On the Interaction between Patent Screening and its Enforcement

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Motivation

The patent system consists of two independent agencies

- The Patent office (e.g., USPTO, EPO, CIPO): screens innovators
  - Gives the right of exclusion
  - Novelty, useful and non-obvious
- Courts (e.g, PTAB and USCAFC, UPC):
  - Determines validity of patents and infringement claims

Literature (generally) abstracts away from them

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However, they do interact: among them and w/ innovators

- A judge's ex-ante belief that a patent infringes *depends on the quality of the screening* by the patent office

Research Questions

If both agencies are welfare maximizing, how do they affect: incentives to innovate and each other?

- **Mechanism 1:** Patent office and courts affect innovation rents. Thus, incentives to innovate
- **Mechanism 2:** While the Patent Office *screens* every innovation, courts only act (*enforce*) conditional on an infringement claim
  - Impact of screening and enforcement decisions on welfare is asymmetric
  - A particular judge weights statistical error type I and II of their decision. While patent office assesses welfare in general.

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What is the nature of the interaction

- How does the incentives between PO and Court differ?
- Is the Patent Office a (strategic) complement or substitute of courts?

Policy Relevance

Is the patent office (PO) screening too much or too little?

- **Argument 1:** It is optimal for PO to be *Rational Ignorant*. It is too costly to screen comprehensively (Lemley, 2001)
- **Argument 2:** Too much litigation is costly too (Farrell and Merges, 2004)
- **Evidence:** Patent office operates constrained and more resources improves outcomes.

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Leahy-Smith America Invents Act of 2011 (among many changes) increased PO resources

Without a model to formally think about these issues, no way to assess/measure the impact of a policy change

Findings

- Even in the absence of screening cost, *Rational ignorance* is optimal! i.e., for patent office **to allow obvious patents**.

  This facilitates future entry by:
  - increasing number of competitive markets
  - inducing judges to exert effort

- The Patent Office screening effort is a **strategic complement** for the effort of judges!! Better screening leads to better enforcement!

Literature

- Quality ladders: Grossman and Helpman, 1991; Aghion and Howitt, 1992
- Sequential innovation: Green and Scotchmer, 1995; Scotchmer and Green, 1990; Bessen and Maskin, 2009; Parra (2019)
- Probabilistic Patents: Lemley and Shapiro, 2005; Farrell and Shapiro, 2008
- How legal framework affect interaction among firms: Spier, 2007; Hovenkamp, 2016; Lemus and Hovenkamp, 2018; Scott Morton and Shapiro, 2016
- Sequential Decision Making: Sah and Stiglitz (1988)
- Patent Office and Courts as players: Reinganum and Daughety

The Model

Key: Each market competes in quality ladder.
Market can be *Monopolized* or *Competitive*.

Setup

- Infinite horizon, discrete time t. Discount factor $\beta < 1$
- A continuum of markets of mass 1
- Each market competes in a **quality ladder**
- The latest quality in the market is protected by a **patent**
- **Two types** of markets, depending on last **allowed** innovation:
  - **Monopolized:** If innovation was novel. Incumbent receives π
  - **Competitive:** If innovations was obvious/imitation. Zero profits

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Market Competition and the Quality Ladder

- Firms compete in price. Unit demand per product
- Novel innovation increases quality by π
- Obvious innovation brings a product with the existing quality

The Model (part II)

Key: Entrants (innovations) are *Obvious* or *Nobel*
Patent office screens entrants

Entry Process (Timing and the Patent office)

- At t, a measure e_t of firms produce an innovation at a costs 1
- Innovations are **novel** with probability α (and *obvious* with $1 - \alpha$)
- Innovators do not know ex-ante which market they'll land nor the quality of their innovation (anticommons problem)

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- Innovations are **novel** with probability α (and *obvious* with $1-\alpha$)
- Innovators do not know ex-ante which market they'll land nor the quality of their innovation (anticommons problem)
- The Patent Office reviews prior art to decide whether innovation is novel (patentable)
  - If novel, no prior work is found, and innovator gets a patent.
  - If obvious, with probability λ no prior work is found, and innovator gets a patent.
- Only patent holders can enter their respective markets.

The Model (part III)

Key: Incumbent fights entry by litigating
A judge decides

Infringement and Litigation

- An incumbent that faces entry may choose to litigate:
    - Litigation has no cost but, when indifferent, no litigation occur
    - **No litigation**: entry occurs — 0 profits going forward
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- Judges rules in favor of the entrant with probability
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- After courts decide, production and payoffs takes place
- The period t ends

The Model (part IV)

Laws of motion at period t

Recall that e_t represents the mass of entrants

- The proportion of monopolized niches x_t

$$x_{t+1} = x_t \left[1 - (\alpha\mu_n + (1-\alpha)\lambda\mu_o)e_t\right] + e_t p_t.$$

where $p_t = \alpha\left[(1-x_t) + x_t\mu_n\right]$ is the prob. of successful novel entry

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- The present value of profits of a novel incumbent is

$$v_t = \pi + \beta\left[1 - (\alpha\mu_n + (1-\alpha)\lambda\mu_o)e_{t+1}\right] v_{t+1}.$$

  today's profit plus probability of being incumbent in the future

- The free-entry condition: $p_t v_t = 1$

Solving for the Steady-State

Proposition (Equilibrium and Comparative Statics)

If $\pi > (1-\beta)/\alpha\mu_n$ there exists a unique SS equilibrium with interior e_{ss} given by

$$x_{ss} = \frac{\alpha}{\alpha + (1-\alpha)\lambda\mu_o}, \qquad p_{ss} = \frac{\alpha\left(\alpha\mu_n + (1-\alpha)\lambda\mu_o\right)}{\alpha + (1-\alpha)\lambda\mu_o},$$

$$v_{ss} = \frac{1}{p_{ss}}, \qquad e_{ss} = \frac{\pi p_{ss} - (1-\beta)}{\beta\left(\alpha\mu_n + (1-\alpha)\lambda\mu_o\right)}$$

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The equilibrium comparative statics are:

	π	β	α	$\lambda\mu_o$	μ_n
x_{ss}	0	0	+	−	0
p_{ss}	0	0	+	+	+
v_{ss}	0	0	−	−	−
e_{ss}	+	+	+	?	+

Solving for the Steady-State II

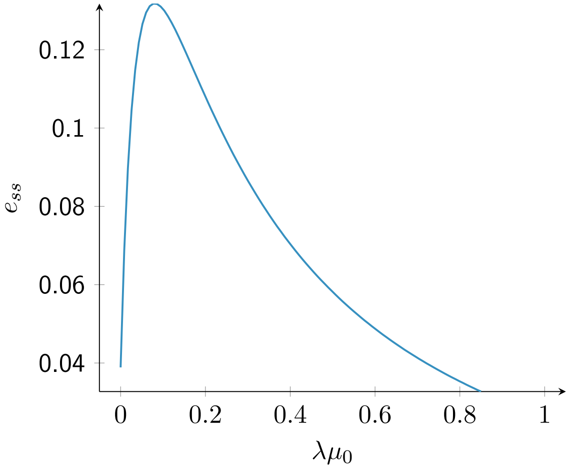

Figure: Entry is maximized at an interior value of $\lambda\mu_o$.

Notes: Parameter values are $\alpha = 0.1$, $\pi = 2.4$, $\beta = 0.8$, and $\mu_n = 0.85$.

Key Intuition

- The term $\lambda\mu_o$ represents Pr of obvious patent to reach the market
- A higher $\lambda\mu_o$ has two effects
  - Decreases v_t by shortening the incumbency status
  - Increases proportion obvious niches $1 - x_t$, making the successful entry of a novel innovation more likely

    $$p_t = \alpha \left[(1 - x_t) + x_t \mu_n\right]$$

    This effect is quite robust as long as $\mu_n < 1$
  - If $\mu_n = 1$, optimal $\lambda\mu_o = 0$. If every novel innovation succeed, it is optimal not to allow imitation.
- When $\mu_n < 1$, allowing obvious innovations can increase entry!
- But entry is costly is not the same as welfare...

The Patent Office Problem

Assume the Patent Office maximizes welfare; i.e.,

$$\max_{\lambda \in [0,1]} W = e_{ss} \left(p_{ss} \frac{\pi}{1-\beta} - 1 - k(\lambda) \right)$$

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Proposition

In a Steady State equilibrium with $\mu_n < 1$, even if $k(\cdot) = 0$, welfare might be maximized at an interior λ.

We have closed-form solution for λ^*

Criticism: Well you are taking Judges' behavior as exogenous!

Endogenizing Judge Behavior

Endogenous Courts

The Legal Technology

- When a case reaches the court, a judge reviews the case
- The judge has a **prior** γ about the entrant's patent being *obvious*. This prior is **consistent** with the patent office behavior

$$\gamma = \frac{(1-\alpha)\lambda}{\alpha + (1-\alpha)\lambda} \in [0, 1-\alpha] \, .$$

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$$\gamma = \frac{(1-\alpha)\lambda}{\alpha + (1-\alpha)\lambda} \in [0, 1-\alpha].$$

- The judge exert **effort** $s \in [0, 1]$ to look for evidence of infringement
- It receives a binary **signal** $\sigma \in \{0, 1\}$ regarding this evidence.

$$\mu_n(s) = \Pr[\sigma = 0|\text{novel}] = \frac{1+s}{2}; \quad \mu_o(s) = \Pr[\sigma = 0|\text{obvious}] = \frac{1-s}{2}$$

The Single-Judge Problem

Judge's Objective

Judges are **evidence based**:

- **No evidence** ($\sigma = 0$): entrant's patent is valid
- **Evidence**: Entrant is out of the market
- **Evidence is not perfect and takes effort**: Judges make mistakes

The judge maximizes welfare. Equivalently, minimizes the **social cost** of its **expected errors**

$$\min_{s \in [0,1]} J(s; \gamma, \hat{s}) = (1-\gamma)(1-\mu_n(s))E_I + \gamma \mu_o(s) E_{II}(\gamma, \hat{s}) + c \cdot s$$

where $\hat{s}$ is other judges aggregated effort.

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where $\hat{s}$ is other judges aggregated effort.
Type-I Error: A **novel** innovation is forbidden and wasted

$$E_I = \frac{\pi}{1-\beta}$$

The Single-Judge Problem

Judge's Objective

Type-II Error: An **obvious** innovation is upheld

- Existing (monopolistic) rents are transferred to consumers
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Judge's Objective

Type-II Error: An **obvious** innovation is upheld

- Existing (monopolistic) rents are transferred to consumers
- Niche becomes competitive: probability of future entry increases (increase in future welfare)
- Future entry depends on equilibrium effort $\hat{s}$ and patent office decisions

$$E_{II}(\gamma, \hat{s}) = -\frac{\pi}{1-\beta} \frac{(1-\gamma)\alpha\beta e_{ss}(\hat{s})(1-\mu_n(\hat{s}))}{(1-\gamma)(1-\beta) + \gamma\mu_o(\hat{s})\alpha\beta e_{ss}(\hat{s})} < 0$$

IP policy's time inconsistency!

- Benefit increases in γ (explain)

Despite this, welfare-loss of an incorrect ruling is positive!

details

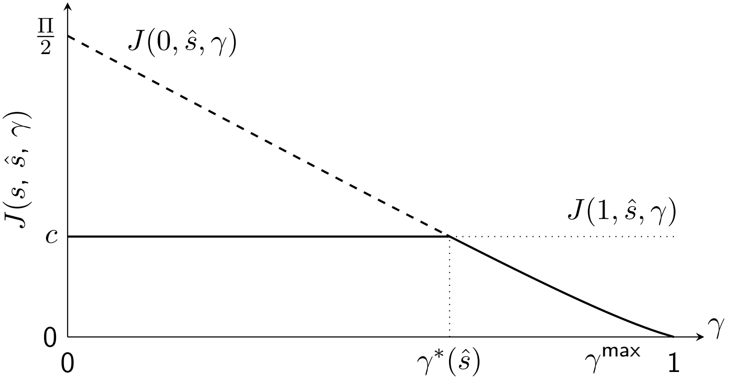
The Judge Problem: Equilibrium

Proposition (Court Equilibrium)

There exists a unique symmetric equilibrium among judges.
The Patent office effort is a strategic complement to the courts' effort.
That is, an increase in screening quality increases the enforcement quality.

The decision of an individual judge

Binary effort scenario



Recall the judge's objective

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Optimal screening

Let's revisit optimal screening when enforcement best responds

$$W(\lambda; s^*, c) = e\left(s^*, \lambda\right)\left[p\left(s^*, \lambda\right)\Pi - 1 - \kappa(\lambda) - c(\alpha + (1-\alpha)\lambda)x\left(s^*, \lambda\right)s^*\right]$$

where $\Pi = \pi/(1-\beta)$. Need to consider the enforcement costs!!

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- When $s = 0$, back to original problem

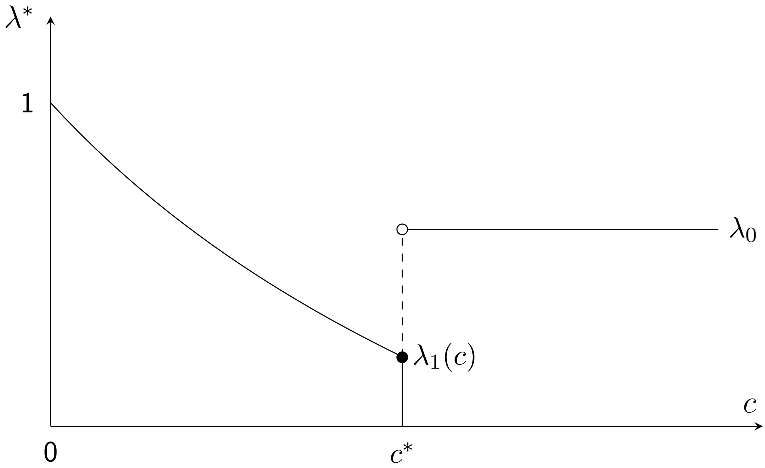
$$W(\lambda; 0) = e\left(0, \lambda\right)\left[p\left(0, \lambda\right)\Pi - 1 - \kappa(\lambda)\right]$$

  does not depend on c.
- But s^* is a function of λ

Optimal screening as a function of the enforcement cost

Screening and Enforcement are complements: Binary screening effort

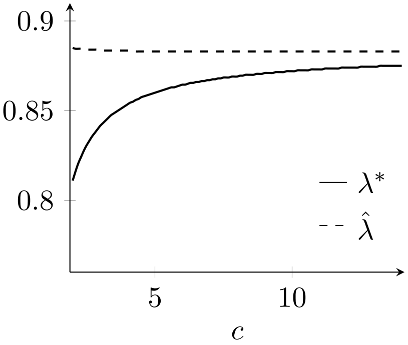
$\lambda_s(c)$: optimal screening when judges exert binary effort $s \in \{0, 1\}$.



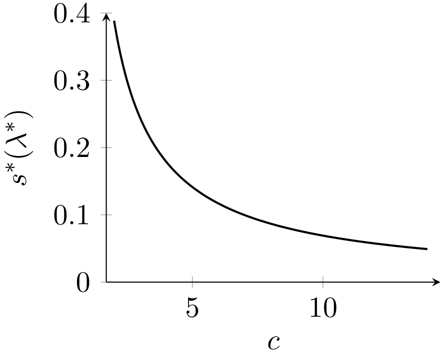
Optimal screening as a function of the enforcement cost

Screening and Enforcement are complements: Continuous screening effort

$\lambda^*(c)$: optimal screening.
$\hat{\lambda}(c)$: optimal screening and screening effort is taken as exogenous.



(a) Optimal screening



(b) Optimal enforcement

Extensions

Static Inefficiency: Cost-saving innovation

Let's assume instead a market demand is $q = a/p$ and a innovation reduces marginal costs by $1 - \delta$.

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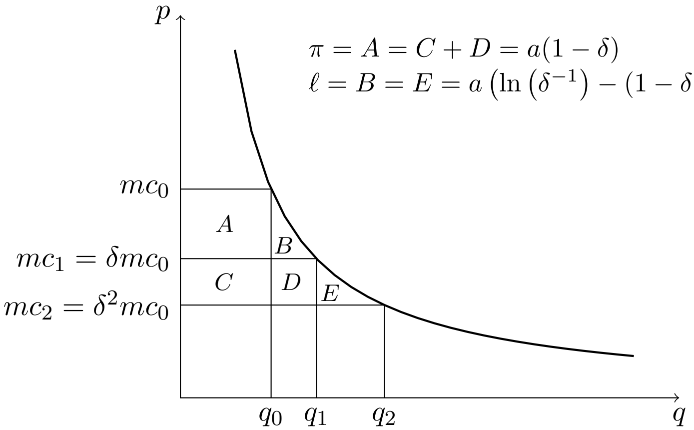

Figure: Cost-saving innovation – innovation profits (π) and deadweight losses (ℓ)

Cost-saving Innovation

Welfare Function: Has same structure as before

$$W(\lambda; s^*, c) = e\left(s^*, \lambda\right)\left[p\left(s^*, \lambda\right)\frac{\pi + \ell}{1 - \beta} - 1 - \kappa(\lambda)\right]$$

Cost-saving Innovation

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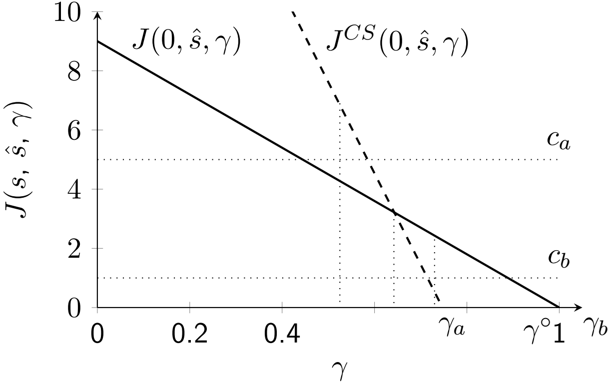
Judges Problem: Complementarity remains



Conclusion

- Contrary to common wisdom, better screening induces better enforcement
- But, an increase in enforcement costs should be optimally accommodated with less rather than more ex ante screening.
- Any attempt to assess efficiency of a policy, such as increasing PO resources, needs to take into consideration this interaction.

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Thank You!

Error Types and their Social Welfare Costs ◂ Go Back

The type-II error can be computed as $E_{II} = \beta * (w_M - w_C)$, where w_M and w_C are the present value of the social welfare that a niche generates in monopoly and competition, respectively. These values are obtained as

$$w_C = \beta w_C + e\left[\alpha\left(\Pi + \beta(w_M - w_C)\right) - 1\right],$$
$$w_M = \beta w_M + e\left[(1-\alpha)\lambda\mu_0\beta(w_C - w_M) + \alpha\mu_1\Pi - 1\right].$$