Mergers in Innovative Industries: The Role of Product Market Competition

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Motivation

- Innovation has become relevant for merger analysis.
  - Gilbert (2006): 40% of mergers between 2003-05 in "R&D industries".

- Are the current current guidelines appropriate?
  - Is price the only relevant object in innovative industries?
  - If a merger increases incentives to innovate, short-run price effects may be compensated for.

- "Competition and innovation" are mentioned in the guidelines:
  - Less competition may reduce incentives to perform R&D.
    - This argument was used in the Pfizer–Wyeth and Manitowoc–Enodis mergers.
  - Conflicts with evidence of a non-monotonic relationship between competition and innovation.
  - How does this evidence play in practice?

The role of product market competition

- Firms perform R&D to gain a competitive advantage or to capture a larger share of the market.
  - Intel and AMD were doubling CPU performance every 7 quarters in the 1993-2004 period (Goettler and Gordon, 2011).

- Product market payoffs determine the value of an innovation.
  - Ultimately firms innovate to obtain more profits.

- Product market payoffs are affected by competition.
  - Number of competitors; demand conditions; quantity, quality or price competition.

- Thus: Product market competition affects R&D incentives.

This paper

- Dynamic framework to analyze mergers in innovative industries.
  - Patent race model of sequential innovations.
  - No merger-specific R&D efficiencies $\rightarrow$ Focus on role of product market competition.

- Study the relation of market concentration and R&D outcomes.

- Provide conditions —based on static competition— for when a dynamic and static merger approval are aligned.
  - When rejecting/approving a merger based on price effects is aligned with rejecting/approving based on price and innovation effects.

- Derive a condition for when a static and dynamic criteria are not aligned: despite price effect, when does a merger increase long-run consumer surplus due to its effect in innovation?

Literature

- Discussion of the interaction between innovation and competition stems from Schumpeter (1942).

- No formal analysis on the effects of mergers on innovation.
  - Gilbert and Sunshine (1995) and Katz and Shelanski (2006) discuss limitations of merger guidelines for innovative industries.

- Aghion et al. (2005) find an empirical non-monotonic relation between competition and innovation.
  - Duopolistic model where substitution plays the role of competition.

- Dynamic Competition Policy.
  - Gowrisankaran (1999, 2004), Hopenhayn et al. (2006), Nocke and Whinston (2010, 2013), Parra (2016), Segal and Whinston (2007). Mermelstein et al. (2015), Igami and Uetake (2016)

Road map

1. Model
2. Market structure and Innovation
3. Merger analysis
4. Lessons

Model

Firms compete through innovations and in the product market

Baseline model

Consider a patent race model with an infinite sequence of innovations:

- Time is continuous and future is discounted at a rate r.
- There are $n+1$ "large" firms competing in both the product market and developing innovations.
  - One market leader: the firm with the latest technology.
  - n followers: 2^{nd}-best technology, investing to become the new leader.
  - The leader earns π_n^l, and each of the n followers $\pi_n^f < \pi_n^l$.
  - Observe that profits depend on n
  - Infinite patent protection —precludes imitation— until replaced by better technology.
- m "research labs" that only perform R&D.
  - Research labs do not compete in product market.
  - Sell innovations using 2^{nd}-price auctions.

Baseline model

The n followers and m research labs invest in R&D.

- Innovate at a Poisson rate: x.
- Flow cost of R&D: $c(x)$ —is strictly convex.
- Arrow's replacement effect + stationarity: leader performs no R&D.

This model accommodates:

- Various form of product market competition.
  - Firms competing in price, quantity, or quality.
- Different types of innovation
  - Quality ladders: discrete choice demand.
  - Cost innovation: hyperbolic demands.
  - Creative destruction: Technology replaces the previous one.

Model interpretation

Value functions satisfy

$$\text{leader: } rV = \pi_n^l + \lambda(W - V)$$

$$\text{follower: } rW = \max_{x_i} \left\{ \pi_n^f + x_i(V - W) - c(x_i) \right\}.$$

$$\text{lab: } rL = \max_{y_i} \left\{ y_i(V - W) - c(y_i) \right\}.$$

where $\lambda = \sum_i x_i + \sum_j y_j$ is the pace of innovation.

Value functions and investments rates are a function of n and m.

Proposition

There is a unique symmetric equilibrium. In equilibrium $x_i = y_i = x^*$ and

$$c'(x^*) = V - W.$$

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Market structure and R&D

How a change in market structure affects the pace of innovation?

Innovation incentives

- A merger between large firms affects *product market competition* and *innovation competition*.

- A key element in our analysis is the profit gap between the leader and a follower, $\Delta\pi_n \equiv \pi_n^l - \pi_n^f$.
  - This profit gap is what incentivizes R&D (i.e., it determines $V - W$).
  - The profit gap is a function of n.

- Innovation competition affects R&D directly through $n + m$ and indirectly determining $V - W$.

- To understand these forces, we first study how an isolated change in product market or innovation competition affects market outcomes.

Innovation incentives

Proposition (Product and innovation market competition)

Competition affects innovation outcomes through two channels:

i) *Product market competition: Fix n and m, an increase in the profit gap, $\Delta\pi_n$, increases firms investments, x^*, and the pace of innovation, λ.*

ii) *Innovation competition: A decrease in the number of research labs, m, increases firms investments, x^*, but decreases the pace of innovation, λ.*

- A merger creates both effects at the same time.
- These effects can reinforce each other or collide.

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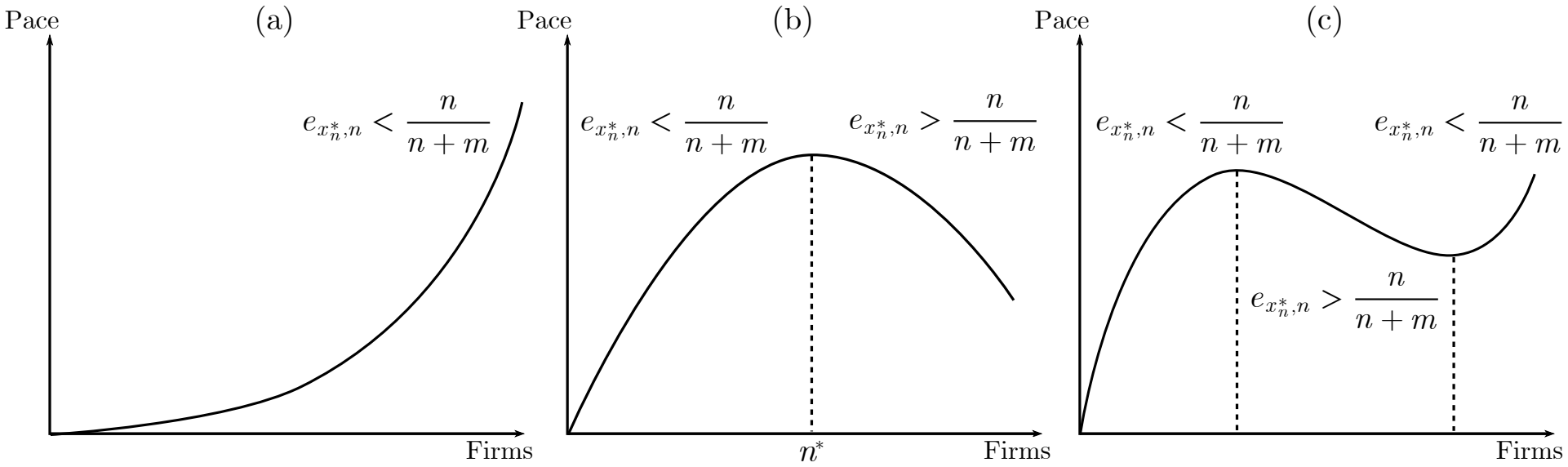
Effects of market concentration on R&D

The elasticity of a follower's R&D level with respect to the number of competitors summarizes R&D effects

Proposition: Concentrating the industry leads to an increase the pace of innovation iff

$$e_{x^*,n} = -\frac{dx^*}{dn}\frac{n}{x^*} > \frac{n}{n+m}.$$

We provide examples for the following cases:



Merger analysis

Can we incorporate the previous result into merger analysis?

What is a Merger?

We focus on the market concentration effects of a merger instead of on potential efficiencies created by a merger.

Mergers can be justified with the existence of R&D fixed costs:

$$W(n-1) > 2W(n) \text{ or } V(n-1) > V(n) + W(n)$$

Definitions

- A merger is desirable in the *static sense* if it increases (the flow of) consumer surplus at the very moment when the merger takes place.
- A merger is desirable in the *dynamic sense* if it increases the expectation of the discounted consumer surplus.

Sufficiency of static merger analysis

Proposition (Increasing differences)

A profit gap, $\Delta\pi_n$, that is weakly increasing in the number of product market competitors, n, is sufficient for a merger to decrease the pace of innovation.

A weakly increasing profit gap:

- implies $e_{x^*,n} < n/(n+m)$.
- merger effects on innovation reinforce the lessening of product market competition.
- is sufficient to guarantee that a merger rejection in the static sense is aligned with a dynamic criterion.

Sufficiency of static merger analysis

Proposition (Necessity of decreasing differences)

A profit gap, $\Delta\pi_n$, that is weakly decreasing in n, is necessary for a merger to increase the pace of innovation. If the number of research labs m is large enough, a decreasing profit gap is also sufficient.

Under decreasing differences:

- the product market competition and innovation competition effects collide.
- If R&D is in some sense "atomistic", approving a merger using a static merger criterion is aligned with approving it using a dynamic criterion

So, can we tell more about $\Delta\pi_n$

- We know that under homogeneous price competition $\Delta\pi_n$ is decreasing, i.e. concentration leads to less R&D.
- In general, we cannot tell.
- In the paper, we give examples of Cournot competition with log linear demands $q = (A/P)^{1/\sigma}$ and can go either way.
- Importance of demand specification

Dynamic Merger analysis

When criteria are not aligned

Dynamic merger analysis

Unfortunately, the static and the dynamic merger review criteria are not always aligned.

To assess whether a merger is desirable in the dynamic sense we need to impose further structure.

- The flow of consumer surplus, cs_n (decreases in n).
- Each innovation increases the flow if consumer surplus in δ_n

The expected discounted consumer surplus of the consumers in this market is given by

$$rCS = cs_n + \lambda \frac{\delta_n}{r}$$

Dynamic merger analysis

Proposition (Dynamic merger analysis)
A merger is desirable in the dynamic sense iff

$$e_{x^*,n} > \frac{n}{n+m} + \frac{rn}{\delta_n \lambda} \frac{dcs_n}{dn} + \frac{d\delta_n}{dn} \frac{n}{\delta_n}. \tag{1}$$

where $dCS_{0,n}/dn$ is the derivative of the consumer surplus flow (at the moment when the merger takes place) with respect to n.

Rewrite previous condition:

$$\underbrace{\lambda \left(e_{x^*,n} - \frac{n}{n+m} - \frac{d\delta_n}{dn} \frac{n}{\delta_n} \right)}_{\text{change in R\&D pace adjusted by pass-through}} \overbrace{\frac{\delta_n}{r}}^{\text{discounted increase in } cs} > \underbrace{cs_n \; e_{cs_n,n}}_{\text{static change in } cs \text{ flow}},$$

We show that mergers rejected according to a static criterion may increase consumer welfare from a dynamic standpoint.

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Lessons for new guidelines

- Current guidelines: R&D is increasing in the number of firms.
- This is not necessarily true.
- The price effects that hurt consumers in the short run may more than compensate consumers in the long run by boosting innovation incentives.
  - This is true even if the merger does not produce R&D efficiencies.
- How firms compete is key for understanding the impact of a merger on innovation incentives.
- We can use these results towards building a structural empirical framework on how to asses merger in innovative industries.

Thank you!