Industry Cohesion & Knowledge Sharing: Network based Absorptive Capacity

David Dreyfus

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- What is the impact of search cost on R&D allocation decisions?
- How does industry size and cohesion affect search cost and the optimal allocation of R&D investments?

Major findings

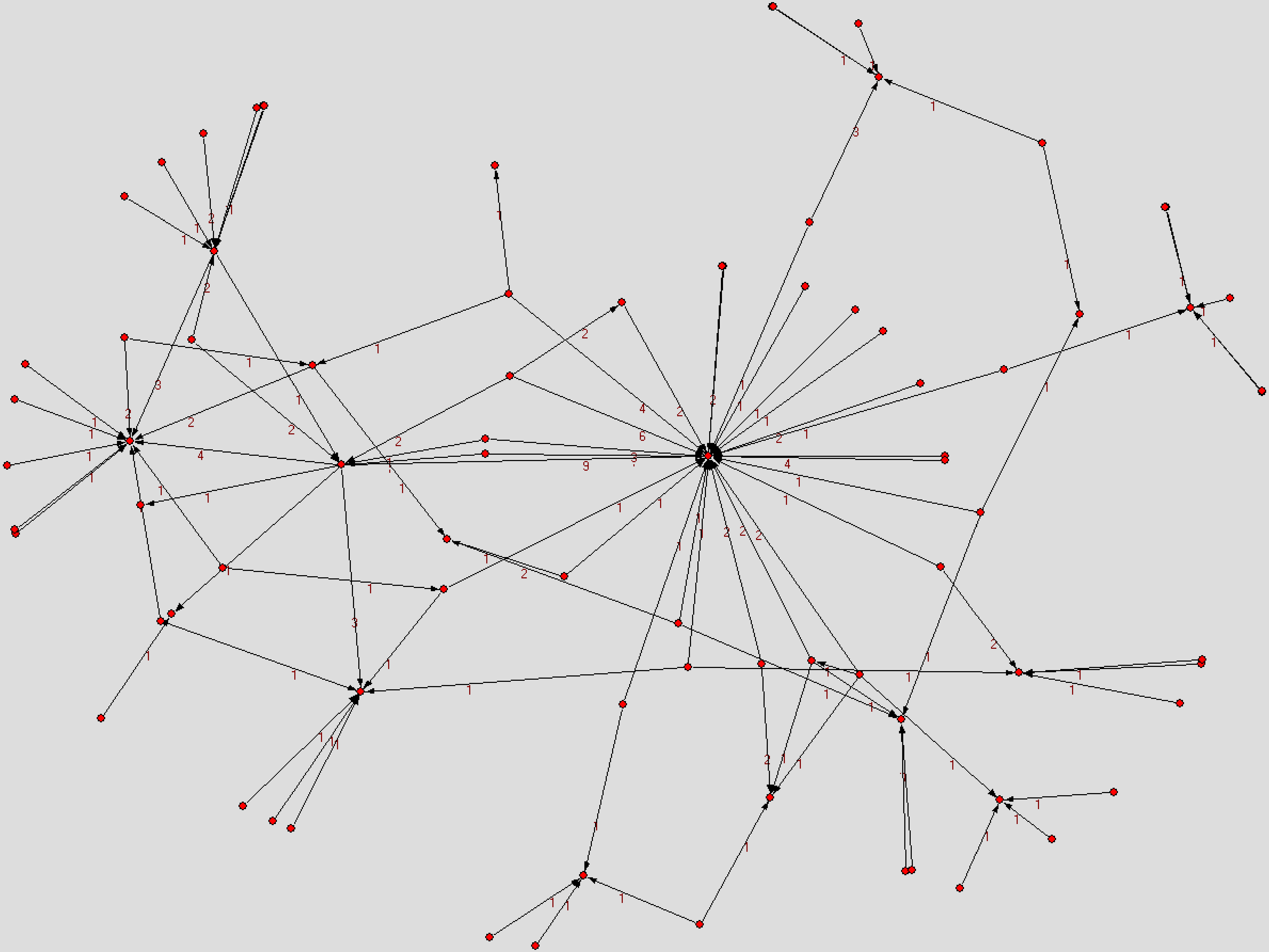
- Search and own R&D are complementary
- The impact of a growing number of firms is dependent on the existing number and network cohesion
- Network cohesion determines the quality and quantity of search

Theoretical Development

- Costless information (Arrow 1962)
- Absorptive capacity (Cohen and Levinthal, 1999, 2000)
- Joint knowledge production (Saxenian 1991)
- Sticky Knowledge (Sakakibara 2002; Alcacer et al. 2002; von Hippel 1994, 1988; Mansfield 1988; Allen 1977)

Spillovers

- Firm boundaries and knowledge sharing (Brynjolfsson 1994; Williamson 1975).
- Innovation by borrowing (von Hippel 1988; March et al. 1958)
- Appropriation mechanism to control spillover varies by industry (Levin et al. 1987).
- Formal and informal search



Networks

- Social ties among firms shape economic action Uzzi (1996)
- Firms make strategic decisions in determining who they partnered with Baum et al. (2003)
- Bounded Rationality (Simon 1945) leads to assertion that the size and shape of the firm's network is a critical component of its knowledge investment decisions.

Model motivation

- Consider the actions of a single firm
- Profits depend on knowledge
- Allocating R&D in order to develop, learn and search
- Subject to a constraint.
  - Explicit budget
  - Implicit marginal return on investment > 0
- Find the optimal investment decision in terms of exogenous parameters (Lagrangian optimization)

Model development

- Profit maximizing firm.
- Profits depend on knowledge
- Constrained investment allocation

$$\Pi = \sum_{t=0}^{\infty} \pi(t)u(t)$$

$\pi(t) = \pi(Z_t, K_t, L_t)$

$$\frac{\partial Z}{\partial t} = z$$

$$z = M + \gamma(\theta \sum_{j}^{J} \left(\chi^{j} \cdot Q_{j} \right) + T)$$

$$C \geq r \cdot M + s \cdot \alpha$$

Functional Forms

- Absorptive Capacity increases with M, decreases with Delta
- Search Effectiveness increases with investment and cohesiveness, decreases with industry size

$$\gamma = (1 - e^{-M/\delta}) \qquad \chi = (1 - e^{-\alpha/(1+J^2(1-\phi))})$$

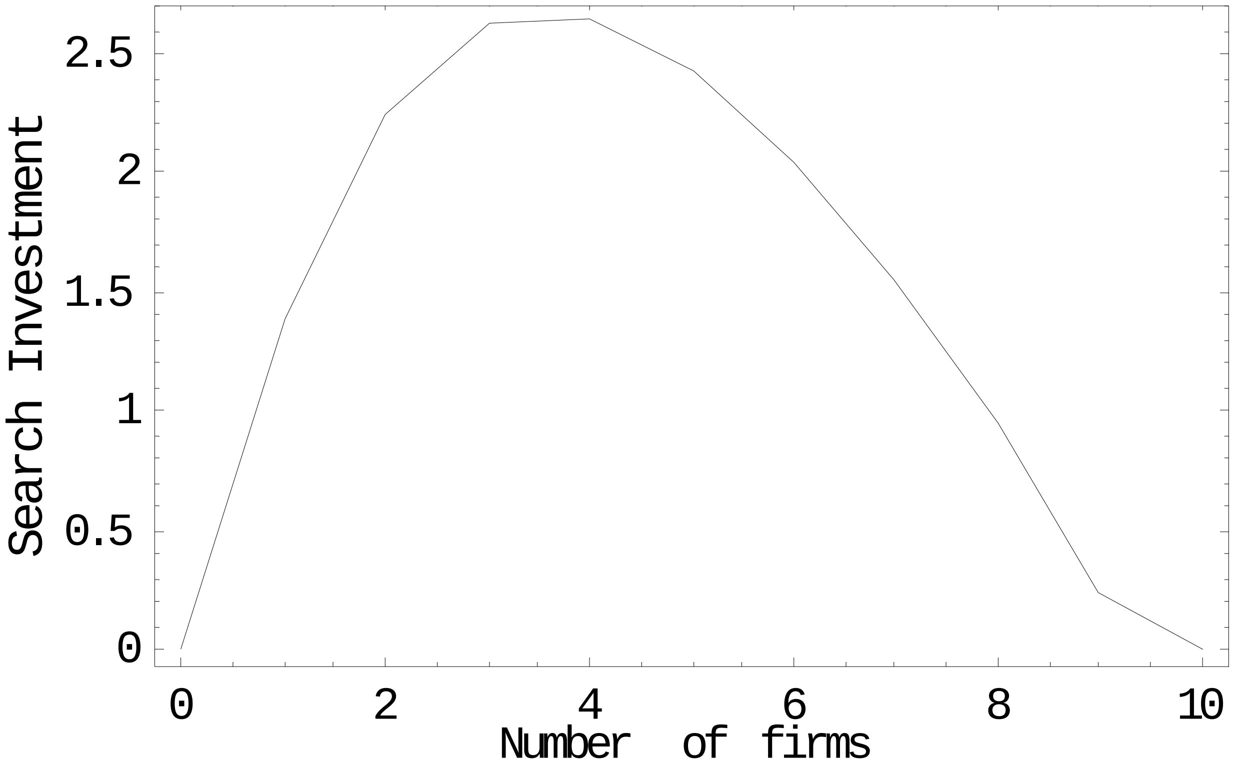
$$\lim_{J\to\infty} J(1 - e^{-1/J}) = 1 \qquad \lim_{J\to\infty} J(1 - e^{-1/J^2}) = 0$$

Not Closed Form

$$\left\{\alpha\left(\frac{s\left(-1+\frac{e^{-\frac{M}{\delta}}\left(\left(-1+e^{\frac{\alpha}{-1+J^2\,(-1+\phi)}}\right)J\,Q\,\theta-\tau\right)}{\delta}\right)}{r}+\frac{e^{\frac{\alpha}{-1+J^2\,(-1+\phi)}}\left(1-e^{-\frac{M}{\delta}}\right)J\,Q\,\theta}{1-J^2\,(-1+\phi)}\right)==0,\right.$$

$$\left.\frac{(C-M\,r-s\,\alpha)\left(-1+\frac{e^{-\frac{M}{\delta}}\left(\left(-1+e^{\frac{\alpha}{-1+J^2\,(-1+\phi)}}\right)J\,Q\,\theta-\tau\right)}{\delta}\right)}{r}==0\right\}$$

Simulation



Simplified Forms

$$\gamma = M \cdot (1-\delta), \frac{\partial \gamma}{\partial M} > 0, \frac{\partial \gamma}{\partial \delta} < 0, 0 \le M \le 1$$

$$\chi = \alpha / (1 + J^2(1-\phi)), \frac{\partial \chi}{\partial \alpha} > 0, \frac{\partial \chi}{\partial \phi} > 0, \frac{\partial \chi}{\partial J} < 0, 0 \le \alpha \le 1$$

Simplified closed-form solution

$$\left\{\{M \to 0, \lambda \to 0\},\right.$$

$$\left\{M \to \frac{C}{r}, \lambda \to \frac{1 + \tau - \delta\tau}{r}, \alpha \to 0\right\},$$

$$\left\{M \to \frac{C J Q (-1+\delta)\theta - s(-1+(-1+\delta)\tau)(-1+J^2(-1+\phi))}{2 J Q r (-1+\delta)\theta},\right.$$

$$\alpha \to \frac{C J Q (-1+\delta)\theta + s(-1+(-1+\delta)\tau)(-1+J^2(-1+\phi))}{2 J Q s (-1+\delta)\theta},$$

$$\left.\left.\lambda \to \frac{C J Q (-1+\delta)\theta - s(-1+(-1+\delta)\tau)(-1+J^2(-1+\phi))}{2 r s (-1+J^2(-1+\phi))}\right\}\right\}$$

Complementarities

$$\partial^2_\alpha Z == -\frac{e^{-\frac{\alpha}{1+J^2(1-\phi)}}\left(1-e^{-\frac{M}{\delta}}\right) J Q \theta}{(1+J^2(1-\phi))^2} < 0$$

$$\partial_{\alpha,M} Z == \frac{e^{-\frac{M}{\delta}-\frac{\alpha}{1+J^2(1-\phi)}} J Q \theta}{\delta\,(1+J^2(1-\phi))} > 0$$

$$\partial_\alpha Z == \frac{e^{-\frac{\alpha}{1+J^2(1-\phi)}}\left(1-e^{-\frac{M}{\delta}}\right) J Q \theta}{1+J^2(1-\phi)} > 0$$

Results

- Own R&D improves search
- Cohesion increases search, infer it changes type of search
- Information economics predicts more search

Thoughts

- Open Source focuses on the Search component
- R&D investment as cost of entry (Pay to Play)
- Joint Ventures as Loss Leaders

Questions?