPEG-2 digital technology standard for video compression.]
BRIEF HISTORY OF PATENT POOLS (2)

1945
- Railroads
- Planes
- TV
- Radio
- Cars

1997 Revival (mainly in IT)
Guidelines

Department of Justice focuses on following criteria:

Information light:
- Pool members retain right to license separately.
- Grantback provisions*
- Of course, no ancillary restraints.

Information intensive:
- Pool includes only “essential” patents - those without substitutes.
  Internal and external tests.
- No bogus patents.

* US Antitrust-IP Guidelines: grantback = agreement by which a licensee extends to the licensor the “right to use the licensee’s improvements to the licensed technology.”
  - Suppression of competition in R&D market vs. wider diffusion/prevention of hold-up?
  - DOJ/FTC: should be nonexclusive and narrow (limited to the subject matter of the pool)
Royalty staking hinders the diffusion of technologies. Analogy:

Co-marketing is desirable
Akin to merger to monopoly.
Two symmetric firms/patents/products \( i = 1, 2 \) [theory is much more general than this: see Lecture II]

Users have utility

\[
V - P - \theta \text{ if consume both products at total price } P
\]
\[
[V - e] - p - \theta \text{ if consume one product at price } p
\]

where

- \( e \) = essentiality parameter (lies between 0 and \( V \))
- \( \theta = \) idiosyncratic (opportunity) cost of adopting technology (distribution \( F(\theta) \) on \([0, V]\))

Perfect substitutes when \( e = 0 \).
Perfect complements when \( e = V \) (one useless without other).
Everything in between.
Heterogeneity in $\theta$ gives downward sloping demand for technology.

*Example:* $\theta$ uniform on $[0,1]$ and $V = 1$. Let $P =$ price of complete technology.

$$D(P) = \Pr(1 - P - \theta \geq 0) = 1 - P.$$ Linear demand

- Simple set-up
  - Under separate marketing, all users pick the same basket if they adopt the technology.
  - Menus do not increase profit under joint marketing

  (“menu” means offering $\{1\}$, $\{2\}$ and $\{1, 2\}$) $\implies$ pool will offer only the bundle $\{1, 2\}$.
Demand*

- for bundle $D(P) \equiv F(V - P)$
- for incomplete technology $D(p + e) = F(V - e - p)$

\[ p + e = \text{“quality-adjusted” price} \]

Cost (IP interpretation): assume production cost is 0.

Monopoly price $P^m$:

\[ \max \{PD(P)\} \]

Linear demand example: \[ \max P(1 - P) \Rightarrow P^m = 1/2. \]

Let $\pi^m \equiv P^m D(P^m)$.

* Assumption: $D'(P) + PD''(P) < 0$ (satisfied e.g. for linear demand). Role of this assumption: ensures that reaction curve has slope in $(-1, 0)$ (strategic substitutability).
(a) *Separate marketing*

Each sets its price non-cooperatively.

- *Perfect substitutes*: Bertrand competition. Only competitive equilibrium: $p_1 = p_2 = 0$. 

\[ P^c = 0 \]
Perfect complements: “Cournot double marginalization”:
\[
\text{max } \{p_iD(p_i + p_j)\}
\]

As if \( i \) chose total price \( P \):
\[
\text{max } \{(P - p_j)D(P)\}
\]
“costly” production (must acquire right from other at price \( p_j \))
\[
P^c = \hat{P} > P^m
\]

Example above:
\[
\text{max } p_i(1 - p_i - p_j) \rightarrow 1 - 2p_i - p_j = 0
\]

Equilibrium is symmetrical:
\( p_i = p_j = \hat{p} = 1/3 \)
\[
\hat{P} = 2/3 > P^m = 1/2
\]

Inefficient:
\( \circ \) high price
\( \circ \) low profit!
(b) *Joint marketing (patent pool)*

\[ \Rightarrow \text{ sell both at } P^m \]

- like a cartel: bad if perfect substitutes (raises price)
- good for everyone if perfect complements (lowers price).

However, how do antitrust authorities know whether complements or substitutes?
INDEPENDENT LICENSING

Pool

1

sells bundle at $P$

$\rho_1$

2

dividends

$\rho_2$
Timing:
  - Pool sets price $P$ for the bundle, as well as revenue sharing rule (e.g. 50 – 50)
  - Il owners non-cooperatively set prices $p_i$ for their individual offerings ($IL$).

No change if perfect complements (one independent license is useless). And collectively cannot make more than the monopoly profit (which they make by charging $P^m$ for the bundle).

Perfect substitutes: Suppose pool charges, say, $P = P^m$. Then incentive to undercut and charge $P^m - \varepsilon$: gets (almost) $\pi^m$ instead of $\pi^m / 2 \implies$ restores competition!
ROBUSTNESS # 1: Arbitrary essentiality ($0 \leq e \leq V$)

Equilibrium under separate marketing: necessarily per-patent price $p^c \leq e$. Suppose that $p^c < e$ (can raise price without being kicked out of consumption basket) and say linear demand.

$$\max_p p D(p + p^c) = \max_p (1 - p - p^c)$$

$$\implies p = \frac{1 - p^c}{2}.$$ 

Contradiction if resulting $p > p^c$ or $p \geq \frac{1}{3} = \hat{p}$. True more generally (whatever $D(\cdot)$).
(a) Competitive benchmark

\[ r(p_j) = \arg \max \{ p D(p + p_j) \} \]

Per-patent prices

\[ p^c \]

\[ 2p^m \]

\[ \hat{p} \]

Competitive price

\[ p^m \]

\[ \hat{p} \]

rivalry

weak complements

strong complements

45°
(b) Pool

Per-patent prices

\[
r(p_j) = \arg \max \{ p D(p + p_j) \}
\]

IL restores competition if \( e < p^m \), is neutral if \( e > p^m \). Miracle cure!
General value proposition $V(S)$, where $S$ is set of acquired licenses $\Rightarrow$ net user surplus

$$V(S) - P(S) - \theta$$

[$P(S) =$ cost of acquisition of licenses in $S$]

Results extend (see Lecture II).

*Caveat:* When $n \geq 3$ and pool is welfare decreasing, there exists an equilibrium of the IL game in which the competitive equilibrium is restored. Uniqueness is not guaranteed.
Illustration: $n = 3$, symmetric patents. Let $V(k) =$ value when $k$ licences, with

$$V(0) = 0 < V(1) = \varepsilon < V(2) = V(3) = V$$

where $\varepsilon$ is small. $\theta = 0$ for all users (no heterogeneity).

Unique competitive equilibrium: $p_i = 0$ for all $i$.

Pool with independent licensing charging $P = V$ (dividend $V/3$ each):

- $p_{iL}^I = 0$ is an equilibrium
- so is $p_i^I$ large ($= V$, say) $\Rightarrow$ no unraveling of pool

Coordination problem in IL game
To obtain uniqueness and restoration of competitive equilibrium, 
append unbundling:

\[ P = \Sigma_i p_{i,\text{pool}} \]

Aleksandra Boutin (2014): unique IL equilibrium when detrimental 
pool = competitive equilibrium.

Intuition in example above: Suppose \( p_{i,\text{pool}} = V/2 \) (to receive \( V \) overall). 
Then no longer a coordination problem: each IP owner can offer \( p_{i,\text{IL}} \) a 
bit below \( V/2 \) and obtain (approximately) \( V/2 \) rather than \( V/3 \).
Lerner et al *RJE* 2007 paper.
Data = 63 pools between 1895 and 2001 (7 of them post 1997)

- Expect pools with substitutes to be more reluctant to require IL.
- Difficult to find proxies for “substitutes”/“complements”. Use litigation + outcome of litigation as proxies for substitutability. Pattern consistent with prediction.
- Other prediction: on grantbacks*. Grantbacks more likely to be associated with pools of complements**(. Also satisfied by data

*Suggestive. Better data will be available in the future.*

[* Grantback trade-off: deters hold-up, but deters also subsequent innovation.

** Under substitutes, the owner of an unobserved blocking patent obtains monopoly profit by staying outside the pool ⇒ no cost of no requiring grantback.]
III. TACIT COORDINATION

Should we worry about tacit coordination?

- rivalry: may not want to undercut pool because afraid of retaliation
- complements: could tacit coordination suffice to reduce prices? need for a pool?

No pool: each IP owner $i$ maximizes intertemporal profit

$$\sum_{t=0}^{\infty} \delta^t \pi_i(t).$$
OPTIMAL PUNISHMENTS AFTER A DEVIATION

- \( e \leq \hat{p} \): static Nash
  - when firm \( i \) charges \( e \)
    - it remains in the consumption basket
    - the quality-adjusted price is at most \( 2e \)
  
  \[ \Rightarrow \text{can thus secure at least } eD(2e) = \pi^c \]

- \( e > \hat{p} \): see Rey-Tirole paper for worst punishment
Let $\tilde{\pi}(p) \equiv pD(p + e)$ and $\pi(p) \equiv pD(2p)$.

<table>
<thead>
<tr>
<th>Rivalry $(e \leq p^m)$</th>
<th>Must sustain price $p &gt; e \Rightarrow$ incomplete technology $\frac{\tilde{\pi}(p)}{2} \geq (1 - \delta)\tilde{\pi}(p) + \delta\pi(e)$</th>
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</thead>
<tbody>
<tr>
<td>Sustain $p &gt; p^N = e$</td>
<td></td>
</tr>
<tr>
<td>Weak complementors $(p^m &lt; e \leq \hat{p})$</td>
<td>Deviation: would like to charge above $\hat{p}$ (impossible) $\Rightarrow$ charges $e$  $\pi(p) \geq eD(p + e) + \delta\pi(e)$</td>
</tr>
<tr>
<td>Sustain $p &lt; p^N = e$</td>
<td></td>
</tr>
<tr>
<td>Strong complementors $(p^m &lt; \hat{p} \leq e)$</td>
<td>Issue: optimal punishments (Abreu’s codes) $\pi(p) \geq (1 - \delta)\max_{\hat{p} \leq e}{\hat{p}D(p + \hat{p})} + \delta\pi(p)$</td>
</tr>
<tr>
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<td></td>
</tr>
</tbody>
</table>
TACIT COORDINATION: MOST PROFITABLE EQUILIBRIUM

- Rivalry
- Complementors
- Weak
- Strong
- Cooperation at $p^m$
- Collusion at $\tilde{p}^m$
- Limited cooperation

Graphical representation with axes $\delta$ and $e$.
JOINT MARKETING WITH INDEPENDENT LICENSING

- **Modeling**
  - At date 0, pool sets price $P$ for the bundle (and possibly prices for individual patents), as well as the revenue sharing rule
  - At each date $t = 1, 2, \cdots$, firms non-cooperatively set prices for their individual offerings

- **Independent licensing is irrelevant under complementors ($e > p^m$)**
  - Pool sets price $P = 2p^m$ (and “high” individual prices), equal sharing of dividends
  - Undercutting through one’s individual offering: as $e > p^m$,

$$
(2p^m - e) D(2p^m) < p^m D(2p^m)
$$

undercutting
Corollary: Pool always welfare beneficial if complementors

✓ weakly so if \( p^m \) is already sustainable without a pool

✓ strongly so otherwise.

Rivalry \((e < p^m)\)

 Pool stability when pool charges \(2p\):

\[
\pi(p) \geq (1 - \delta) (2p - e) \ \underbrace{D(2p) + \delta \pi(e)}_{\text{undercutting}}
\]
Rivalry

Complementors

Impact of a pool
(+: beneficial; -: welfare reducing; blank: neutral)
Additional information-free regulatory requirement

- **Unbundling:**
  \[ P = \sum_{i=1}^{2} p_{i}^{\text{pool}} \]

- **Pass-through:**
  firm \( i \)'s dividend = pool’s price times \( i \)'s sales through the pool

\[ \implies \text{no subsidization among members: each member obtains the pool’s revenue from its patent} \]

\[ \implies \text{the pool acts as if setting price caps} \]
Proposition

Unbundling and independent licensing make joint marketing always socially desirable:

- no impact if firms are complementors
- restores no-pool outcome under rivalry

Intuition: pool cannot sell both at $p^P_i > e \Rightarrow$ unbundling prevents pool from enlarging opportunities for cartelization.

- Need both requirements (unbundling alone does not suffice to make pool always desirable).
Does joint marketing promote the right investment incentives? Provides incentives to bring to market value-creating rather than business-stealing innovations?

Suppose that

- one piece of the technology is available
- a second innovator can invest $I/(1 - \delta)$ to create a second one

Impact of the pool?

- **Rivalry region**
  - pool is neutral
  - does not affect investment incentives

- **Complementors**
  - pool increases profits
  - hence encourages innovation
Caution: For complementors, cannot directly conclude that pool is beneficial, because there can be business stealing:

$$\tilde{p}^m D(\tilde{p}^m + e) > p^m D(2p^m) \text{ for } e < e^*, \text{ where } p^m < e^* < \hat{p}.$$ 

Yet JMA with unbundling and independent licensing always desirable, as it is neutral for rivalry, and for complementors:

- lowers price
- fosters socially desirable investment
Extension to asymmetric offerings

- using technology $i$ yields value $[V - e_j] - p - \theta$
- rivalry / complementors if $e_1 + e_2 \geq p^m$
- Unbundling and IL still provide a perfect screen

Extension to any number $n$ of offerings

- using $k \leq n$ technologies yields value $V(k) - p - \theta$
- when subject to unbundling and independent licensing, pools
  - still achieve perfect cooperation when socially desirable
  - cannot raise prices in symmetric equilibria based on Nash punishments
The JMA could also be used to punish deviation
E.g., the pool offers the deviator’s IP for free afterwards

To avoid this, some restrictions on governance can help
- Unanimity rule for price changes
- Making reductions in bundle price irreversible
IV. CONCLUDING REMARKS

For policy purposes, find requirements that require little or no information, and screen in good alliances and out bad ones. In this respect, JMAs brought in safer territory.

**Alleys for future research:**
- Generalization of nested demand function
  - heterogeneity of technology basket with and without JMA
  - second-degree price discrimination

**Incomplete knowledge of technology**
Several facets:
(a) *Mistakes on* $V(\cdot)$ *function*. Example: someone has a blocking patent.
(b) *Probabilistic patents* (à la Lemley-Shapiro 2005). Llobet-Padilla (work in progress) looks at perfect complements.
  Threshold royalty (deterring litigation) $\bar{p}_i$ increases with
  - probability that patent $i$ is upheld in court (obvious)
  - litigation cost for user (obvious)
  - prices of other licenses (“$P_{-i}$”) = “inverse Cournot effect”: Taking $p_i$ to 0 (invalidation) more interesting when $P_{-i}$ low.
So far: standard-free environment. Standardization process crucial in a number of industries (IT...)  
  - value discovery ("certifying $V(S)$")  
  - interoperability: coordination and standard essential patents.

Lecture II.
THANK YOU VERY MUCH!