

EC2212 Industrial Growth
and Competition

Lecture 3

Large Firms Are Innovative
(and when)

Organization of Lecture

1. Large firms sometimes dominate innovation

A Story That Must Be Told:

2. Schumpeter's view: large better
 3. Investigation suggests: small better
 4. Theory reinterprets: large often better
5. Large firms are better in these circumstances...

Large Firms Sometimes Dominate Innovation

% of Major Innovations from Largest Firms

Autos top 2
product 43%
process 95%

Tires top 4
product 98%
process most/all

Televisions top 5
product 84%
process most/all

Penicillin top 4
product 100%
process most/all

Source: Data from K. Simons (see Klepper & Simons, 1997).

Schumpeter on Innovation (1)

“[I]n capitalist reality as distinguished from its textbook picture, it is not [price] competition which counts but the competition from the new commodity, the new technology, the new source of supply, the new type of organization...—competition which commands a decisive cost or quality advantage and which strikes not at the margins of the profits and the outputs of the existing firms but at their foundations and their very lives. This kind of competition is as much more effective than the other as a bombardment is in comparison with forcing a door, and so much more important that it becomes a matter of comparative indifference whether competition in the ordinary sense functions more or less promptly; the powerful lever than in the long run expands output and brings down prices is in any case made of other stuff.”

(Capitalism, Socialism and Democracy, 3rd ed., 1950, pp. 84-85)

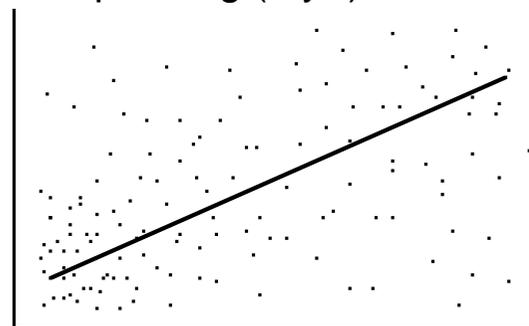
Schumpeter on Innovation (2)

Tracking down sources of economic progress, “the trail leads... precisely to the doors of the large concerns” (1950, p. 82)

1. Monopoly prices justifiable as insurance against new technology.
2. Monopolistic or oligopolistic behavior not so bad, vs. benefit from technological change. Good (e.g. stability in recessions).
3. Technology drives down prices anyway; use hedonic prices.
4. Firms adopt new innovations despite any “loss” in capital.
- 5a. True monopoly is exceedingly rare; large size is not monopoly.
- 5b. Monopolists may be more efficient, create new products.
- 5c. Short-run monopoly more common than long-run monopoly.
6. Replace static perfect competition economic view; need dynamic understanding with technology. Technological change cannot happen in perfect competition, which disallows profits from innovation.

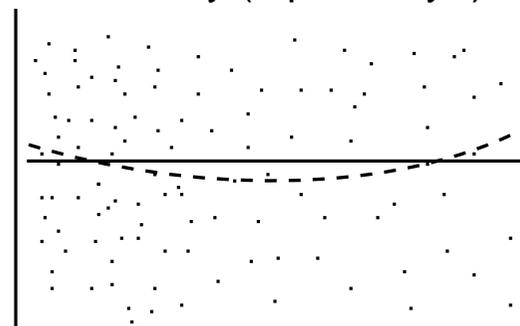
Empirical Studies of Innovation

R&D spending (\$/yr.)



firm size

R&D intensity (\$/person/yr.)

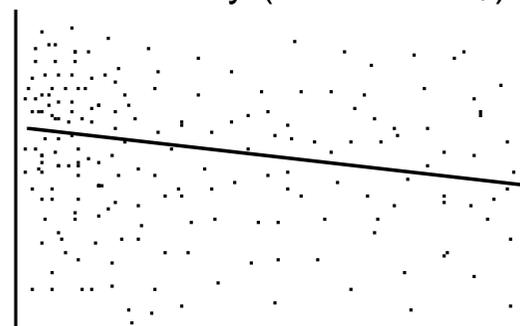


firm size

Fake data illustrate real findings:

- R&D spending rises with firm size
- R&D intensity flat with firm size (Scherer finds slight inverted-U)
- R&D efficiency falls with firm size
- I.e., small firms spend same per employee and get more results!

R&D efficiency (value/R&D\$)



firm size

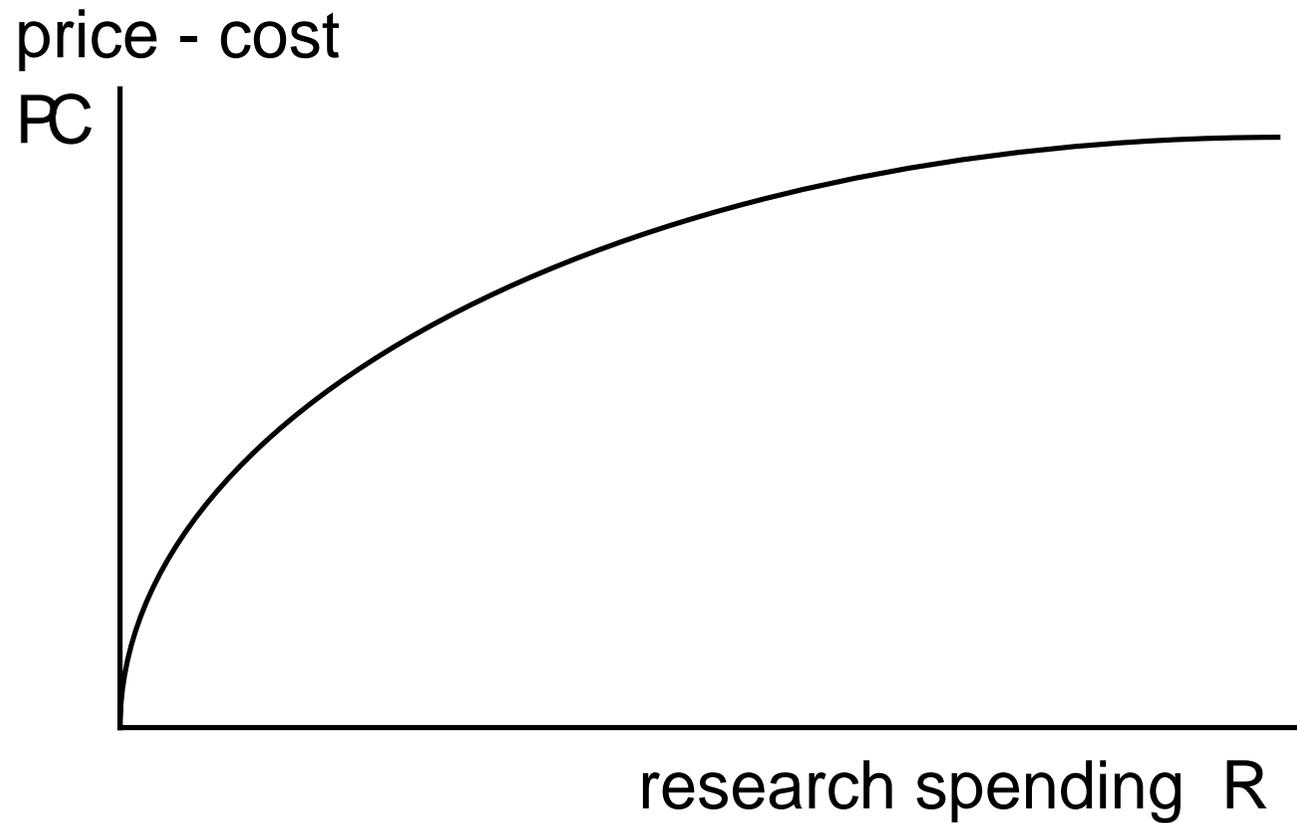
A Theory of R&D and Firm Size

- Facts sometimes mislead, when not informed by correct theory
- I will show an economic theory (simple version of Cohen & Klepper, 1996)
- Assumptions of theory fit most industries
- The theory fits empirical facts
- The theory implies large firms better

Assumptions of Theory

- Firm spends R on research & development
- R&D increases quality, lowers unit cost
 - (Or expected quality and unit cost)
 - I.e., R&D increases $PC = \text{price} - \text{cost}$: $PC'(R) > 0$
 - Diminishing marginal returns to R : $PC''(R) < 0$
- Firms max. profit: $\Pi = PC(R) \times Q - R$
- Future output Q is fixed; firm chooses R

Price-Cost Margin versus R



Why Two Key Assumptions

- Research results cannot be sold to other companies
 - Returns to R&D rarely can be appropriated except through a company's own sales
 - Firms can “invent around” patents, use lawsuits
- Future output Q is a fixed constant
 - E.g., $Q_{\text{future}} = Q_{\text{now}} \times k$
 - Firm growth k is limited in practice

Three Implications of the Theory

1. Large firms: more R&D than small firms,
not (necc.) more R&D per unit of size
2. Large firms: higher PC than small firms
 - Better for society (better quality and cost)
 - Better competitors (higher profit margin)
3. Large firms: less R&D results per R&D \$
 - Less wasteful duplication of easy research
 - Do more challenging (more marginal) R&D too

Proofs Step 0: A Lemma

The firm maximizes Π
by choosing R .

At the maximum, $d\Pi/dR$
must equal 0, and $d^2\Pi/dR^2$
must be negative.

So, the firm chooses R so
that the marginal increase
in the price-cost margin
from another \$ of R&D
spending equals $1/Q$;
that is, $PC'(R) = 1/Q$.

$$\Pi = PC(R) \times Q - R$$

$$\frac{d\Pi}{dR} = PC'(R) \times Q - 1 = 0$$

$$\text{i.e., } PC'(R) = \frac{1}{Q}$$

$$\frac{d^2\Pi}{dR^2} = PC''(R) \times Q < 0$$

Proofs Step 1: Theorems 1a & 1b

$$PC'(R) = \frac{1}{Q}$$

$$\frac{d}{dQ}(PC'(R)) = \frac{d}{dQ}\left(\frac{1}{Q}\right)$$

$$PC''(R) \frac{dR}{dQ} = \frac{-1}{Q^2}$$

$$\frac{dR}{dQ} = \frac{-1}{Q^2 PC''(R)} > 0$$

Bigger firms do more R&D.

Let : $PC(R) = k \log(R)$

Then : $PC'(R) = k / R$,

so use $PC'(R) = 1 / Q$,

to get $\frac{k}{R} = \frac{1}{Q}$

Then : $\frac{d(R/Q)}{dQ} = 0$

Bigger firms are not necessarily more R&D intensive.

Proofs Step 2: Theorems 2a & 2b

Since R increases with firm size ($dR/dQ > 0$), and since PC increases with R, PC must increase with firm size:

$$\frac{dPC}{dQ} > 0$$

Bigger firms have better quality and lower unit cost.

Compare sizes $Q_2 > Q_1$.
Optimal R&D is $R_2 > R_1$.
Suppose the larger firm spends only R_1 on R&D.

Then its profit per unit,
 $[PC(R_1) \times Q_2 - R_1] / Q_2$
exceeds that of the smaller firm,
 $[PC(R_1) \times Q_1 - R_1] / Q_1$.
Choosing optimal R&D R_2
only increases profit per unit.

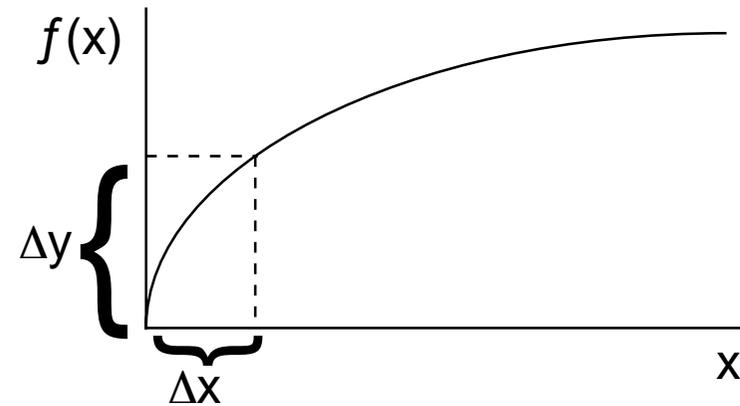
Bigger firms earn more profit per unit.
They are “fitter” competitors.

Proof Step 3: Theorem 3

For any concave increasing function $f(x)$, $\Delta y/\Delta x$ is smaller for larger Δx . Since $PC(R)$ is a concave increasing function ($PC'(R) > 0$, $PC''(R) < 0$),

$$\frac{d[(PC(R) - PC(0))/R]}{dR} < 0$$

Bigger firms accomplish less unit-cost savings per average \$ spent on R&D. I.e., they don't just duplicate small firms' R&D; they do more challenging R&D too.



You Have Learned

- Schumpeter's story can fit the evidence...
- When:
 - Returns to R&D are not appropriable
 - Future output is limited in practice
 - R&D is duplicated across firms
 - I.e., especially for gradual improvement, not for patentable radical inventions
- Then larger firms do more intensive R&D, are fitter competitors; society benefits more