Extending Sutton’s “Bounds”: A Model of Endogenous Market Structure, Innovation, and Licensing

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Motivation

• Anand and Khanna (2000)
  – Licensing and cross-licensing constitute 20-33% of all strategic alliances in R&D-intensive sectors

• Sutton (1998; 2007)
  – Endogenous fixed cost (EFC) model of market structure and innovation
  – Lower bound to industry concentration and R&D-intensity in industries characterized by quality-differentiated products and fixed costs in R&D
Objectives

• Combine and extend two veins of literature:
  – Relationship between market structure and incentives to innovate allowing for strategic alliances
  – Incentives to license technology in a fully endogenous framework

• Secondary contributions:
  – Heterogeneous firms (in R&D costs parameters)
  – Mixed models of vertical (quality) and horizontal (attributes) differentiation
  – Multiproduct competition (to a lesser extent)
Primary Findings

• Lower Bound to Concentration:
  – Given a feasible lump-sum royalty payment, the lower bound to concentration under licensing converges to a strictly greater bound

• Lower Bound to R&D-Intensity:
  – The lower bound to the R&D/sales ratio of the firm offering the market-leading level of quality, is greater than the lower bound to market concentration
Model Setup

• Definitions:
  – Industry consisting of $K$ submarkets with quantity $x_k$ and quality $u_k$
  – Each good consists of a set of attributes with associated competencies $v_m$ such that overall quality is given by $u_k = f(v_1, \ldots, v_m, \ldots, v_M)$
  – The set of qualities that a Firm $i$ produces across products is $u_i$ such that the set of qualities across all firms in equilibrium is given by a configuration $\mathbf{u}$
Model Setup

• Fixed (sunk) R&D Costs:

\[ F(v_{im}) = F_0 v_{im}^{\beta_i}, \quad \beta_i \geq 2 \forall i. \]

• Fixed (sunk) Licensing Costs:

\[
T(v_{jm}) = T_0 + P_{im}^j + F \left( (1 - \delta) v_{jm} \right) \\
= T_0 + \rho(v_{jm}) S \sum_{k \in I_m} r_{ik}(u) + F_0 (1 - \delta) \beta_i v_{jm}^{\beta_i}.
\]
Equilibrium Configurations

• Viability Conditions: “Survivorship Principle”
  – No Licensing: \( S\pi(\hat{u}|u) - F^L(\hat{v}) - \sum_{m\neq n} F^L(v_m) \geq 0. \)
  – Licensor: \( [1 + L^n \rho(\hat{v}')\gamma_n]S\pi(\hat{u}'|\hat{u}) - F^L(\hat{v}') - \sum_{m\neq n} F^L(v_m) \geq 0, \)
  – Licensee: \( [1 - \rho(\hat{v}')\gamma_n]S\pi(\hat{u}'|\hat{u}) - \sum_{m\neq n} F^H(v_m) - [1 - (1 - \delta)^{\beta^H}]F_0\hat{v}'^{\beta^H} - T_0 \geq 0, \)

• Stability Conditions: “(No) Arbitrage Principle”
  – No Licensing: \( S\pi(\kappa\hat{u}|u) - F^L(\kappa\hat{v}) - \sum_{m\neq n} F^L(v_m) \leq 0, \ \forall \kappa > 1. \)
  – Licensor: \( [1 + L^n \rho(\kappa\hat{v}')\gamma_n]S\pi(\kappa\hat{u}'|\hat{u}) - F^L(\kappa\hat{v}') - \sum_{m\neq n} F^L(v_m) \leq 0, \ \forall \kappa > 1, \)
  – Licensee: \( [1 + L^n \rho(\kappa\hat{v}')\gamma_n]S\pi(\kappa\hat{u}'|\hat{u}) - \rho(\hat{v}')\gamma_n S\pi(\hat{u}'|\hat{u}) - \sum_{m\neq n} F^H(v_m) - \kappa^{\beta^H} [1 - (1 - \delta)^{\beta^H}]F_0\hat{v}'^{\beta^H} - T_0 \leq 0, \ \forall \kappa > 1. \)
Equilibrium Configurations

Figure 1: Equilibrium Configurations

Concentration

Firms
Define: \[
\dot{a}(\kappa) \equiv \inf_{\hat{u}} \frac{\pi(\kappa \hat{u} | \hat{u})}{r(\hat{u})}.
\]

Royalty payment: \[
\rho(\hat{v}') \geq \frac{1}{\gamma_n} \left[ \frac{\kappa \beta^H - \kappa \beta^L}{\kappa \beta^L \ln + \kappa \beta^H - 1} \right], \forall \kappa \geq 1,
\]

Lower Bound to Industry Concentration under Licensing:

\[
\frac{\dot{a}(\kappa)}{\kappa \beta^H} \cdot \left[ \frac{1 + L_n \gamma_n \rho(\kappa \hat{v}')}{{1 - \left( \frac{\kappa \beta^H - 1}{\kappa \beta^H} \right)} \gamma_n \rho(\hat{v}')} \right] + \left( \frac{\kappa \beta^H - 1}{\kappa \beta^H} \right) \left[ \frac{\sum_{m \neq n} F^H(\overline{v}_m) + T_0}{[1 - \left( \frac{\kappa \beta^H - 1}{\kappa \beta^H} \right) \gamma_n \rho(\hat{v}')] S_r(\hat{u})} \right].
\]
Lower Bound to R&D-Intensity under Licensing

• Define: \( \hat{\alpha} \equiv \sup_{\kappa} \frac{\hat{\alpha}(\kappa)}{\kappa^{\beta_H}} \cdot \left[ \frac{1 + L^n \gamma_n \rho(\kappa \hat{\nu}')}{{\kappa}^{\beta_H} - 1} \gamma_n \rho(\hat{\nu}') \right] \).

• Lower Bound to R&D-Intensity under Licensing:

\[ \hat{\alpha} \kappa^{\beta_H - \beta_L} \left[ 1 - \left( \frac{\kappa^{\beta_H} - 1}{\kappa^{\beta_H}} \right) \gamma_n \rho(\hat{\nu}') \right], \forall \kappa > 1. \]
Conclusion

• Analysis of licensing agreements and anticompetitive behavior should distinguish between industry characteristics

• Welfare (consumer) effects are ambiguous
  – Increased concentration: “Bad”
  – Increased R&D-intensity: “Good” (Both higher quality and more differentiated goods)
  – Ambiguous change in total industry R&D
Thanks!

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