

Patent Pools and Dynamic R&D Incentives

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Objectives

To characterize the dynamic incentives to perform R&D when firms anticipate from the outset participation in a patent pool.

“Patent pools generally are created when a group of patent holders each decides to license its respective patents to each other and to third parties collectively.” (US DOJ and the FTC, 2007)

Examples: MPEG-2 (1997), MPEG-4 (1998), DVD-ROM (1998), DVD-Video (1999), 3G-Mobile Com. (2001), One-Blue (2009), POINT (2009), MPP (2010)

In a continuous-time model where firms compete in R&D in order to patent the essential technologies necessary to start a pool:

- the pool starts immediately after the essential technologies are patented;
- R&D efforts increase stepwise over time before the pool starts;
- firms over invest in R&D compared to a joint profit-max level;
- adding nonessential patents implies slower time to market.

The ex post approach:

The pooling of *given* patents impacts welfare (regulator's viewpoint).

Shapiro (*NBER*, 2001), Lerner and Tirole (*AER*, 2004), Kato (*IRLE* 2004), Kim (*RIO* 2004), Aoki and Nagaoka (*WP* 2005), Schmidt (*WP* 2009), Brenner (*ET* 2009), Quint (*WP* 2012), Jeitschko and Zhang (*WP* 2012)

The ex ante approach:

The anticipation of *future* pool startup impacts R&D incentives (firms' viewpoint).

“Prospective inventors face different rewards if their intellectual property goes into a patent pool than if they license individually.” (Scotchmer, 2004, p. 178)

Lerner and Tirole (*NBER* 2008), Gilbert and Katz (*IJIO* 2011)

The Setup (1/3)

R&D programs:

- N firm-specific programs
- firm i 's R&D effort x_i
- probability of patenting before time τ is $1 - e^{-x_i\tau}$
- flow cost of R&D $c(x_i)$

Complementary patents:

- first K "essential" patents
- subsequent $N - K$ "non-essential" patents

The pool size S verifies:

$$K \leq S \leq N$$

The Setup (2/3)

Pool formation protocol: S^* (Brenner, *ET* 2009)

S^* = endogenous pool size.

One of the first K innovators proposes the formation of a pool to subset S :

- if all these firms accept the pool is formed;
- otherwise another firm makes a new proposal, and so on.

If no proposal is successful the protocol restarts with the $K + 1$ -th innovator, and so on.

Instantaneous patent values: $\underline{v} < \hat{v} \leq \bar{v}$

- Inside the pool:
 - \bar{v} (essential)
 - \hat{v} (nonessential)
- Outside the pool:
 - \hat{v} (licensee)
 - \underline{v} (independent)

The Setup (3/3)

Profit-sharing:

Each initiator of a S -patent pool receives:

$$\frac{1}{S} \left(\underbrace{K\bar{v}}_{\text{essential patents}} + \underbrace{(S-K)\hat{v}}_{\text{nonessential patents}} \right) \quad \text{and} \quad \frac{1}{S} \left(\underbrace{\hat{v} - \bar{v} - \varepsilon}_{\text{royalties}} \right)$$

from each successful outsider, with $\varepsilon \rightarrow 0$.

Timing:

- 1) each firm continuously and non-cooperatively invests in R&D until it receives a patent;
- 2) when K technologies are discovered the formation protocol starts until a pool forms;
- 3) the pool licenses the IP rights to all outsiders when successful in R&D.

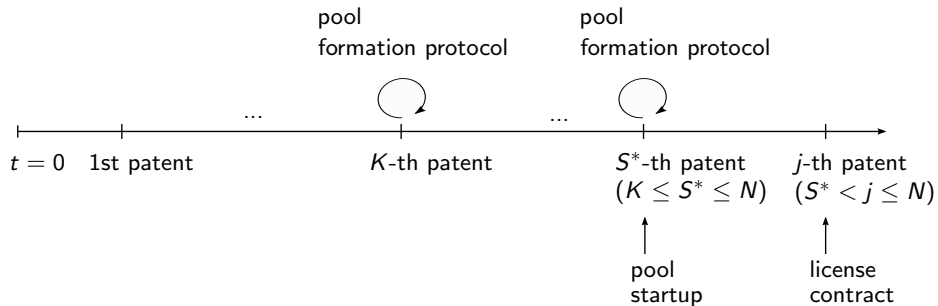


Figure 1: The Timing.

Computation of R&D Levels (1/2)

The No-Pool Benchmark: Independent R&D Projects

$V(\underbrace{0}_{\text{"failure"}})$: present value of ongoing R&D program

$V(\underbrace{1}_{\text{"success"}})$: present value of a patent = $\int_0^{\infty} e^{-rt} \underline{v} dt = \frac{\underline{v}}{r}$

For a representative firm, $V(0)$ verifies:

$$rV(0) = \max_x \left[\underbrace{x(V(1) - V(0))}_{\text{expected value diff.}} - c(x) \right].$$

The FOC for a firm's optimal R&D is:

$$\underline{v} - (r + \underline{x})c'(\underline{x}) + c(\underline{x}) = 0.$$

(Grossman and Shapiro *RAND* 1986)

Sequential Patent Races: The First S Innovators Start the Pool

$V_s^i(\underbrace{0}_{\text{"failure"}})$: present value of firm i 's R&D program of rank $s \leq S$

$V_s^i(\underbrace{1}_{\text{"success"}})$: present value of firm i 's patent of rank $s \leq S$

For firm i , in race of rank s , $V_s^i(0)$ verifies:

$$rV_s^i(0) = \max_{x^i} \left[\underbrace{x^i (V_s^i(1) - V_s^i(0))}_{\text{firm } i \text{ patents in race } s} + \underbrace{X^{-i} (V_{s+1}^i(0) - V_s^i(0))}_{\text{a rival patents in race } s} - c(x^i) \right].$$

The FOC for firm i 's optimal R&D is:

$$x_s^i = (c')^{-1} (V_s^i(1) - V_s^i(0)).$$

The Endogenous Pool Size S^* .

Proposition 1

The pool is founded as soon as the essential technologies are patented: $S^* = K$.

The value of participating in the pool startup is:

$$V_{S^*}(1) = \frac{1}{r} \left[\underbrace{\bar{v}}_{\text{essential patent}} + \underbrace{\frac{N-K}{K} \frac{x}{r+x} (\hat{v} - \underline{v})}_{\text{expected royalties}} \right].$$

$V_{S^*}(1)$ (weakly) decreases in K and increases in the number of outsiders $N - K$.

The Pattern of R&D Efforts (1/3)

The value of a patent increases as the rank s progresses to S^* :

Lemma 1

For all $s \leq S^* - 1$: $\frac{v}{r} < V_s(1) < V_{s+1}(1)$.

The equilibrium pattern of R&D efforts to the pool is increasing stepwise over time:

Proposition 2

For all $s \leq S^* - 1$: $\underline{x} < x_s < x_{s+1}$.

→ time-to-market implication.

The Pattern of R&D Efforts (2/3)

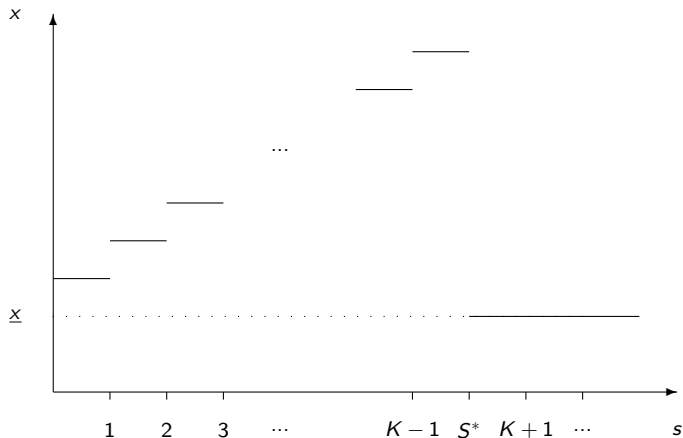


Figure 2: Pattern of equilibrium R&D effort levels (with $S^* = K < N$).

The Pattern of R&D Efforts (3/3)

Assume that:

- (i) only one patent is essential ($K = 1$: no delay);
- (ii) nonessential as valuable as essential ($\hat{v} = \bar{v}$: max instantaneous value).

⇒ The industry joint profit-maximizing R&D level is \bar{x} .

In the non-cooperative case with any $K \geq 1$ and $\hat{v} \leq \bar{v}$:

Proposition 3

$$x_{S^*} > \bar{x} > \underline{x}.$$

The final race (rank $S^* = K$) exhibits an overinvestment in R&D compared to \bar{x} .

Addition of Nonessential Patents (1/3)

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“(…) the difficulty of identifying the handful of patents essential to a particular standard” (Simcoe, 2010, p. 17).

“(…) the difficulties encountered within standard-setting organisations themselves strongly suggest that real life bargaining is unlikely to reliably produce the most efficient outcome” (Regibeau and Rockett, 2011, p. 14).

Addition of Nonessential Patents (2/3)

Suppose that firms anticipate the formation of a L -patent pool, with $L > S^* = K$, so that the pool incorporates one or several nonessential patents:

Proposition 4

For any pool size $L > S^* = K$, the equilibrium R&D efforts are such that:

- (i) R&D efforts at each rank s with S^* patents are higher than with $L > S^*$
- (ii) R&D efforts of outsiders fall at the no-pool optimal level \underline{x} for all pool sizes
- (iii) R&D efforts for the patents $S^* + 1, \dots, L$ are above the no-pool optimal level
- (iv) R&D efforts in the final race with S^* patents are higher than with $L > S^*$

→ time-to-market implication.

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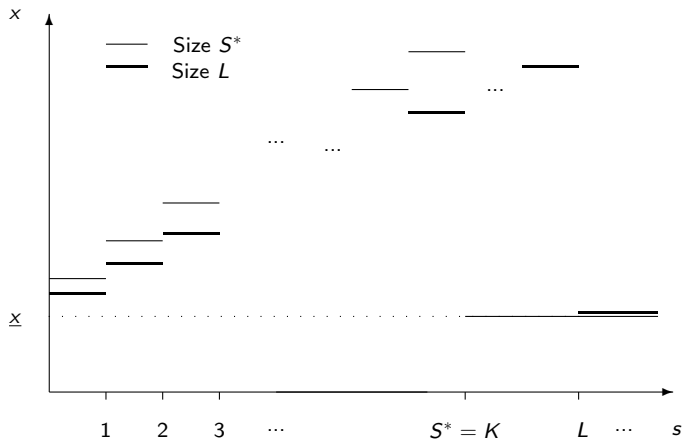


Figure 3: Comparing equilibrium R&D efforts for two pool sizes (with $L > S^* = K$).

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“[P]atents by outside firms spiked just after the pool had been established. The annual number of patents (...) jumped from 25 in 1856 to almost 100 patents in 1858. If outside firms failed to enter the pool because they were slower (rather than less productive), this increase is consistent with the idea of a patent race leading up to the pool.” (Lampe and Moser, *JEH*, 2010, pp. 910-11).

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“Pool members and other firms produced fewer patents after the pool had formed” (Lampe and Moser, *NBER WP*, 2011, p. 22).

“[W]e find a significant impact of patent pools on the number of patent declarations. We then analyze the impact of patent pools on the timing of patent declarations with respect to standardization. (...) [W]e find strong evidence for patent races in the wake of patent pool creation.” (Baron and Pohlmann, *CERNA Mines Paris WP*, 2010, p. 2).

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“Our results suggest that pool patents have a higher intrinsic value, at the time of introduction, than patents with similar characteristics not included in a pool.” (Delcamp, 2011 *CERNA Mines Paris WP*, 2011, p. 5).

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