Strategic Information Disclosure: The Case of Pending Patents

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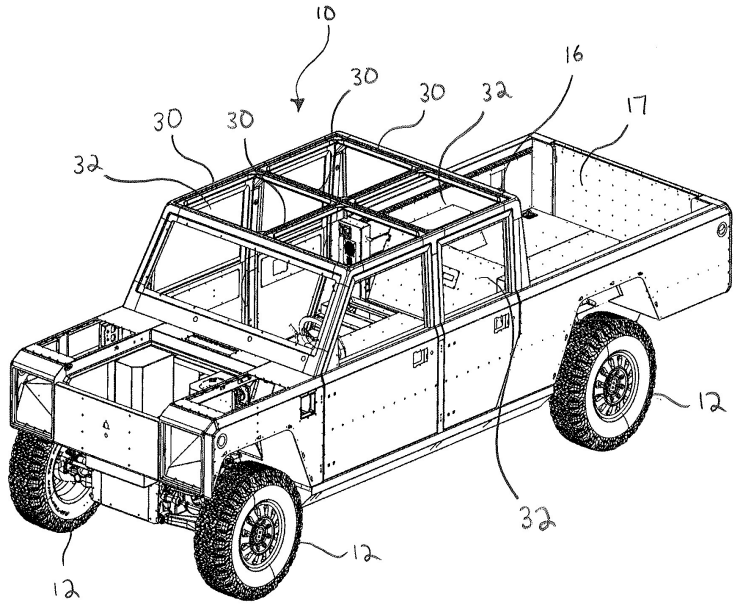
“The worlds most capable class 3 truck”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- invented by Bollinger Motors LLC, Detroit
- provisional application filed November 18, 2019
- provisional application filing **publicly announced** January 8th, 2020

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"DETROIT, Jan. 8, 2020 /PRNewswire/ – Bollinger Motors has filed for patent protection for its all electric, all-wheel drive, Class 3 vehicles. The scope of the patent includes the entire vehicle, and gives particular emphasis on the specific arrangement of major components and subsystems.

"The patent highlights the vehicle-controls strategy and innovative software solutions used to achieve performance targets including adjustable ride height, variable payload responses, virtual front and rear differential, and various modes of operations, including outboard power usage.

"The technical content contained in the application provides substantial competitive advantage and adds to a growing portfolio of intellectual property for Bollinger Motors." [. . .]

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- utility patent application filed October 12, 2020
- application published May 20, 2021

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Why do firms announce patent applications

. . . but do not disclose any content?

Roadmap

Why?

How?

What?

So What?

And Now?

Shapes of Disclosure

- Disclose patent grant documents and enabling information (Anton and Yao, 2004)
- Disclose patent grant documents
- Disclose existence of patent grant
- Disclose content of patent application
- **Disclose existence of the application**

Announcement in this Story?

- In practice:
  - → press release or statement
  - → conversation with competitors
  - → …
- In theory: a message $m \in \{\varnothing, A\}$
- With an announcement the applicant …
  - → credibly discloses existence of a technology and patent application
  - → **without revealing technical details of that technology**

Main Takeaway

- Applicant **signals** to competitor the existence of (probabilistic) IP to deter follow-on innovation

- This is effective if follower does not learn too much about her own R&D prospects and does not become a fiercer competitor in the product market
  - → Sufficiently low R&D correlation
  - → Strategic substitutes, or weak strategic complements

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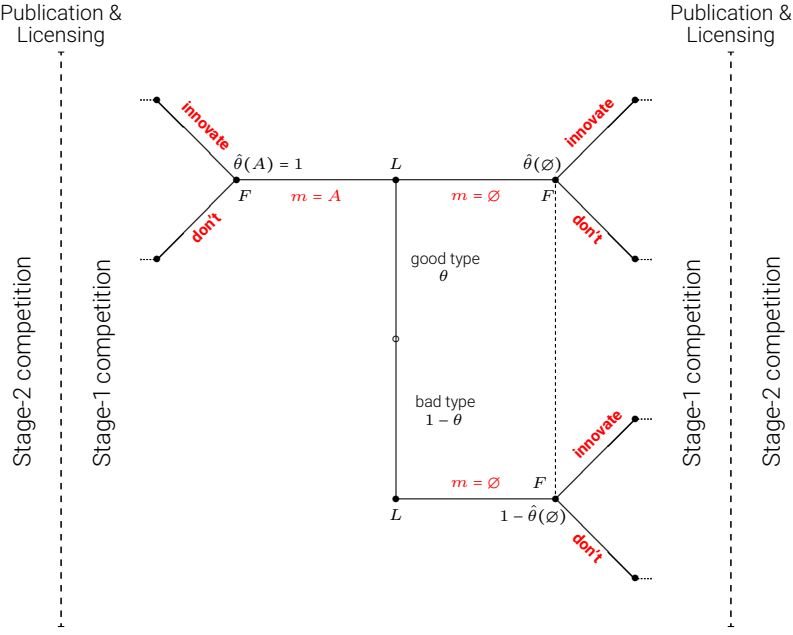
Model

Modeling Approach

- Simple model with two players
  - → leader L
  - → follower F
- Leader may have a technology (= patent application) and can announce its existence
- Follower can invest in R&D
- Parties compete in the product market *twice*
  - → reduced-form representation of payoffs and disclosure effects

Timeline

1. Leader may have technology/patent application (types G, B)
2. If G: leader can announce its type ($m \in \{\varnothing, A\}$)
3. Follower invests in R&D at cost K
4. Stage-1 competition
5. Patent application is published and examined
6. Firms observe outcome of follower's R&D
7. License negotiations
8. Stage-2 competition


Publication & Licensing
Publication & Licensing
Stage-2 competition
Stage-1 competition
Stage-1 competition
Stage-2 competition
innovate
don't
innovate
don't
innovate
don't
$\hat{\theta}(A) = 1$
$\hat{\theta}(\varnothing)$
L
F
$m = A$
$m = \varnothing$
F
good type
θ
bad type
$1 - \theta$
$m = \varnothing$
F
L
$1 - \hat{\theta}(\varnothing)$

Assumptions

Assumption 1: Technology leader with patent application if and only if of good type G.

Assumption 2: Good technology leader can credibly announce technology ($M_G = \{\varnothing, A\}$). Bad leader is a passive player with $M_B = \{\varnothing\}$.

Technology / R&D

- Leader has technology with prior probability θ
- Leader applicant (type G) can *announce* pending patent before stage-1 competition and follower's investment

$$m \in \{\varnothing, A\} \qquad \text{and} \qquad \mu = \Pr(m = A)$$

- Follower's posterior belief (by Bayes' rule):

$$\hat{\theta}(A) = 1 \qquad \text{and} \qquad \hat{\theta}(\varnothing) = \frac{\theta\,(1-\mu)}{1-\theta\mu} = \{0, \theta\}$$

Some more details

- Follower updates expectations of her own success upon leader's announcement (positive correlation!)
- Follower's expectations about her own R&D success ($\tau \geq 0$):

$$\tilde{\theta} = \theta + \tau\left(\hat{\theta} - \theta\right)$$

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- Reduced-form model of product market competition
  - → Stage profits with symmetric information: π_{ij} with $i, j = G, B$

$$\pi_{GB} > \pi_{GG} > \pi_{BB} > \pi_{BG} = 0$$

  - → Nature of competition captured by parameter σ:

$$\tilde{\pi}_G(\hat{\theta}) = \left(1 + \sigma(1 - \hat{\theta})\right)\pi_{GB}$$

    with $\sigma > 0 \Leftrightarrow$ competition in complements

Intellectual Property

- (No) patent application is given (leader's type)
- Patent granted with probability $\gamma \in [0, 1]$
  - → *Strength* of the application
  - → Alternative interpretation: probability of patent upheld in litigation (Farrell-Shapiro 2008)
- If follower innovates successfully, she is found infringing on the leader's patent with probability $\eta \in [0, 1]$
- Let $\beta \equiv (1 - \eta)\,\gamma$ capture IPR protection
- Follower pays license fee $\lambda = \frac{\pi_{GB}}{2}$

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Results

The Leader's Trade-Off

[+] "Fear of the unknown" creates "advantage in the market place."

- → IPR deters follower's R&D
- → Strategic substitutes with $\sigma < 0$ (mimic good type to soften competition)

[–] If existence of application is informative of technology or business strategy/environment, then the loss of the secret has negative payoff effects.

- → Follower updates success probability if $\tau > 0$
- → Strategic complements with $\sigma > 0$ (mimic bad type to soften competition)

Equilibrium

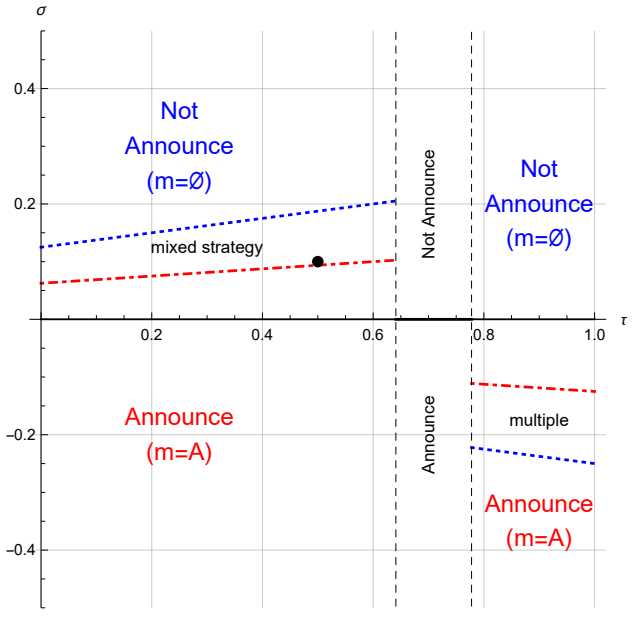
Two questions:

- Step 1: Does announcement A deter or trigger follower's innovation?
  - Does the IPR effect offset the learning effect?
  - Look at stage 2!
  - Follower's net benefits from R&D:

$$R(\hat{\theta}) = \hat{\theta}\tilde{\theta}_G \underbrace{\beta\lambda}_{\psi_{F|G}} + \left(1-\hat{\theta}\right)\tilde{\theta}_B \underbrace{\left[\pi_{GB} - \pi_{BB}\right]}_{\psi_{F|B}} - K$$

  $\Rightarrow$ Trade off expected gain from license fee saving and market profit increase against certain cost of R&D

- Step 2: Is it optimal for the leader to deter or trigger follower's innovation? How does disclosure affect stage-1 competition?


σ
0.4
0.2
−0.2
−0.4
0.2
0.4
0.6
0.8
1.0
τ
Not
Announce
(m=∅)
mixed strategy
Not Announce
Not
Announce
(m=∅)
Announce
(m=A)
Announce
multiple
Announce
(m=A)

When Does a Firm Disclose?

World with weak "spillovers" τ so that $m = A$ deters, disclose if

$$\frac{2\sigma}{(1-\tau)\,\theta + \tau} \leq \beta$$

1. Technology / R&D
   - Higher θ: announce more often
   - Higher τ: announce more often [but not too high]
2. Product Market
   - Higher σ: announce less often
   - $\sigma < 0$: Always announce with strategic substitutes.
3. Intellectual Property Rights ($\beta = (1-\eta)\,\gamma$)
   - Higher η: announce less often
   - Higher γ: announce more often

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1. Qualification of the classic result about disclosure of private cost information:
   - → Gal-or 1986, Restud: disclosure under Cournot, concealing under Bertrand
   - → elaborations in the accounting literature (Darrough, 1993, Acc Rev; Hughes & Pae, 2015, Rev Acc Stud), do not change the basic prediction
   - → this paper: with patents (innovation!), threshold depends on strength of competitive interaction
2. Opportunity to attempt an empirical approach:
   - → patents as a clearly delineated type of “cost information”
   - → patent applications not otherwise motivated (?)

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Data?

Data 1: announcements

- Press releases via DowJones Factiva / LexisNexis
- Searching for “patent application(s)” AND “file(s/d)”, 2020, US
- 2,240 results, manually classified
- 107 announcing grants, 130 announcing applications
- matched issuing company to ORBIS database

Data 2: competition

- common: intensity of competition
- rare: nature of competition
- theory: Bulow et al., 1985 JPE: sign of the cross-partial derivative
- empirics: finance literature using sales to proxy strategic variable
  - → Sundaram et al., 1996 J Financ Econ
  - → Lyandres, 2006 J Bus
  - → Kedia, 2006 JBF

Approach: regress the following by OLS:

$$d\left[\frac{\partial \pi^i}{\partial s^i}\right] = \beta_1 s^i \, \mathrm{d}s^i + \beta_2 \, \mathrm{d}s^i + \beta_3 s^i \, \mathrm{d}s^{-i} + \beta_4 \, \mathrm{d}s^{-i}$$

Data 3: preliminary results

Competition in	complements	substitutes
Number of industries	107	89
Number of listed firms	363	703
Number of patent documents	107,913	62,832
Number of application announcements	20	107
Mean intensity of interaction	.03	1.15

Similar results obtained when classifying all remaining industries based on the mean sign over all firms, ignoring stat sign difference from zero.

Summary

- What motivates innovators to disclose the existence of a pending patent when their applications enjoy a period of temporary secrecy?
- We propose a model that takes into account three different effects:
  - Follower's learning about R&D prospects
  - Strategic information effects in product market competition under asymmetric information
  - Deterrence of follower's R&D through probabilistic patent rights
- Disclose when effects from R&D deterrence more than offset the strategic information effects in product market competition.

Outlook

- Acquisition of larger dataset
- Empirical proxies for additional variables (esp. τ and β)
- What if assumption 1 fails to hold? Bad leader can apply for patent, too!
- Expectation: bad leader will try mimic good leader, informativeness of announcement decreases
- Possible remedy: disclosure of details of the innovation (though costly, too)

Strategic Information Disclosure:
The Case of Pending Patents

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More detail on model setup

Technology / R&D (2)

- Follower updates expectations of her own success upon leader's announcement (positive correlation!)
- Follower's expectations about her own R&D success ($\tau \geq 0$):

$$\tilde{\theta} = \theta + \tau\left(\hat{\theta} - \theta\right)$$

Product Market

- Stage profits with symmetric information: π_{ij} with $i, j = G, B$

$$\pi_{GB} > \pi_{GG} > \pi_{BB} > \pi_{BG} = 0$$

- Leader's stage-1 profits depend on follower's beliefs. Let $-1 < \sigma < 1$:
  - → Good leader:

$$\tilde{\pi}_G(\hat{\theta}) = \left(1 + \sigma\left(1 - \hat{\theta}\right)\right)\pi_{GB} = \left(1 - \sigma\hat{\theta} + \sigma\right)\pi_{GB}$$

  - → Bad leader:

$$\tilde{\pi}_B(\hat{\theta}) = \left(1 - \sigma\hat{\theta}\right)\pi_{BB}$$

- Strategic substitutability (Anton and Yao 2004) with $\sigma < 0$
- Stage-2 competition under symmetric information!

Intellectual Property

- (No) patent application is given (leader's type)
- Patent granted with probability $\gamma \in [0, 1]$
  - → *Strength* of the application
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More detail on model results

Follower's R&D

- Follower's stage-2 payoffs:

$$\tilde{\pi}_F = \hat{\theta}(m)\left[\pi_{GG} - \gamma\lambda + r\tilde{\theta}_G\beta\lambda\right] + \left(1 - \hat{\theta}(m)\right)\left[\pi_{BB} + r\tilde{\theta}_B\left[\pi_{GB} - \pi_{BB}\right]\right]$$

  where $r = 0, 1$ is the follower's R&D decision.

- Follower's net benefits from R&D:

$$R(\hat{\theta}) = \hat{\theta}\tilde{\theta}_G \underbrace{\beta\lambda}_{\psi_{F|G}} + \left(1 - \hat{\theta}\right)\tilde{\theta}_B \underbrace{\left[\pi_{GB} - \pi_{BB}\right]}_{\psi_{F|B}} - K$$

Deter or Trigger R&D?

- Follower's net benefits of R&D decreasing in beliefs $\hat{\theta}$ if

$$(1-\tau)\,\theta\left[\psi_{F|G}-\psi_{F|B}\right]+\tau\psi_{F|G}<0 \qquad (\#)$$

- Four cases:
  1. $m = A$ deters R&D if $R(\hat{\theta}(\varnothing)) \geq 0 > R(1)$
  2. $m = A$ triggers R&D if $R(1) \geq 0 > R(\hat{\theta}(\varnothing))$
  3. Follower always invests if $\min\left\{R(1), R(\hat{\theta}(\varnothing))\right\} \geq 0$
  4. Follower never invests if $\max\left\{R(1), R(\hat{\theta}(\varnothing))\right\} < 0$

- Suppose (#) holds: then [1], [3], and [4]

Assume: IPR Stronger Than Learning

- If A deters ([1]): Follower invests if and only if $m = \varnothing$. Leader:
  - $m = A$ if
$$\frac{2\sigma}{(1-\tau)\theta+\tau} \leq \beta \qquad (\#_A)$$
  - $m = \varnothing$ if
$$\frac{2\sigma(1-\theta)}{(1-\tau)\theta+\tau} \geq \beta \qquad (\#_\varnothing)$$
  - If β in between, then mixed $\mu_G^* = \Pr(m = A)$:
$$\mu_G^* = \frac{1}{\theta} - \frac{1-\theta}{\theta}\frac{2\sigma}{\left[(1-\tau)\theta+\tau\right]\beta}$$
- If A ineffective ([3], [4]): $m = A$ if $\sigma > 0$ and $m = \varnothing$ if $\sigma \leq 0$

Why Should We Care?

“Bogus” Patents


FORTUNE
THIS CEO IS OUT FOR BLOOD
ELIZABETH HOLMES AND HER SECRETIVE COMPANY, THERANOS, AIM TO REVOLUTIONIZE HEALTH CARE
BY ROGER PARLOFF
THE END OF DRIVING (as We Know It)
BY MICHAL LEV-RAM
STOCK PICKS THE PROS OWN THEMSELVES
BY JEN WIECZNER
IS TONY FADELL THE NEXT STEVE JOBS OR . . . THE NEXT LARRY PAGE?
BY ADAM LASHINSKY

THE DEFINITIVE RANKING OF THE RICHEST PEOPLE IN AMERICA
SPECIAL EDITION
Forbes
THE FRESHMAN
ELIZABETH HOLMES LEADS THE CLASS OF 2014
THE FORBES 400

Inc.
THE NEXT STEVE JOBS
8 WOMEN WHO COULD OWN THE FUTURE
PAGE 47
Elizabeth Holmes has taken Theranos to a $10 billion valuation in 12 years.
HOW TO BUILD A COMPANY TO LAST 100 YEARS
THE ART OF GIVING (AND TAKING) EQUITY
DO YOU REALLY

- envisioned technology didn't work
- never produced the products that made it famous
- still was assigned >1,000 patents (Contreras, 2021)

Bogus Patents?

- "Bogus" patent application ~ application with weak content or without meaningful content
- Non-applicants (no technology) with a bogus application to mimic applicant with technology
- With the introduction of *provisional patent applications* [a "Patent Pending"], concern of flood of bogus applications
- Koenen-Peitz (2015) offer a reputation-based explanation of why that concern may be unfounded.
- Different approach here: **does a bad-type leader find a bogus application useful?**

Assumption 1': Technology leader of good type has application with certainty; bad type (without new technology) has patent application with probability α_B.

Assumption 2': Patent applicant with actions $M_{PA} = \{A, \varnothing\}$; non-applicant with actions $M_{NA} = \{\varnothing\}$.

Assumption 3: Separating equilibrium (so that $\hat{\theta} = 1$) deters follower's R&D investment relative to pooling equilibrium: $R(\theta) \geq 0 > R(1)$.

Assumption 4: Patent applications come with nominal filing costs $\epsilon > 0$.

Should We Expect a Flood of "Bogus" Applications?

- Fix α_B, bogus applicant will always try to mimic the good applicant
  $\Rightarrow$ No separating equilibrium.

- If a good-type leader does not disclose, the bad-type leader has no incentive to obtain a bogus application (for $\epsilon > 0$)

- If a good-type leader otherwise discloses, then the bad-type leader's application decision depends on the stage-1 profit effects of disclosure:
  - $\rightarrow$ Some bogus applications if disclosure lowers stage-1 product market profits (follower is fiercer competitor)
  - $\rightarrow$ Always bogus applications if disclosure increases stage-1 product market profits (follower is softer competitor)
  - $\Rightarrow$ Possible "solution": (partial) patent disclosure

More detail on results with bogus applications

Disclosing a Bogus Application

- Fix α_B, bogus applicant will always try to mimic the good applicant (because $R(1) < 0 < R(\theta) < R(0)$).
- No separating equilibrium.
- Beliefs in semi-pooling equilibrium are

$$\hat{\theta}(A) = \frac{\theta}{\theta + \alpha_B (1 - \theta)} > \theta \qquad \text{and} \qquad \hat{\theta}(\varnothing) = 0$$

Applying for a Bogus Application

- Silence space (no disclosure for $\alpha_B = 0$) where ($\#_\varnothing$) holds
  - no bogus applications for cost reasons

- Announcement space (disclosure for $\alpha_B = 0$) where ($\#_A$) holds
  - With sufficiently high α_B we have $R(\hat{\theta}) \geq 0 \rightarrow$ bad-type leader does not successfully deter follower R&D.
  - With $\sigma > 0$, stage-1 profits are lower $\rightarrow$ disclosure not profitable $\rightarrow$ bad-leader does not apply for bogus patent and $\alpha_B = 0$.
  - But then, $\hat{\theta}(A) = 1 \rightarrow$ Bad-type leader with incentive to deviate and $\alpha_B = 1$

  $\Rightarrow$ Bad-type leader applies for bogus patent with $0 < \alpha_B^* < 1$.

- If $\sigma < 0$: No negative stage-1 profit effects. Bad-type leader always applies for bogus patent.