On optimality of secrecy and scarcity of idea

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Motivations

- Firms often prefer secrecy as a means of appropriating investment (Levin et al. 1987; Cohen et al. 2000).
- However, society tends to prefer patenting, due to its mandatory disclosure requirement of knowledge.
- The objectives of this study are
  - How to align the private incentive with social optimum with a patent policy?
  - Are there any cases where secrecy is socially preferable to patenting?

Comparison of patent vs. secrecy

Patent

- Separate patent law
- Limited life of protection
- Disclosure of knowledge
- High cost of getting the rights
- Stronger protection

Trade secret

- Contract law
- No fixed life
- Secret knowledge
- Relatively low cost of maintaining secrecy
- Weaker protection (reverse engineering; independent innovation; accidental leakage)

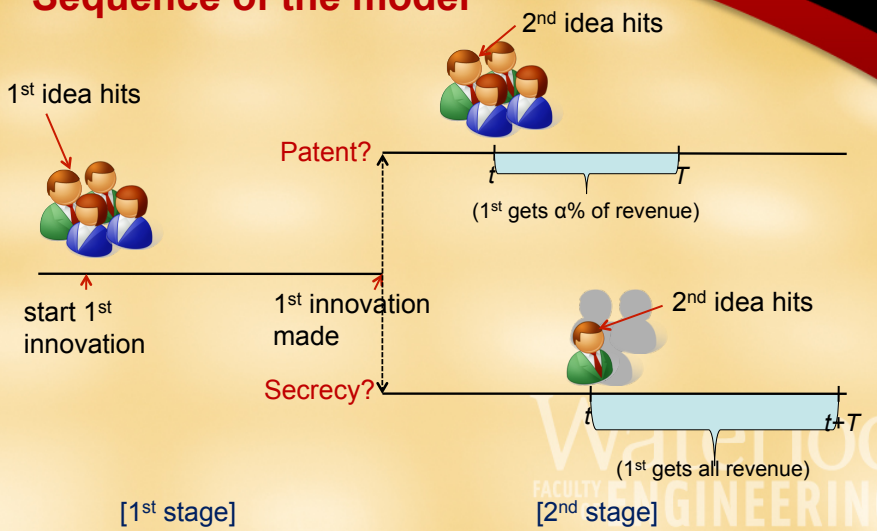
When to use trade secret?

1. The innovation is simply not patentable.
   - It does not meet the patentability criteria, or is not patentable subject (e.g., customer list).
2. The value of the innovation is not large enough to justify the costs of patenting.
3. The knowledge of the innovation is not likely to be disclosed easily.
   - The innovation can be protected longer under secrecy.
   - Intermediate outputs are more likely to be kept secret. ☒ This study focuses on this case.

Main features of the model

- Two-stage innovation: the 1st innovation has zero commercial value, and the 2nd has a flow value of v.
- The first innovator can commercialize her innovation.
- Idea for the second innovation arrives according to an independent Poisson rate [illegible].
  - Patenting: Competitive firms are on an equal footing.
  - Secrecy: Only the first innovator can get the idea
- Time-dependent licensing arrangement
  - With patenting, the first innovator receives [illegible] of v during $[t,T]$.
  - With secrecy, she gets the full value during $[t, t+T]$.

Sequence of the model



Assumptions

- The first innovation has already been achieved.
- The second innovation is always patented with a life *T*.
- Investment cost *F* should have been paid in advance.
- Innovation cost *c* converts an idea to innovation w/ zero lag.
- Four inputs are required for the second innovation
  - Knowledge of the first innovation
  - Preliminary investment of *F*: complementary assets
  - Idea for the second innovation: arrives with a rate of [illegible]
  - Innovation cost *c*: paid after the idea arrival

Rents under secrecy

- If an idea arrives at *t*, the 1st innovator's revenue is

$$V_1^s(t) = \int_t^{T+t} ve^{-r\tau} d\tau = \frac{v(1-e^{-rT})}{r} e^{-rt}$$

- With an investment of *F* and an innovation cost of *c* , the expected revenue of the 1st innovator is

$$\Pi_s(T) = \int_0^{\infty} \left[V_s(t) - ce^{-rt} \right] \phi e^{-\phi t} dt - F$$

- Social welfare is

$$W_s = \int_0^{\infty} \left[\frac{v}{r} - c \right] \phi e^{-(r+\phi)t} dt - F$$

Rents under patenting (1)

- Royalty revenue if the innovation is made by other firm

$$V_p(t) = \alpha \int_t^T v e^{-r\tau} d\tau = \frac{\alpha v}{r}\left[e^{-rt} - e^{-rT}\right]$$

- Timing of the second innovation by other firms
  - If the innovation cost *c* is low, the second innovation is made at the arrival of an idea.
  - If *c* is high, the second innovation is made only if the idea arrives after date [illegible], where

$$\tau = -\frac{1}{r}\log\left[\frac{\alpha e^{-rT}}{cr/v - (1-\alpha) + e^{-rT}}\right]$$

Rents under patenting (2)

- The first innovator's expected revenue is

$$\Pi_p(T) = \int_0^\tau \left[V_s(t) - ce^{-rt}\right]\phi e^{-\phi t} dt$$
$$+ e^{-(r+\phi)\tau} \int_0^\infty \left[V_s(t) - ce^{-rt}\right]\phi e^{-n\phi t} dt$$
$$+ e^{-(r+\phi)\tau} \int_0^{T-\tau} V_p(t)(n-1)\phi e^{-n\phi t} dt - F$$

- Social welfare: $W_p = \int_0^\tau \left(\frac{v}{r} - c\right)\phi e^{-(r+\phi)t} dt$
$$+ e^{-(r+\phi)\tau} \int_0^\infty \left(\frac{v}{r} - c\right) n\phi e^{-(r+n\phi)t} dt - nF$$

Optimal strategy: fixed *n* (*F* = 0)

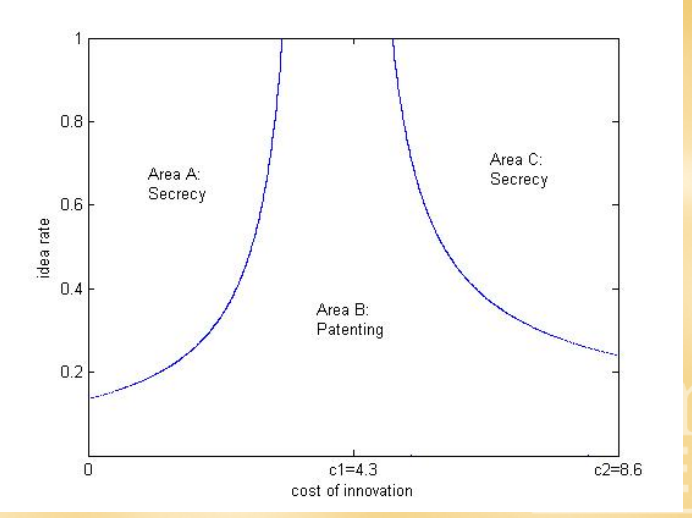
- First innovator's decision: $\Pi_s(T) - \Pi_p(T) \; ? \; 0$
- First innovator prefers secrecy if

$$\phi > \frac{\alpha v}{(1-\alpha)(v/r) - c}$$

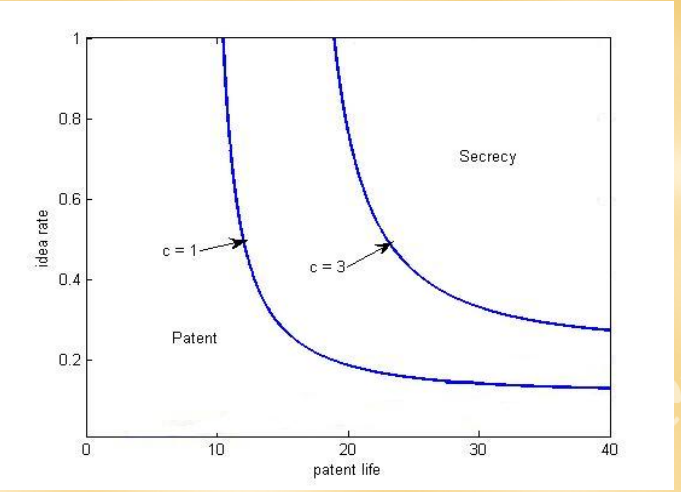
- Society always prefers patenting (if *F* = 0)

$$W_s - W_p = -\frac{(n-1)r\phi}{(r+\phi)(r+n\phi)} e^{-(r+\phi)\tau}\left(\frac{v}{r} - c\right) \le 0$$

1st innovator's strategy (given *T*, *F* = 0)



1st innovator's strategy (given *c*, *F* = 0)



Optimal strategy: variable *n* (*F* > 0)

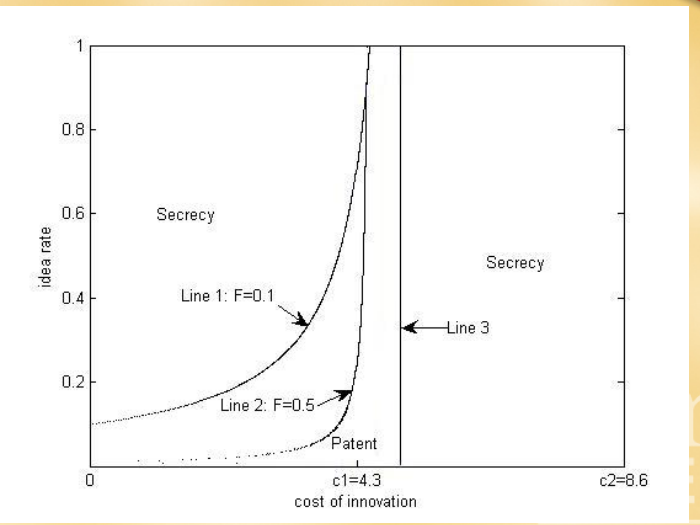
- First innovator's decision: same as above
- Relation between *n* and *F*

$$F = \frac{\phi}{(r+n\phi)}\left(\frac{(1-\alpha)v}{r} - c\right)$$

- Social welfare decision (if *F* > 0)

$$W_s - W_p = \frac{(n-1)\phi}{(r+\phi)(r+n\phi)}\left[-r\left(\frac{v}{r} - c\right) + (r+\phi)\left(\frac{(1-\alpha)v}{r} - c\right)\right]$$

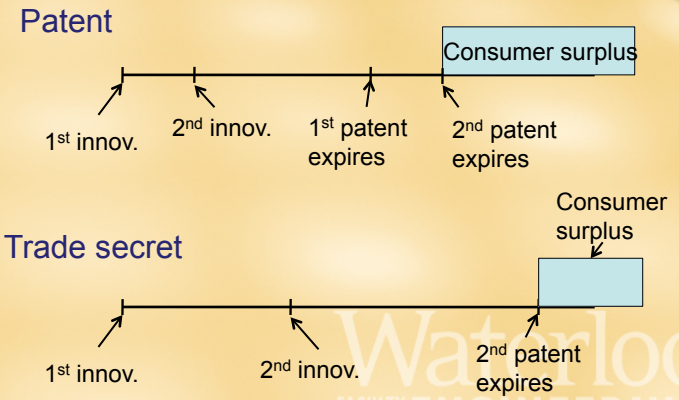
Social welfare strategy (given c, $F > 0$)



Conclusion

- We show the case where trade secret is socially optimal.
- If the fixed cost is sunk or negligible ($F = 0$),
  - Firms prefer secrecy for high idea rate with low/high costs.
  - Society always prefers patenting.
  - A shorter patent life induces firms to patent their innovation.
- If the fixed cost is positive ($F > 0$ and n is endogenous),
  - Secrecy can be socially optimal for high idea rate or high cost of innovation.
  - There is less conflict of incentives between firms and society.
- Next step: Full two-stage analysis

Implication: Outline of social welfare (1)



Implication: Outline of social welfare (2)