Screening for Patent Quality

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- In 1999, Amazon obtains patent on "one-click checkout"
- Allows customers to complete a purchase in a single click (without having to re-enter previously stored customer information)
- Patent gave Amazon an important competitive edge. By all accounts, very valuable
- Many observers were skeptical as to its validity: non-obviousness?
- Yet, patent was never challenged in court
- It ran to full term (expiring Sept. 2017)

What to do about bad patents?

- Lemley (2001): "rational ignorance" at the patent office:
    - Most patents are not very valuable: only about 1% are litigated
    - No point spending more money on patent office examination
- But Amazon one-click example suggests no litigation doesn't mean there is no problem:
    - Bad patents may not get challenged
    - Royalties lead to higher prices for consumers

Policy-driven research questions

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- Patent offices spend large sums on examination/search. Should examination be intensified? Or should we move to a registration system, shifting burden of screening to courts?
- Patent offices charge a variety of fees. Current USPTO fees:
    - Patent application with $\leq$ 3 claims $\rightarrow$ \$1,740 in pre-grant fees
    - If patent renewed to full term $\rightarrow$ \$13,560 in post-grant fees

  Should we change the fee structure (frontload or backload)?
- What is the effect of introducing a post-grant review procedure ($\rightarrow$ PTAB), cheaper but less accurate than the courts?

This paper

- We develop a model of patent screening in which the inventor has private information about validity
- A competitor updates beliefs about inventor's type based on observed decisions (grant, payment of fees, license contract)
- Patent office and courts receive an informative signal about validity:
  - Patent office: all applications screened, but imperfect signal
  - Courts: perfect signal, but requires challenge by competitor
- This setup allows us to analyze all key instruments together ($\rightarrow$ interaction) in a framework with endogenous challenges
- We parameterize a simulated version of the model to match key features of US patent and litigation data, and use it to conduct policy experiments

Preview of results

- Theory:
  - Frontloading fees improves screening and welfare
  - Courts (even if perfect) cannot achieve full screening because some bad patents are not challenged
  - Incentives to challenge are inefficient: may lead to too many or too few challenges
- Quantification:
  - About 80% of applications are made on inventions that would be developed even without patent incentive (i.e., they are not "innovation inducing")
  - Patent office screens out 35%, implying about 75 of granted patents are not innovation-inducing
  - Frontloading, and using additional fee revenue to increase examination intensity, raises welfare by 1.43%
  - Post-grant review within patent office (cheaper but less accurate than courts) raises welfare by 0.35%

Basic setup

- Inventor endowed with privately observed idea $\theta \in \{L, H\}$:
  - $\theta = H$: high R&D cost κ_H (probability λ)
  - $\theta = L$: low R&D cost κ_L (probability $1 - \lambda$)
- R&D investment κ_θ is required to develop idea into invention
- The profit from the invention without a patent is π
- Patents generate an additional profit Δ
- Assume
  - $\kappa_L \leq \pi$
  - $\pi < \kappa_H \leq \pi + \Delta$

Patentability

- Social planner wants to give patents only to type H ($\kappa_H > \pi$). Type-L inventions are developed even without a patent because $\kappa_L \leq \pi$
- In line with rationale given by courts and legal scholars for nonobviousness requirement in patent law Quotes
- Problem: type-L inventors also benefit from patent. Patent office and courts must enforce patentability requirement

Obtaining patents

- Inventor observes θ and decides whether to invest κ_θ
- To apply for a patent, inventor must pay a pre-grant fee $\phi_A \geq 0$
- The patent office examines the application for patentability:
  - Valid types ($\theta = H$) always pass the examination
  - Invalid types ($\theta = L$) pass with probability $1 - e$ and are rejected with probability e
  - $e \in [0, 1]$ is the patent office's examination intensity
- If granted a patent, the inventor must pay a post-grant fee $\phi_P \geq 0$ for the patent to become effective (activation)

Inventor behavior without challenges

- Suppose challenges are not possible
- Type H invests, applies, and activates iff

$$\Delta + \pi - \kappa_H - \phi_P - \phi_A \geq 0 \tag{H}$$

- Type L:
  - Always invests because $\kappa_L < \pi$
  - Applies for patent and activates iff

$$(1 - e)(\Delta - \phi_P) - \phi_A \geq 0 \tag{L}$$

Result

Application fees screen better than activation fees.

- Fixing $\phi_A + \phi_P$, type H is indifferent over all mixtures of fees
- Type L prefers ϕ_P, which is only paid conditional on grant

Licensing game

- We now introduce courts through an explicit model of licensing
- Each inventor (I) has a single competitor (C)
- If the inventor holds a patent, he can make a take-it-or-leave-it offer to the competitor to license the invention for royalty F
- The competitor's outside option is $\pi - \Delta_C$
- If the competitor rejects the license contract, she decides whether to challenge the patent in court (litigation costs l_C and l_I)
- Courts are mistake-free in determining validity:
    - Uphold valid patents ($\theta = H$)
    - Revoke invalid patents ($\theta = L$)

Inventor behavior in the presence of courts

- The equilibrium is semi-separating:
  - type H charges $F = \Delta_C$
  - type L randomizes over license fee:

$$F = \begin{cases} \Delta_C & \text{with probability } y \\ l_C & \text{with probability } 1 - y \end{cases}$$

- Competitor challenges with prob. x if offered $F = \Delta_C$

Result

The possibility of challenges does not eliminate all bad patents:

- A fraction y of low types preempts challenges
- Of the remaining $1 - y$, only a fraction x is challenged

- Intuition: if no low types apply, competitor doesn't challenge

Continuous invention values and R&D costs

- Suppose an idea is a pair (v, κ), where v is social value and κ is R&D cost
- Let $v \sim F(\cdot)$ on $[\underline{v}, \overline{v}]$
- Let $\kappa \sim G_v(\cdot)$ on $[\underline{\kappa}, \overline{\kappa}]$
- Assume profits, patent premium and litigation costs are increasing functions of v: $\pi(v)$, $\Delta(v)$, $l(v)$
- Consistent with previous notation, refer to ideas with $\kappa \geq \pi(v)$ as high types
- For a given v, share of high types depends on distribution of κ:

$$\lambda(v) = \frac{G_v(\pi(v) + \Delta(v)) - G_v(\pi(v))}{G_v(\pi(v) + \Delta(v))}$$

Equilibrium

Under some conditions, there exist cutoffs v^*, $\hat{v}$, and v^{cc} such that

- For $v < v^*$, nobody applies.
- For $v \in [v^*, \hat{v})$, only high types apply. No challenges.
- For $v \in [\hat{v}, v^{cc})$, low types apply as well and offer the same license contract as high types. No challenges.
- For $v \geq v^{cc}$, low types offer the high-type contract with prob. $y(v)$ and are challenged with prob. $x(v)$ if they do.

Welfare maximization

- The planner chooses (ϕ_A, ϕ_P, e) to maximize

$$\int W(v, \kappa) dG_v(\kappa) dF(v)$$

- May want to impose budget constraint: fee revenue $\geq$ examination cost

Optimal fee structure

Proposition

The optimal fee structure is frontloaded: fixing $\phi_A + \phi_P = \bar{\phi}$, the planner optimally sets $\phi_A = \bar{\phi}$ and $\phi_P = 0$.

- Raises $\hat{v}$: deterrence of low types
- No effect on v^*: high types unaffected
- If patent office is budget constrained: frontloading raises fee revenue, relaxing the budget constraint (provided elasticity of low-type applications w.r.t. fees is low)
- Note: the optimal level of fees trades off innovation incentives and deterrence

The virtues of patent examination

- Raising e has three effects:
  1. Detection: avoid deadweight loss for fraction e of low-type applications
  2. Deterrence: marginal low types stop applying ($\hat{v} \uparrow$)
  3. Litigation: marginal challenges stop being credible ($v^{cc} \uparrow$)
- If $\Delta_C \geq (l_C/(l_C + l_I))D$ (true in Cournot model), so that challenges are excessive, reducing litigation is welfare enhancing

Parameterizing the model (1)

- Homogeneous-goods Cournot model with linear demand $P(Q) = a - Q$ and constant unit cost c
- We treat 6-digit NAICS sectors (about 440 of them) as "markets." From information on price-cost margins and number of firms (from Herfindahl index) for 1987-2005, we can compute the parameters (a, c).
  - We use a symmetric n-firm Cournot model for each market and information on the Herfindahl index and price-cost margins to back out (a, c).

Parameterizing the model (2)

- Invention reduces unit cost by fraction $s \sim$ Beta distribution function $F^{*}(s; \alpha, \beta)$
  - Average TFP growth in sector divided by number of patent applications is taken as mean $s = \frac{\alpha}{\alpha+\beta}$
  - R&D equation pins down β, and thus α

Parameterizing the model (3)

- Development cost κ with Exponential distribution function $G^*(\kappa;\theta)$ where $\theta = \theta_0 + \theta_1 s$
- R&D per patent application (2018 $): 3-digit NAICS-level domestic R&D, adjusted by sector-specific patent propensity (Cohen and Walsh U.S. survey, 2000), and divided by number of domestic patent applications by U.S. corporations
- Litigaton rate: number of invalidity suits for domestic patentees per patent grant to US corporations = 2.38% (Lanjow and Schankerman, 2004)
- Grant rate: mean grant rate (including continuations) 1998-2005 = 71.2% (Carley, Hegde and Marco, 2015)

Parameterizing the model (4)

- Patentee win rate: overall win rate on invalidity judgments = 57.6% (Allison, Lemley and Schwartz, 2014)
- Common litigation cost $l = L_0 + L_1\Delta$; set $L_0 = \$650,000$ and $L_1 = 0.15$ based on AIPLA surveys (2011)
- Examination cost function: $\gamma(e) = \gamma_0 e^{\gamma_1}$: γ_1 pinned down by simulated (A_L, A_H, e) and Frakes & Wasserman (2008) estimate of elasticity of grate rate wrt examiner time per application; γ_0 by assuming examiner costs = fee revenue
- We have all parameters for six technology fields and aggregate level

Target moments

Model has four equations (observables):

1. Grant rate equation (GR)
2. Litigation rate equation (LR)
3. Patentee win rate equation (WR)
4. R&D per application equation (RDA)

Estimated parameters

Model has four parameters to be simulated/estimated:

1. examination intensity, e
2. distribution of development cost parameters, θ_0 and θ_1
3. distribution of invention size parameters, α and β (one is pinned down by mean TFP growth)

Baseline Calibration Results (Perfect Courts)

% H, Apps	e %	% H, Grants	$\bar{y}$	$\bar{x}$	γ_1	θ_0 (000's)	θ_1 (10^{10})
17.35	34.8	24.4	9.0	41.8	1.16	121.0	1.15

External Validation/Plausibility

1. Survey evidence from 100 firms by Mansfield (1986) indicate that 15-20% of patented inventions would not have been developed or commercialized without patent protection. Similar to our share of H-types among applications/grants
2. Simulated litigation cost at mean $s = 844k$. At mean s, $\Delta = 1.29m$. Broadly consistent with AIPLA survey evidence: $650k for values at stake $<$ 1 million; $2.5 million for values at stake of $1-25 million.
3. Mild convexity in examination cost function (γ_1)

Simulating counterfactual policy experiments (1)

- Now we take the calibrated parameters, impose policy reforms, then calculate changes in outcomes and welfare
- Experiments:
  1. Frontloading: shift all fees to pre-grant stage, return extra revenue to government
  2. Frontloading: shift all fees to pre-grant stage, invest extra revenue to increase e (revenue neutral)
  3. Registration: shift to pure registration system (like copyrights) with $e = 0$
  4. Perfect post-grant review (PGR): litigation cost reduced to $350k, perfect review: $q_L = 0, q_H = 1$ (validation probabilities)
  5. Impferfect PGR: litigation cost reduced to $350k, imperfect review: $q_L = 0.25, q_H = 1$
  6. Impferfect PGR: litigation cost reduced to $350k, imperfect review: $q_L = 0.25, q_H = 0.75$

Simulating counterfactual policy experiments (2)

Experiment	% H, A	e %	% H, G	$\bar{y}$	$\bar{x}$	% ΔW	% ΔCS
Status quo	17.3	34.9	24.4	9.0	41.8	–	–
Frontload, no invest	17.4	34.9	24.4	9.0	41.8	$<$0.001	$<$0.001
Frontload, invest	17.5	45.0	27.8	9.8	42.1	1.43	9.18
Registration system	17.3	0	17.3	7.3	41.1	-4.92	-31.6
Perfect PGR	17.3	34.9	24.4	7.2	62.7	0.35	0.98
PGR $(.25, 1)$	17.3	34.9	24.4	7.1	60.8	0.37	1.03
PGR $(.25, .75)$	17.3	34.9	24.3	3.0	59.6	0.40	1.12

Other experiments we want to run

- first best examination intensity and frontloaded fees
- marginal benefit (welfare)-cost ratio for e and compare to shadow price of public funds
- welfare impact of government taking a fraction of PTO revenue
- impact of fee shifting (English rule – "loser pays")
- impact of presumption of validity in PGR (preponderance of evidence vs clear and convincing standard)
- impact of SCOTUS decision (ACTAVIS) on negative fixed licensing fees ("pay for delay")

Conclusion

- Improving patent screening is important: many problems associated with the patent system (thickets, trolls...) can be traced back to lack of patent quality
- We develop a model of patent litigation with: private information on validity, heterogeneous R&D costs, heterogeneous invention values, PTO fees and examination
- Allows us to analyze the effects of various screening tools in an integrated framework with endogenous challenges
- Key results:
  - Examination is crucial for screening because (unlike challenges) it is not based on Bayesian updating from equilibrium strategies
  - Frontloading fees improves screening and increases welfare
  - Post-grant review increases welfare, but depends on how accurate it is

Rationales for the nonobviousness requirement

In theory, this standard prevents issuance of patents on inventions that (. . .) are likely to be forthcoming even without patent incentives.

Eisenberg (2004, p. 885)

The inherent problem was to develop some means of weeding out those inventions which would not be disclosed or devised but for the inducement of a patent.

Graham v. John Deere Co., 383 U.S. 1, 11 (1965)

The non-obviousness test makes an effort, necessarily an awkward one, to sort out those innovations that would not be developed absent a patent system.

Kitch (1966, p. 301)

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