Research Joint Ventures: The Role of Financial Constraints

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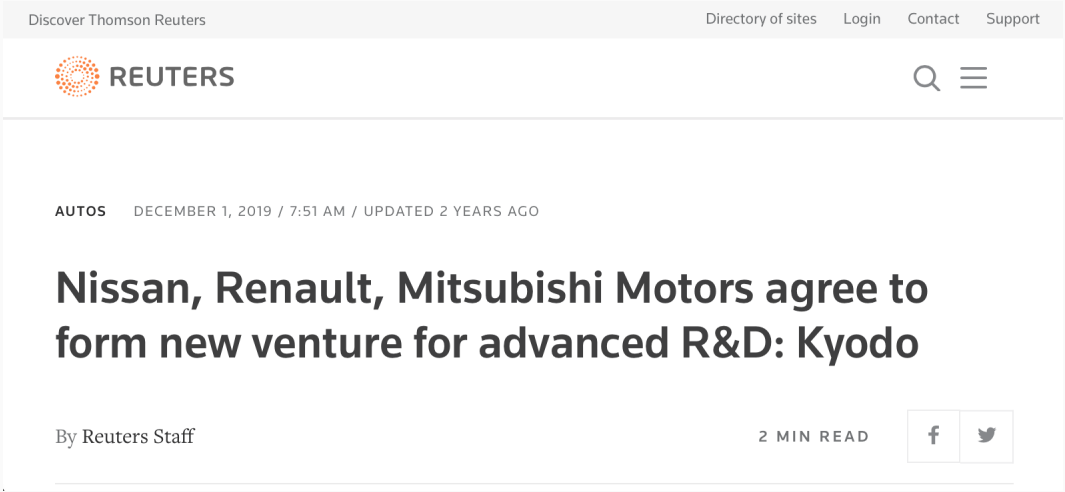
Introduction



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Introduction

- Competition policy typically treats full-function joint ventures under merger policy; loose cooperation as potential horizontal agreement
- Either way, RJVs receive lenient treatment:
  - EU: R&D BER (exp. '22) and Sec. 3 of Horizontal Guidelines;
  - US: 1993 National Cooperative Research and Production Act;
  - CH: Art. 6 para. 1(a) CartA.
- Is this justified?

Introduction

This paper:

- clarifies the conditions under which RJVs increase innovation probabilities
- identifies the circumstances under which firms want to form RJVs

Main differences to previous literature (e.g., Katz (1986), d'Aspremont and Jacquemin (1988), Kamien et al. (1992)):

- budget-constrained firms (rather than spillovers)
- choice between many different research projects
- uncertainty about which projects are good

Main Results

Innovation Effects of RJVs

- With soft competition, RJVs increase variety of innovation projects and thereby innovation probability
- With more intense competition, this only happens if financial constraints are sufficiently tight

Profitability of RJVs

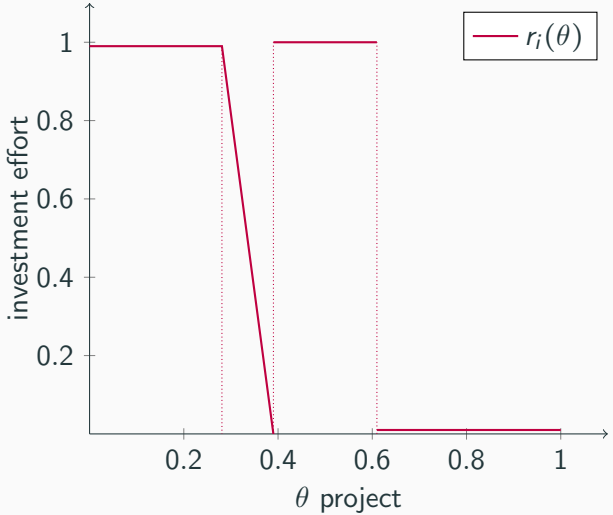
- If RJVs increase innovation, they are typically profitable.
- RJVs that reduce innovation may also be profitable

The Model

Assumptions

- Two firms, each can invest in innovation.
- Continuum of research projects $\Theta = [0, 1)$.
- Only one project $\hat{\theta} \in \Theta$ is correct (ex ante unclear which).
- Each firm chooses a research intensity $r_i(\theta) \in [0, 1]$ for any $\theta \in [0, 1)$.
- Developing costs per project: $r_i(\theta)C(\theta)$, where $C(\theta)$ is differentiable and strictly increasing, satisfies Inada conditions.
- Each firm has a budget B, additional funds can be borrowed externally at some interest rate $\rho > 0$.

Investment Strategies



Assumptions ctd.

Product market profits: $\pi_i = \pi(t_i, t_j)$, where $t_i, t_j \in \{0, I\}$ is technology level.

Assumption 1:

(i) Profits are non-negative: $\pi(t_i, t_j) \geq 0$ *for all* t_i *and* t_j.

(ii) Symmetric innovation increases profits: $\pi(I, I) \geq \pi(0, 0)$.

(iii) Competitor innovation reduces profits: $\pi(t_i, 0) \geq \pi(t_i, I)$ *for* $t_i \in \{0, I\}$.

(iv) Escaping competition is more valuable than catching up: $\pi(I, 0) - \pi(0, 0) \geq \pi(I, I) - \pi(0, I)$.

Assumption 2: *Budget B is small enough that both firms will be financially constrained in equilibrium under R&D competition.*

Intensity of Competition

We define three different types of competition intensity:

- Competition is intense if avoiding the competitor catching up is more valuable than catching up: $\pi(I,0) - \pi(I,I) > \pi(I,I) - \pi(0,I)$.
- Competition is soft if improving together is more valuable than avoiding catching up of the competitor: $\pi(I,I) - \pi(0,0) > \pi(I,0) - \pi(I,I)$.
- Competition is moderate if neither of the above cases holds.

Plan

We will compare three regimes:

- R&D competition: firms independently choose R&D strategies and compete on the market.
- RJV: firms jointly choose R&D strategy, share R&D costs and results, but compete on the market.
- Merger: The merged entity takes all decisions.

Results

R&D Competition: Equilibrium Portfolio

Lemma 1: *Under R&D Competition, equilibria with cut-offs θ_1, θ_2 emerge. θ_2 depends on the value of catching up, θ_1 on the value of escaping competition.*

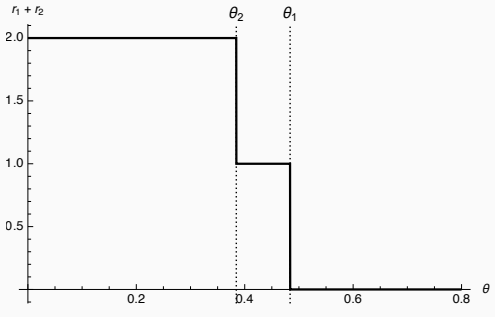


Figure 1: Simple equilibrium with $r_j(\theta) \in \{0, 1\}$ for all j and θ.

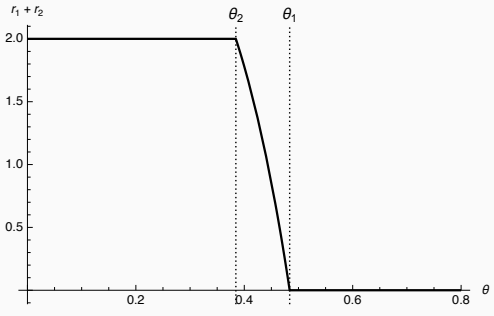


Figure 2: Unique symmetric equilibrium with $0 < \bar{r}(\theta) < 1$ for $\theta \in (\theta_2, \theta_1)$.

Research Joint Venture: Equilibrium Portfolio

Let θ^B, θ^u and θ^ρ be solutions of

$$C(\theta^u) = 2[\pi(I, I) - \pi(0, 0)]$$
$$(1 + \rho)C(\theta^\rho) = 2[\pi(I, I) - \pi(0, 0)]$$
$$\int_0^{\theta^B} C(\theta)d\theta = 2B$$

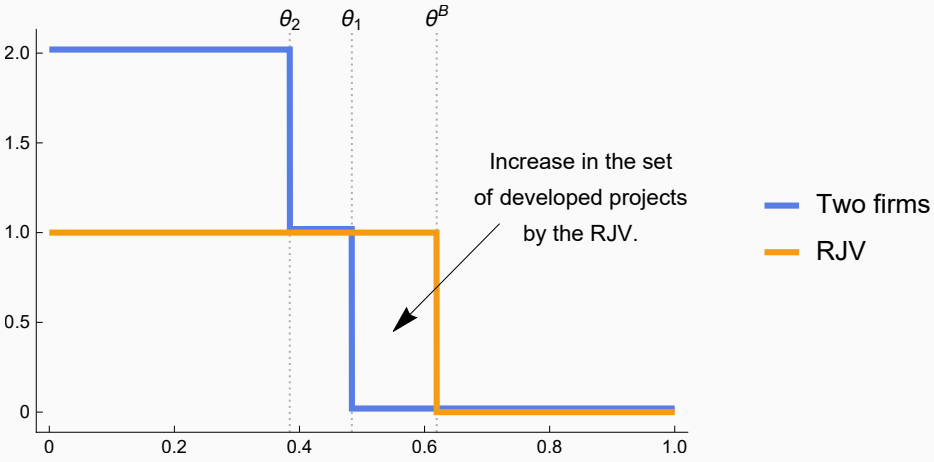
Lemma 2:
The RJV optimally applies a single cut-off strategy:

(i) θ^ρ if $\theta^B < \theta^\rho$

(ii) θ^B if $\theta^B \in [\theta^\rho, \theta^u]$

(iii) θ^u if $\theta^B > \theta^u$

Effect of RJV



Effect of RJV

Proposition 1 (Comparison of competition and RJV):

1. *Suppose competition is soft. Then project variety and innovation probability are strictly larger under the RJV than under R&D competition.*
2. *Suppose competition is moderate or intense. Then:*
   (a) Project variety and innovation probability are strictly larger under the RJV than in any equilibrium under competition if $B > \bar{B}(\rho)$ *and* $\rho > \bar{\rho}$.
   (b) If $B \leq \bar{B}(\rho)$ *or* $\rho \leq \bar{\rho}$ *then project variety is weakly smaller under the RJV than in any equilibrium under competition, while innovation probability under the RJV is weakly smaller than in any simple equilibrium under competition.*
   (c) If the formation of the RJV strictly increases project variety, then it weakly decreases total R&D spending.

RJV Profitability

Proposition 2: When RJV increases innovation probability, then the incentive constraint is satisfied most cases. Only if competition is very intense, it is not satisfied.

Proposition 3: There exist cases where incentive constraints are satisfied and an RJV reduces innovation probability.

Concluding remarks

- We study research joint ventures in a setting where firms are financially constrained and research duplication is a concern.
- We show that RJVs can increase the probability of innovation while decreasing the total R&D cost.
- We show that when RJVs increase innovation probability, then in most cases the incentive constraint of firms to form an RJV is satisfied.
- RJVs can be a better alternative than mergers.

RJV Profitability

Proposition 3 *(Profitable innovation-reducing RJV):*
Suppose that the following conditions hold:

(i) $2\pi(I,I) - (\pi(I,0) + \pi(0,0)) = 0.$

(ii) $B \leq \bar{B}(\rho)$ or $\rho \leq \bar{\rho}.$

(iii) $\pi(I,I) > \pi(0,I).$

Then there exists some $\hat{\pi}(I,0) > \pi(I,0)$ *such that for all* $\pi'(I,0) \in (\pi(I,0), \hat{\pi}(I,0))$ *and keeping other parameters fixed, the RJV is profitable, but reduces the innovation*

The result holds for intermediate competition, near the boundary to soft competition

Example: Differentiated Price Competition

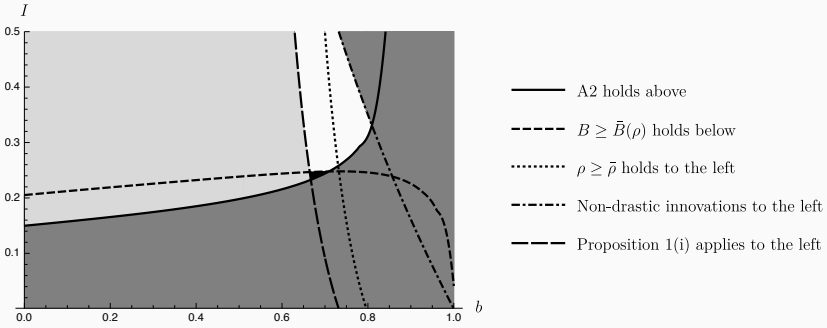


Figure 3: Price competition with inverse demand function $p_i = 1 - q_i - bq_j$ and constant marginal cost $c = 0.5$.

Example: Cournot Competition

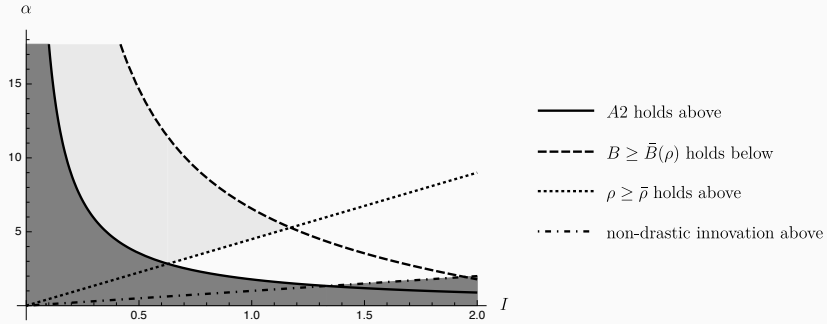


Figure 4: Cournot model with $P(Q) = a - bQ$, constant marginal cost c, $\alpha = a - c$, $B = 0.01$, $\rho = 0.1$.

Merger and RJV: Comparison

Proposition:

1. *If* $2[\pi(I,I) - \pi(0,0)] \geq \pi(I) - \pi(0)$*, the innovation probability under an RJV is weakly higher than under a merger. The difference is strict, except when the budget size is intermediate or* $2[\pi(I,I) - \pi(0,0)] = \pi(I) - \pi(0)$*.*
2. *If* $2[\pi(I,I) - \pi(0,0)] < \pi(I) - \pi(0)$*, the innovation probability under an RJV is weakly lower than under a merger. The difference is strict, except when the budget size is intermediate.*

Other Results

1. With spillovers,
   - but without financial constraints: Project variety and innovation probability are strictly larger under the RJV than under R&D competition if and only if spillovers are sufficiently high and competition sufficiently soft.
   - and financial constraints: Higher interest rate and higher spillovers both make it more likely that the RJV increases the innovation probability.
2. With licensing: An RJV is less likely to increase innovation

d'Aspremont, C. and A. Jacquemin (1988): "Cooperative and noncooperative R&D in duopoly with spillovers," *American Economic Review*, 78, 1133–1137.

Kamien, M. I., E. Muller, and I. Zang (1992): "Research joint ventures and R&D cartels," *American Economic Review*, 1293–1306.

Katz, M. L. (1986): "An analysis of cooperative research and development," *RAND Journal of Economics*, 527–543.