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Firm Reputation and Incentives to “Milk” Pending Patents

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May, 2011

Motivation

- “When your competitors see the words ‘Patent pending’ at a trade show, on your new product, on your web site, or in your sales literature, they will naturally wonder about the scope of your patent application. [...] Your patent application will not be discoverable for at least eighteen months or more, and even then, prosecution could impact what ultimately may issue. So your competitor’s fear of the unknown may provide you a temporary but substantial advantage in the marketplace. Use it well.”(Patent agents Robert Gunderman and John Hammond.)

Motivation (cont'd)

- Firms benefit from a patent far before it has been granted – the pending phase is potentially valuable
- Competitors for a substantial period of time have no option to counteract pending patents
- This issue *has not been addressed* in the literature so far
- Firms may be tempted to apply for patents with bogus ideas to reap the short-term benefits while their applications are pending.
- A firm's reputation may act as a countervailing force to this tendency.

Contribution

This paper

- develops a reputation model in the spirit of Klein and Leffler (1981) to address reputation issues of patenting.
- highlights that reputation concerns may limit a firm's inclination to reap benefits from pending patents
- uncovers the role of the existing patent portfolio

Contribution

This paper

- obtains empirical predictions as to the patent behavior depending on firm observables
- policy: provides guidance to design a more efficient inspection policy by the PTO
- policy: clarifies advantages and disadvantages of the European vs. the U.S. patent system

Related Literature

- patent literature: application with bogus ideas / patent inflation: Cook (2007), Bessen and Meurer (2008)
- methodology: Klein and Leffler (JPE 1981), Wernerfelt (Rand 1988), Choi (RES 1998), Cabral (RAND 2000)

Model: Ideas and Patent Applications

- discrete infinite horizon setup
- each period t , with probability ρ the firm's research is successful = "good" idea
- otherwise, "bad" idea
- realization is private information of the firm
- action $a_t \in \{0, 1\}$ whether or not to submit a patent application
- A_t publicly observable history of actions until time t

Model: Patent Inspection and Patent Lifetime

- PTO needs γ periods to inspect a patent application
- good ideas are awarded a patent with certainty
- bad ideas are awarded a patent with probability μ
- a granted patent receives $\Gamma - \gamma$ further periods of protection (we represent the fact that falsely granted patents may be challenged in a reduced form in the payoffs, see below)

Model: Publicly Held Beliefs of Patent Quality

- ψ_i^t is probability at time t that the idea generated in period i is believed to be good
- beliefs depend on
 - ▶ publicly known parameters ρ , γ , Γ , and μ
 - ▶ history of the PTO decisions up until period t , denoted by H_t
 - ▶ history of application decision A_t
- Note that $A_{t-\gamma}$ is contained in H_t .

Model: Payoffs from Patents

- pending patents:
 - ▶ $\pi_t^+(\psi_i)$ in period t from a good idea generated in period i
 - ▶ $\pi_t^-(\psi_i)$ in period t from a bad idea generated in period i
- granted patents:
 - ▶ $\Pi_t^+(\psi_i)$ in period t from a good idea generated in period i
 - ▶ $\Pi_t^-(\psi_i)$ in period t from a bad idea generated in period i
- Assumption 1
 - ▶ each payoff increases in the public belief regarding quality
 - ▶ i.e. $\frac{\partial \pi_t^+}{\partial \psi_i} \geq 0$, $\frac{\partial \pi_t^-}{\partial \psi_i} \geq 0$, $\frac{\partial \Pi_t^+}{\partial \psi_i} \geq 0$, and $\frac{\partial \Pi_t^-}{\partial \psi_i} \geq 0$
- Assumption 2
 - ▶ good ideas yield a weakly higher payoff than bad ideas
 - ▶ i.e. $\pi^+(\psi_i) \geq \pi^-(\psi_i)$ and $\Pi^+(\psi_i) \geq \Pi^-(\psi_i) \forall \psi_i$

Timeline

At each point in time t

- 1.) Firm observes whether or not a good idea was generated.
- 2.) PTO makes its decision regarding the patent application that was filed γ periods ago (if any).
- 3.) Firm decides whether or not to apply for a patent with its period- t idea.
- 4.) Firm updates its beliefs about what competitors think and its period- t payoff accrues.

Applying with good ideas only

- special case $\gamma = 1$ and $\Gamma = 2$
- equilibrium such that reputational concerns lead the firm to abstaining from applying for a patent whenever a bad idea was generated:
 - ▶ The firm, in accordance with the beliefs held by the public and competitors, only applies for a patent if the underlying idea is good and otherwise does not submit an idea.
 - ▶ formally similar to Choi (RES 1998)
- how to support the bootstrapping equilibrium:
 - ▶ if a patent application has been rejected at any point in the past, then the competitors update to the most stringent possible (out of equilibrium) beliefs that every patent *application* submitted by the firm contains a good idea with probability ρ .
- IC-constraint: A firm with a bad idea must prefer not to submit an application.

Analyzing the IC-constraint

- notation

- ▶ ν_{t+1}^g expected value of the firm's revenue stream from future innovations, given that the patent office has made no negative decision up until period $t + 1$
- ▶ ν_{t+1}^b if at least one application was rejected up until period $t + 1$

Analyzing the IC-constraint

- notation
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 - ▶ ν_{t+1}^b if at least one application was rejected up until period $t + 1$
- Firm value when submitting a patent application despite the underlying idea being bad:
 - ▶ $V_t(1, -) = \pi^-(1) + \beta(\mu[\Pi^-(1) + \nu_{t+1}^g] + (1 - \mu)\nu_{t+1}^b)$
- Firm value when not submitting a patent application when the underlying idea is bad:
 - ▶ $V_t(0, -) = \beta\nu_{t+1}^g$
- IC-constraint is $\pi^-(1) + \beta\mu\Pi^-(1) \leq \beta(1 - \mu)[\nu_{t+1}^g - \nu_{t+1}^b]$
 - ▶ the short-term gains from the pending patent and, in addition, potential gains from the PTO committing an error in its evaluation are exceeded by the potential losses in future rents due to lost reputation, weighted by the probability of being caught in the act of submitting a bad idea as a patent

Analyzing the IC constraint cont'd

- present value if reputation is intact

- ▶ $\nu_{t+1}^g = \frac{1}{1-\beta} [\rho\pi^+(1) + \rho\beta\Pi^+(1)]$

- present value if reputation is ruined

- ▶ submit a patent application in each period

- ▶ belief for each granted patent that the underlying idea is good is

$$\hat{\psi} = \frac{\rho}{\mu + (1-\mu)\rho}$$

- ▶ $\nu_{t+1}^b = \frac{1}{1-\beta} [\rho(\pi^+(\rho)\beta) + (1-\rho)(\pi^-(\rho) + \beta\mu\Pi^+(\hat{\psi}) + \beta(1-\mu)\Pi^-(\hat{\psi}))]$

- $\nu_{t+1}^g - \nu_{t+1}^b$ present value of the difference in expected values of all future ideas between a situation with an intact reputation and one in which the reputation has been ruined

- ▶ $= \frac{1}{1-\beta} \{ \rho[\pi^+(1) - \pi^+(\rho) + \beta(\Pi^+(1) - \Pi^+(\hat{\psi}))] - (1-\rho)[\pi^-(\rho) + \beta\mu\Pi^-(\hat{\psi})] \}$

Analyzing the IC constraint cont'd

- IC-constraint $\pi^-(1) + \beta\mu\Pi^-(1) \leq \beta(1 - \mu)[\nu_{t+1}^g - \nu_{t+1}^b]$ is thus

$$\begin{aligned} & \pi^-(1) + \beta\mu\Pi^-(1) \\ \leq & \frac{\beta}{1-\beta}(1 - \mu)\{\rho[\pi^+(1) - \pi^+(\rho) + \beta(\Pi^+(1) - \Pi^+(\hat{\psi}))] \\ & - (1 - \rho)[\pi^-(\rho) + \beta\mu\Pi^-(\hat{\psi})]\} \end{aligned} \quad (1)$$

Proposition: *A subgame perfect equilibrium in which firms submit only good ideas for patenting and refrain from submitting bad ones (reputation equilibrium) exists only if this inequality is satisfied.*

Further results in the simple model

- more patient firms (higher β) are more likely to be careful of their reputation
- reputation equilibrium more likely to exist for intermediate values of ρ
 - ▶ RHS of IC constraint inverse u-shaped in ρ
- a larger error of the PTO μ leads to negative direct and to indirect effects; overall effect is negative

Analysis of the general model

- Now we allow for $\Gamma > \gamma + 1 \geq 2$
- The firm can accumulate a portfolio of active patents and pending applications.
- A negative signal from the PTO may now affect not only payoffs from future patents, but also from the existing portfolio; we call this the *portfolio effect*.
- denote the expected revenue flow from the currently held patent portfolio as $\Omega_t(A_t, H_t)$
- Most stringent feasible structure of beliefs:
 - ▶ $\psi = 1$ as long as no application has been rejected
 - ▶ beliefs regarding all active patents adjusted downward upon rejection of application
- intuition: competitors cannot observe *when* firm started to deviate and make the strictest possible inference – lower bound for reputation equilibria

The General Model, ctd

- some additional simplifying notation

- ▶ value of first bad application during pending phase:

$$\begin{aligned} p_t^-(1) &= \sum_{k=1}^{\gamma} \beta^{k-1} \pi^-(E(\psi_{t+k-1} | H_t, A_{t+k-1})) \\ &= \sum_{k=1}^{\gamma} \beta^{k-1} \pi^-(1). \end{aligned}$$

- ▶ value of subsequent bad applications during pending phase

$$\begin{aligned} p_{t+j}^-(\Psi_{t+j}) &= \sum_{k=1}^{\gamma} \beta^{k-1} \pi^-(E(\psi_{t+\gamma+k-1} | H_t, A_{t+\gamma+k-1})) \\ &= \sum_{k=1}^{\gamma} \beta^{k-1} [\delta_{t+j} \pi^-(\rho) + (1 - \delta_{t+j} \pi^-(1))] \end{aligned}$$

- analogously, $P_t^-(\psi)$ denotes the value given that a patent has been (falsely) granted and the superscript “+” refers to good underlying ideas

The General Model, ctd

- IC-Constraint for the general model:

$$\begin{aligned} & p_t^-(1) + \mu P_t^-(\Psi_t^d) + \sum_{j=1}^{\infty} \beta^j (1 - \rho) (p_{t+j}^-(\Psi_{t+j}^d) + \mu P_{t+j}^-(\Psi_{t+j}^d)) \\ \leq & \sum_{j=1}^{\infty} \beta^j \rho_{t+j} [p_{t+j}^+(1) - p_{t+j}^+(\Psi_t^d) + P_{t+j}^+(1) - P_{t+j}^+(\Psi_t^d)] + \beta^\gamma \Delta\Omega_{t+\gamma} \end{aligned}$$

- Ψ_t^d is the expected evolution of beliefs given deviation in period t
- $\Delta\Omega_{t+\gamma}$ as shorthand for the expected difference in the value of the patent portfolio in the deviation vs. the compliance regime
- The portfolio effect relaxes the IC-constraint

Extension: Sophisticated PTO Policies

- PTO optimally conditions the frequency and intensity of checking applications
 - ▶ on the age of the firm
 - ▶ on the portfolio of patents (including applications)

Extension: Comparing Patent Systems

- PTO faces trade-off between length of the patent pending phase and the precision when making its decision

Extension: Stochastic Firm Values

- setting
 - ▶ stochastic demand (or stochastic fixed or variable costs)
 - ▶ for simplicity: i.i.d. over time
 - ▶ public information; thus, observed firm heterogeneity
- define partial order on patent portfolios (ordering independent of the discount factor)
- calculate thresholds below which the bootstrap equilibrium can no longer be supported
- threshold monotone on the set of histories (or portfolios) according to the partial order
- firms eventually deviate along the equilibrium path and contribute to the patent inflation
- such deviation more likely the worse the patent portfolio

Summary

The paper

- proposes a reputation-based model of patenting
- evaluates different PTO policies
- provides a market model on patenting behavior that accounts for observed heterogeneity among firms

**Thank you
for your attention!**