Industrial Organization

Master Industries de Réseau et Economie Numérique (IREN) - 2024/2025

Chapter 4: Competition and Investment

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Chapter 4

Outline

- Questions:
  - Which market structures create the most favorable environment for economic growth?
  - Should the presence of large firms be promoted to obtain large scale investment?
  - Or should it be discouraged to promote competition?
    - What is the link between competition and investment?

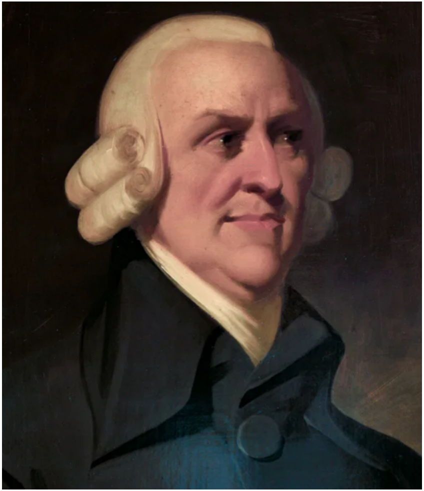
- Answers from the previous chapter:
  - competition decreases firms' profit;
  - competition increases consumers' welfare;
  - Overall the social surplus increases.
- New question. What if the social goal becomes:
  - protecting jobs; or
  - increasing *domestic* firms' profit ?

- Answers from the previous chapter:
  - Unconcentrated market structure is optimal
    - it encourages greater competition and deter collusion between firms
- New question. What if the social goal becomes to promote
  - increasing returns to scale; or
  - investment over the long-term?

- In the previous chapter we have studied the optimal market structure by:
  - focusing on the positive aspect of competition over the short run;
  - neglecting the positive aspect of investment over the long run.
- In this chapter, we shall compare short run vs long run effects.

- In this chapter, we shall also consider intangible assets:
  - Assets that do not have a physical or financial embodiment
    - They consist of human knowledge and ideas
  - Assets to which a legal entitlement, called intellectual property (IP), is usually attached.
- Intangible assets of this kind become increasingly crucial in our economies.
  - It comes from the:
    - growing importance of service industries; and
    - digital economy expansion.

- New questions.
  - Does the patent race in R&D align with optimal outcomes?
  - What are the strategic effects of R&D spillovers?
  - Should public authorities permit R&D cooperation among firms that compete in the same product market?



Adam Smith (1723-1790)

Theoretical debate: Smith, Hayek, and Schumpeter
Adam Smith and the school of Harvard

- Adam Smith praises the virtues of competition as a way to ensure efficiency in:
  - allocation;
    - providing consumers with the entire surplus created by trade.
  - and production.
    - consumers' needs are best satisfied.
- The State should then:
  - prevent the development of dominant firms; and
  - help small firms to survive.

- This vision was developed at the school of Harvard and is known as the "*Structure-Conduct-Performance*" paradigm (see Bain (1956)).
  - It suggests that the *structure* of a market influences the *conduct* of firms, which in turn affects their *performance*.
  - It supports the presence of competitive markets and favors public intervention to keep the structure competitive.

Examples of industry where state support for small firms to develop and survive can be crucial:

- Renewable energy sector
    - The state can provide grants or funding support for small renewable energy firms to conduct R&D innovative technologies.
- Healthcare industry
    - The government can provide grants to small healthcare providers, such as community health centers, clinics, and solo practitioners, to expand access to healthcare services in rural and underserved areas.

- Agricultural sector
  - The state can provide subsidies and grants to small farms to help them cover operating expenses, invest in infrastructure improvements, and adopt sustainable farming practices.
    - Organic farming is small-scale agriculture
  - This financial assistance can help small farms remain competitive and sustainable in the face of fluctuating market prices and input costs.

Examples of industry where the state might seek to prevent the development of dominant firms:

- Telecommunications industry
  - Having a few dominant firms can lead to reduced competition and fewer choices for consumers.
  - This lack of competition can result in higher prices, lower quality services, and reduced innovation.
  - Large telecommunications firms may have:
    - power to control access to essential services such as internet access and mobile phone coverage;
    - access to vast amounts of consumer data, raising concerns about privacy and data security.

Examples of industry where the state might seek to prevent the development of dominant firms:

- Banking and financial services industry
  - Dominant banks or financial institutions can:
    - have significant market power, allowing them to exploit consumers through high fees, predatory lending, or unfair terms and conditions.
    - Limit access to credit and financial services, particularly for small businesses, and low-income individuals.
    - Pose systemic risks to the stability of the financial system.
    - Deter innovation and competition by stifling the entry of new fintech startups.

Friedrich August von Hayek (1899-1992)

Theoretical debate: Smith, Hayek, and Schumpeter
Hayek and the Austrian school

- Hayek claims that the competitive *process* matters more than the competitive *structure.*
  - the number of firms *per se* is irrelevant;
  - only the possibility for a new and more efficient firm to succeed matters.
- This critical view of competitive structure will be followed by the Austrian school.
  - The presence of large firms is not the sign of ill-functioning markets.
  - Large firms may come from higher efficiency.
    - E.g., cost structure displaying increasing returns.

- Automotive industry
  - Economies of scale
    - prototype vs mass market
  - Economies of scope
    - Prototype from scratch vs differentiating existing model
  - Greater resources to invest in R&D, technology, and automation
    - Enhance product quality and reduce cost
- Aerospace
  - same as automotive

Theoretical debate: Smith, Hayek, and Schumpeter
Hayek and the Austrian school

- Airline industry
  - Economies of scale
    - Reduce cost of aircraft acquisition, maintenance, and crew training
  - Higher efficiency in network operations
    - By offering a wide range of destinations and frequent flights, large airlines can attract more passengers and maximize aircraft utilization
  - Yield management
    - By accurately forecasting demand and adjusting fares dynamically, large airlines can determine the optimal pricing strategy for each route and flight.
  - Safety
    - Investing in training, maintenance, and safety management systems to ensure the highest standards of safety and reliability.

Theoretical debate: Smith, Hayek, and Schumpeter

Schumpeter

Joseph Schumpeter (1883-1950)

Theoretical debate: Smith, Hayek, and Schumpeter
Schumpeter

- According to Schumpeter's book ("Capitalism, Socialism and Democracy", 1942), there are many situations where concentrated market structures – in particular the monopolistic structure - are optimal.
- At the core of Schumpeterian argument:
  - The objective to gain market shares provides firms with high *incentives* to invest and innovate.
  - Monopoly rents then maximize the incentives to innovate.
- Monopoly rents then promote economic growth.
  - it provides higher incentive to innovate; and
  - it gives access to large financial reserve required to finance investment.

Examples of industry where monopoly rents can provide higher incentives to innovate:

- Pharmaceutical industry
  - High costs of R&D
    - R&D costs for new drugs$>$1B$
  - Patent protection
    - about 20 years
  - Market exclusivity
    - Regulatory incentives for developing drugs that address rare diseases or unmeet medical needs.
  - Risky R&D
    - Rare diseases, neurodegenerative disorders, and emerging infectious diseases

- Aerospace and defense industry
  - Long development cycles
    - ⋆ Developing new aerospace and defense technologies have long development cycles spanning several years or even decades and require substantial financial resources.
  - Government contracts or exclusive partnerships
    - ⋆ The promise of lucrative government contracts incentivizes companies
  - Intellectual property protection
    - ⋆ By obtaining proprietary technologies and systems, patents, copyrights, or trade secrets for their innovations, companies can maintain a competitive advantage.
  - Export Controls
    - ⋆ National security imperatives restrict the transfer of sensitive technologies to foreign entities

Question

Which market structure is most likely to foster investment?

Answer

Difficult question because the investment changes the market structure!

- So we need to distinguish between:
  - ex-ante market structure (before investment); and
  - ex-post market structure (after the investment).

- We also need to distinguish between:
  - investment in *innovation* ; and
    - i.e., investment that provides property rights;
  - investment in *infrastructure*.
    - i.e., investment that determines the level of firms' physical capital.

1. Introduction

2. Theoretical debate: Smith, Hayek, and Schumpeter

3. Competition and Investment in Innovation
   - Replacement effect vs. Efficiency effect
     - Arrow Replacement Effect
     - The Efficiency Effect
     - Conclusion
   - The Inverse U-Shape curve of innovation
     - Theoretical analysis
     - Empirical analysis
     - Conclusion

4. Competition and infrastructure investment

Question

What is the link between the degree of competition on a market and the choice of innovating?

Answer

Two opposing answers.

Arrow (1962): a monopoly is less likely to invest than a duopoly.

Gilbert and Newbery (1982): monopoly is more likely to invest than its potential competitors.

- Arrow, K. (1962). “Economic Welfare and the Allocation of Resources for Innovations,” R. Nelson ed. The Rate and Direction of Inventive Activity, *Princeton University Press*.
- Arrow Replacement Effect
  - When innovating a monopoly replaces himself.
    - ⋆ It has then smaller incentives to innovate than firms in a competitive situation.

- By innovating, a firm can get a monopoly position
  - Innovation gives an exclusive right of unlimited duration.
    - ⋆ It grants the firm an ex-post monopoly position.
- Two situations/models: monopoly and competitive market.

- Model (competitive market)
  - A large number of firms produce a homogenous good.
  - Firms produce at constant marginal cost c^H.
  - Innovation allows to decrease c^H to c^L (with $c^H > c^L > 0$).
  - Only one firm can acquire the innovation (or makes the investment).
- Prior to innovating, these firms compete in price so the equilibrium price is c^H and there is no residual profit.

- Model (monopoly)
  - Same as before except only one firm.
- Prior to innovating, the monopoly charges $p^m(c^H)$ and makes profit $\pi^m_{c^H} := \pi_{c^H}\left(p = p^m(c^H)\right)$
  - After innovating (if it chooses to do so), the monopoly charges $p^m(c^L)$ and makes profit $\pi^m_{c^L}$.

Competition and Investment in Innovation
Arrow replacement effect

Definition

A **product innovation** is the generation, introduction and diffusion of a new product (with the production process remaining unchanged).

- E.g., Tesla Electric Vehicles, Apple iPhone.

Definition

A **process innovation** is the generation, introduction and diffusion of a new production process (with the products remaining unchanged).

- E.g., robotics or software automation to increase production speed, reduce human error, and reduce producing cost.

- A product innovation is nothing but an extreme case of a process innovation.
  - It can be argued that the new product already "existed" as a prototype but was simply too expensive to produce.
  - So, it took a process innovation to make the new product available.

Question

Are the incentives to innovate higher under p.p.c. than under monopoly?

Answer

It depends on whether the innovation reduces costs to such an extent that it allows the innovator to behave as a monopolist.

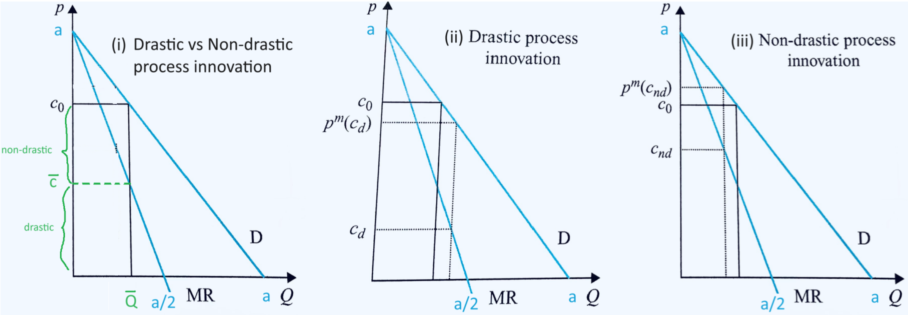
Definition (informal)

An innovation is said to be **drastic** (or **major**) if it reduces costs to such an extent that it allows the innovator to behave as a monopolist without being constrained by price competition in the industry. Otherwise, it is called **non-drastic** (or **minor**).

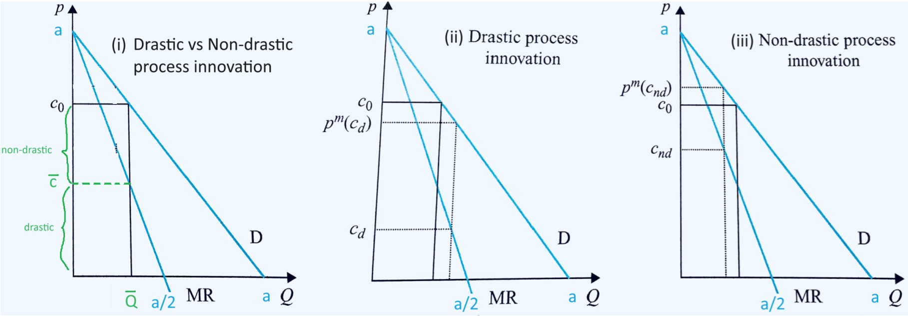
- E.g., smartphone models:
  - **drastic/major:** touchscreen instead of keyboards and buttons.
  - **non-drastic/minor:** latest updates.

Definition (formal)

An innovation is **drastic** (resp. **non-drastic)** if $p^m(c^L) < c^H$ (resp. $p^m(c^L) \geq c^H$).



- (i) Drastic/Non-drastic.
  - $D: Q(p) = a - p \Rightarrow p(Q) = Q - a.$
  - $MR = \frac{\partial}{\partial Q}[p(Q)Q] = \frac{\partial}{\partial Q}[aQ - Q^2] = -2Q + a \Rightarrow p = -2Q + a.$
  - $\bar{c}$ is s.t. $c_0 = a - \bar{Q}$ and $\bar{c} = -2\bar{Q} + a$, so $\bar{c} = 2c_0 - a$.



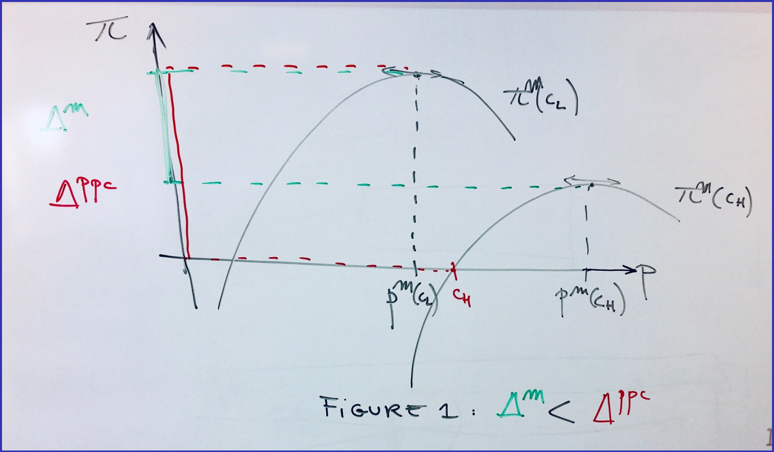
- Innovation reduces the cost from c_0 to c_d (ii) or c_{nd} (iii)
  - (ii): the innovator can fix the monopoly price without fear of competition from the other firms ($p^m(c_d) < c_0$).
  - (iii): He is still constrained by the price competition of the rival firms ($p^m(c_{nd}) > c_0$).

Result

In the case of drastic innovation, the incentives to innovate are higher for the competitive firm than for the monopoly.

- By innovating, a firm produces at cost c^L.
- In any cases (major or minor innovation), the incentives to innovate under monopoly: $\pi^m_{c^L} - \pi^m_{c^H}$.
- If $p^m(c^L) < c^H$, the competitive firm charges $p^m(c^L)$ and it escapes any form of competition.
  - the firm's profit is $\pi^m_{c^L}$
  - incentives to innovate under competition: $\pi^m_{c^L} - \pi_{c^H}\left(p = c^H\right) = \pi^m_{c^L}$.
  - So when $p^m(c^L) < c^H$, incentives to innovate are stronger under competition ($\pi^m_{c^L}$) than under monopoly ($\pi^m_{c^L} - \pi^m_{c^H}$).

Competition and Investment in Innovation



Result

In the case of non-drastic innovation, everything may happen.

- If $p^m(c^L) \geq c^H$, the competitive firm charges $c^H - \varepsilon$ and covers the whole market but gets less than monopoly profit.
  - Upper bound on profits: $\pi_{c^L}\left(p = c^H - \varepsilon\right)$.
  - This may be higher or lower than the incentives to innovate under monopoly: $\pi^m_{c^L} - \pi^m_{c^H}$.

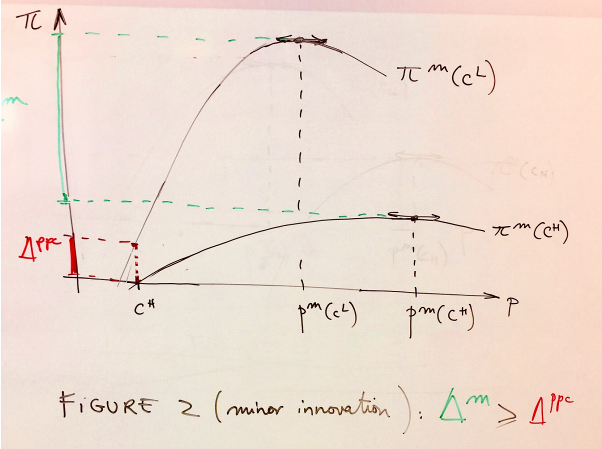


Figure 4.2 (minor innovation): $\Delta^m \geq \Delta^{ppc}$

Competition and Investment in Innovation

Arrow replacement effect

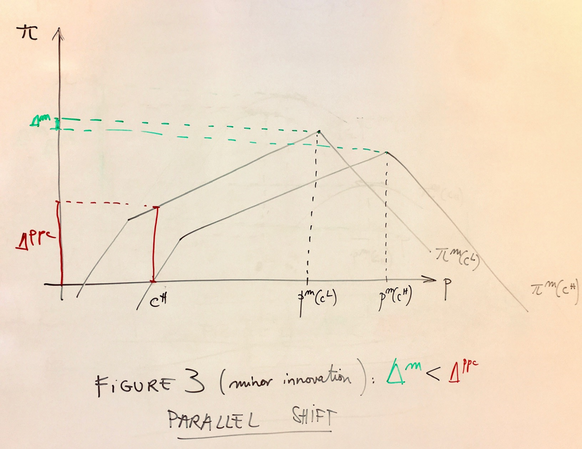
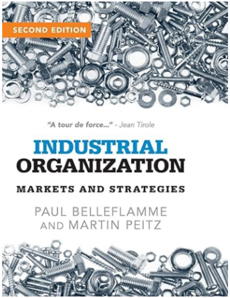


Figure 4.3 (minor innovation): $\Delta^m < \Delta^{ppc}$

- The case of a profit curve transformation (Figure 4.2) is usually ignored in textbooks.
  - They only present the case of a parallel shift (Figure 4.3.).
  - E.g., Belleflamme, P., & Peitz, M. (2015). *Industrial organization: markets and strategies*. Cambridge University Press.



  - See, Lesson 18.1: "*A competitive firm places a larger value on a minor process innovation than a monopoly does.*"(p. 501)

- Arrow's main point in case of drastic innovation is the fact that the monopoly has less to gain in improving his position because he replaced himself when innovating.
- The replacement effect explains the potential smaller incentives of the monopoly – who rests on his "laurels" – compared to firms in a competitive situation.

- In the preceding approach, it was assumed that only one firm could acquire the innovation (or makes the investment).
- Gilbert, R. and Newbery, D. (1982). “Preemptive Patenting and the Persistence of Monopoly,” *American Economic Review*, 72: 514-526
  - They consider an initial situation with an incumbent and a potential entrant.
  - The new technology can either be acquired by the incumbent or the entrant.

- Both the incumbent and the entrant devote some money to increase the speed at which they can secure a position on a market.
  - For the incumbent, a success (preemptive patenting) is equivalent to keeping the initial monopoly position with a more efficient technology.
  - For the potential entrant, success allows to enter the market with a technological advantage on the incumbent (the former monopoly), with a new market structure characterized by an asymmetric duopoly.

Result

The incentives to innovate are higher for the incumbent firm than for the potential entrant.

Intuition

Let $\pi^D_{c_1,c_2}$ denote firm 1's profit under duopoly when his own (resp. competitor) cost is c_1 (resp. c_2).

The potential entrant incentives to innovate (and then entering the market) writes as $\pi^D_{c_L,c_H}$.

The monopoly incentives to preempt innovation writes as $\pi^m_{c_L} - \pi^D_{c_H,c_L}$.

Intuition

The latter expression is greater than the former if

$$\pi^m_{c_L} \geq \pi^D_{c_L,c_H} + \pi^D_{c_H,c_L} \tag{1}$$

which has the interpretation that the profits of an efficient monopolist are higher than the profit of two duopolists choosing their strategy in an uncoordinated way.

- Condition (1) is a very natural property which is always verified for close substitutes.
  - On the contrary, if consumers enjoy variety, the entry of a differentiated product might increase the size of demand in such a way that the inequality is reversed.

Definition

The **efficiency effect** reflects the extent to which the monopoly incentives to preempt innovation is higher than the potential entrant incentives to innovate.

- In a duopoly context, it formally writes as

$$\pi^m_{c_L} - \pi^D_{c_H,c_L} \geq \pi^D_{c_L,c_H}$$

which is equivalent to (1).

- Hence, in a pure race for innovation, the monopolist's incentives to keep his monopoly position are greater than the incentives an entrant has to become a duopolist.
- This explains:
  - Pay-for-delay agreements; and
  - Blocking patents.

Competition and Investment in Innovation
The Efficiency Effect: Pay-for-delay agreements

- From (1), an incumbent firm is willing to pay more to prevent a rival from using an innovation than what this rival is willing to pay to actually use this innovation.
- *'Pay-for-delay' agreements* are commonplace in the pharmaceutical industry.
  - They involve branded drug makers paying generic groups to delay the launch of lower-cost versions of their drugs.
  - It allows originator pharmaceutical firms to prolong their monopoly position.

Question

Why do generic producers accept these deals?

Answer

The maximum amount that the originator is willing to pay to delay entry is the difference between the monopoly and the duopoly profit: $\pi^m_{c_L} - \pi^D_{c_H,c_L}$.

The minimum amount that the generic producer demands to accept not to enter is its incentives to innovate: $\pi^D_{c_L,c_H}$.

An agreement can be found between the two parties if the efficiency effect holds.

- Studies have found that in many industries 40-90% of patents are never exploited or licensed out by their owners.[1]
  - E.g., IBM, Philips and Siemens would (according to the Financial Times) use only about 40% of their portfolio of patents.
- Two explanations:
  1. Sleeping (or “dormant”) patents; and
  2. Blocking patents.

[1] The Economist, "Time to fix patents", Aug 8th 2015

Definition

Sleeping patents are patents that are filed but not actively pursued for commercialization or development.

- A number of new processes or products remain under- or unexploited because of:
  - lack of resources or complementary assets to bring the innovation to market;
  - poor fit between the innovation and the firm's objectives;
  - bargaining leverage in cross-licensing negotiations; or
  - waiting for technological advancements or market demand to mature before actively pursuing commercialization efforts.

Definition

Blocking patents are patents that are actively enforced by the patent holder to control a particular technology or market segment.

- Some blocking patents are sleeping patents.
  - Unused patents may allow dominant firms to block entry into their market.
  - Holding several patents all related to the same process or product would thus create a buffer of protection around the truly valuable patent.
    - ⋆ "Smoke screen" patenting: high number of patent applications are filed in order to hide the important subject matter.
    - ⋆ "Patent clusters": overlapping patents that make it harder for competitors to "invent around" the pro-tected technology.

- Protection for 20 years might make sense in the pharmaceutical industry
  - because to test a drug and bring it to market can take more than a decade.
- But in industries like IT, the time from brain wave to production line, or line of code, is much shorter.
  - E.g., Google has a patent from 1998 on ranking websites in search results by the number of other sites linking to them.
  - E.g., Qualcomm (leading semiconductor and telecommunications company) has over 24,000 active patent families and a patent portfolio of 140,000 global patents, most of them related to cellular communication technologies such as 3G, 4G, 5G, and 6G.

Replacement effect vs. efficiency effect: Conclusion

- It is difficult to draw clear-cut conclusions on the link between market structure and incentives to invest.
  - On one side, there is the classical argument that competition fosters innovation and investment.
    - Because this market structure gives the highest incentives to escape competition.
  - On the other side, we find the Schumpeterian idea that the presence of ex-post rents is crucial to incentivize firms.
    - In this respect, monopoly rents maximize the incentives to innovate.

- In industries where entry represents an important threat, incumbent firms use innovation as a tool to prolong their monopoly situation over time.
  - An interpretation in terms of investment would be that :
    - competition is good to generate new goods (drastic innovation)
    - while monopoly is better to foster regular marginal increase of the production frontier (non-drastic innovation).

- The previous analysis compares pre-investment market structures (and profit) with post-investment market structures (and profit).
- Many innovations or investment do not fundamentally change the degree of competition.
  - It is therefore useful first to find a model flexible enough to study the innovation incentives and second to be able to look at real data and settle the debate as much as possible.
  - To this end, we will turn to more data oriented research, discussing in particular the contribution by Aghion et al. (2005).
- Aghion, P., N. Bloom, R. Blundell, R. Griffith, and P. Howitt. (2005). "Competition and Innovation: An Inverted-U Relationship," *Quarterly Journal of Economics*, 120, 701-728.

- The model by Aghion et al. (2005) is grounded into the Schumpeterian tradition revitalized by the endogenous growth literature (Romer (1990), Aghion-Howitt (1992) and Grossman-Helpman (1991)).
- This literature links higher product market competition to lower post-entry rents and lower incentives to innovate.
- But on top of this well-known idea, the model adds the escape-competition effect whereby a firm in a competitive market wants to innovate to differentiate from its competitors.
- The combination of those two effects will lead to the inverse U-shape curve.

- Two firms operate on a market.
- Firms are characterized by their production functions which depend on two possible technological situations:
  1. Either one firm (the leader) lies ahead of its competitor (the follower); or
  2. Both firms are at technological par with one another.
- The first (resp. second) situation is referred to as “unleveled” (resp. “leveled” or “neck-and-neck”).

- The technological situation is not set once for all.
  - At each period, firms can devote some resource to innovation, and may thereby increase their productivity.
- The model assume that the gap between the two firms never exceeds one technological level.
  - If a leading firm innovates, the follower will automatically get access to the (now) old technology of the leader.

- Competition is modeled by the actual behavior of the firms, and their ability to maintain high prices.
  - When there is a technological leader, competition is soft but only the leader can make some profit.
  - When the industry is leveled, the degree of product market competition is inversely related to the degree to which the two firms are able to collude.
    - If there is no collusion, then Bertrand competition with identical products drives the industry profit to zero.
    - If the collusion is perfect, the firms will share equally the monopoly profit.
    - The competition is therefore parameterized by the fraction of a hypothetical leader's profit that a level firm can reach through collusion.

Result

There is an inverse U-shape curve between competition and innovation

Intuition

Suppose first, the firms have the ***same technology*** *(neck-and-neck situation):*

- If competition is low (collusion is high), the marginal gain from innovation is small.

- If competition is high (collusion is low), the current profits on the market are small so the incentives to innovate to escape competition are high.

Hence, when firms are neck-and-neck increasing competition can foster innovation.

- So, the escape-competition effect dominates.

Intuition

*Suppose second, the firms have **different technologies** with one leader and one follower.*

- If competition is high (collusion is low), the rents that can be captured by a follower (who succeeds in catching up with its rival by innovating) is low.

- the follower has then no incentives to innovate as the returns will be low.

- If competition is low (collusion is high), the follower has more incentive to innovate.

Hence, when the firms have different technologies competition can reduces the follower incentive to innovate.

- Study of a panel of more than 300 British firms over the period 1973-1994.
  - Innovation intensity is measured by the average number of patents taken out by firms in an industry.
    - each patent is weighted by the number of times it has been cited by another patent.

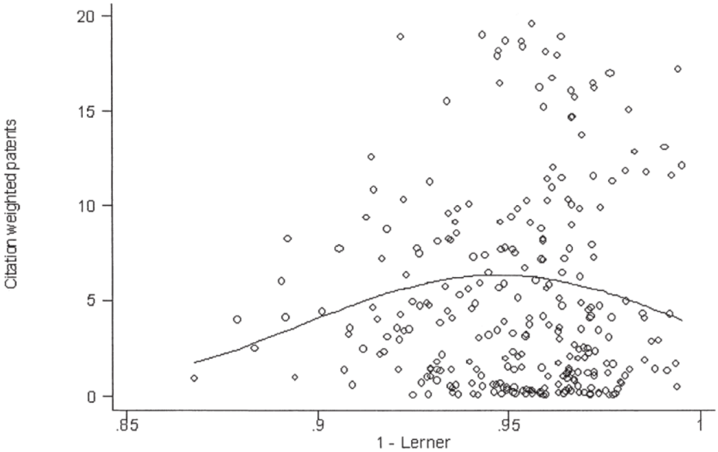
- Degree of competition is measured by a Lerner type of index
  - the ratio between operational profits net of financial cost divided by sales of firm i in year t

$$L_{it} := \frac{\text{operating profit - financial cost}}{\text{sales}}$$

    when price equals marginal cost we have $L_{it} = 0$
  - and then the average of this index across firms in the industry j in year t is taken.

$$c_{jt} := 1 - \frac{1}{N_{jt}} \sum_{i=1}^{N_{jt}} L_{it}$$

  - $c_{jt} = 1$ indicates perfect competition while $c_{jt} < 1$ indicate some market power.



Competition against citation weighted patents.

DESCRIPTIVE STATISTICS

	Mean (s.d.)	Median	Min	Max
Patents	6.59 (8.52)	3.5	0	54
Cite weighted patents	6.65 (8.43)	3.35	0	45
1-Lerner	0.95 (0.023)	0.95	0.87	0.99
Technology gap (m)	0.49 (0.155)	0.51	0.080	0.81

The sample is an unbalanced panel of 354 yearly observations on seventeen industries over the period 1973 to 1994.

- Aghion et al. (2005) allows combining:
  - the Schumpeterian Effect; and
    - more competition meaning less rent and thus less incentives to innovate
  - the "Escape Competition" Effect
    - more competition decreases the current profit and increases the incentive to innovate to gain a technological advantage.

The Inverse U-Shape curve of innovation: Conclusion

- Increasing competition can foster innovation where firms are neck-and-neck
  - i.e. when the production function is the same across firms.
- But when firms are technologically heterogeneous, it is better to decrease competition in order to foster innovation from the laggard firm.

- Infrastructure investment determines the level of firms' physical capital.
- A particular company's choice of infrastructure level depends on the structure of the market it belongs to.
  - A monopoly accumulates physical capital to an extent that may differ from the one that would have been chosen by a firm that only covers a small part of a highly competitive market.

- Government can influence competition and therefore the level of infrastructure investment in several ways.
  - E.g., the regulator can reduces competition by:
    - ⋆ erecting barriers to entry by determining administratively the number of firms through a grant of licenses;
    - ⋆ establishing a system of standards, administrative procedures, red tape and other forms of regulatory burdens that increase firms' adjustment costs;
    - ⋆ imposing a ceiling on the rate of return on capital by setting an upper bound on the ratio profit/capital that firms are allowed to earn;
  - it can also increases competition by:
    - ⋆ providing new entrants with access to incumbents' infrastructure.
- Government intervention can be even more intense when it owns all or part of the company's capital.

- Over the past three decades many OECD countries experienced governmental measures (mostly deregulation) in industries that require heavy infrastructure investments.
  - E.g., as for the sector of aerospace, railways, postal, telecommunications, electricity, gas...

Question

What is the effect of such measures on infrastructure investment?

Answer

Deregulation does not produce the same effect whenever it consists in:

- suppressing barriers to entry;

- reducing the cost of capital adjustment;

- removing the ceiling on the rate of return that can be earned on capital; or

- reducing the State shareholding in the company.

- Alesina, A., Ardagna, S., Nicoletti, G., & Schiantarelli, F. (2005). Regulation and investment. *Journal of the European Economic Association*, 3(4), 791–825.
- Model in the spirit of endogenous growth literature.
  - Several monopolistic competitive firms.
  - Each producing a differentiated product by choosing capital and labor to maximize present discounted value of future profits.

- Assumptions
  - The elasticity of demand increases with the number of firms.
    - I.e., higher number of producers extends the range of products available to consumers.
    - This variety increases the elasticity of substitution between products - the consumer has access to more substitutes - and thus the elasticity of demand that each firm faces increases.
  - Tougher regulation increases the cost of capital adjustment.
  - Marginal productivity of capital is decreasing.
    - This implies that as an additional unit of capital is added to a fixed labor supply, the gain in output is positive but less than the extra output generated by the addition of the previous unit of capital.

Result

Reducing barriers to entry (and/or the cost of capital adjustment) stimulate infrastructure investment.

Intuition

Lowering barriers to entry (and/or the cost of capital adjustment) increases the number of firms.

- The initial capital of a new entrant reproduces somehow a capital already used by incumbents.

- In addition, capital accumulation by entrants more than offsets the potential decline of incumbents' capital as the marginal productivity of capital is assumed to be decreasing.

- Thus, at the aggregate level, both the capital stock and the level of infrastructure investment increase.

Result

Relaxing the constraint on the rate of return on capital reduces infrastructure investment.

Intuition

The choice of factor proportion may be altered in favor of more capital intensive techniques relative to labor intensive ones

- in order to increase the profit that the firm is allowed to earn up to an extent that lets the ratio profit/capital unchanged.

- Said differently, by investing in additional capital the firm may increase the base to which the ceiling on the rate of return is applied

- resulting in a greater total remuneration for capital.

- There is then an excessive amount of investment.

- This well-known argument is due originally to Averch and Johnson (AER, 1962).

Result

Privatization of public enterprises can affect investment in an ambiguous way.

Intuition

On the one side, public enterprises may have stronger ability to foreclose entry to competitors than private enterprises.

- *See Sappington and Sidak (2003).*

Intuition

On the other side, public enterprises may have stronger incentives to invest than private firms because of a political mandate imposed on them.

- E.g., as part of the conduct of a Keynesian policy, the government may ask public companies to invest in major works to reduce unemployment.

- E.g., Public firms may also be heavy investors because of their managers' incentives to behave as empire builders.

- Therefore, one may have overinvestment in public enterprises.

- In order to disentangle the multifaceted effects of privatization, Alesina et al. (2005) offers an empirical study that allows to measure whether the increase of private investment more than compensates the possible fall of investment in privatized enterprises.
- They construct time-series indicators of overall regulation, barriers to entry and public ownership
  - from 1975 to 1998 ;
  - in 21 OECD countries;
  - for 7 nonmanufacturing industries:
    - ⋆ electricity and gas supply;
    - ⋆ road freight, air passenger transport, and rail transport; and
    - ⋆ post and telecommunications (fixed and mobile).

Result

Privatization exercises a positive effect on investment.

- This suggests that the reduction of barriers to entry for private firms associated with privatization more than compensates the reduced importance of potential overinvestment problems due to managerial incentives.

- Excessive R&D incentivized by IP protection.
  - Patent races may lead to duplication of efforts and socially wasteful outcomes.
- R&D with uncertainty about invention success.

Socially Excessive R&D in Patent Race

Patent Race Model

- Two firms contemplate fixed R&D cost (f) for new product development.
- Probability of success (p) translates into monopoly or duopoly profit.
  - No R&D: Firm earns zero profit.
  - R&D Investment:
    - ⋆ R&D alone: Monopoly profit ($\pi^m - f$) with probability p;
    - ⋆ R&D with Rival: Monopoly profit ($\pi^m - f$) with probability $p(1-p)$, or duopoly profit ($\pi^d - f$) with probability p^2.

$1\backslash 2$	R&D	No R&D
R&D	$p^2\pi^d + p(1-p)\pi^m - f; idem$	$p\pi^m - f; 0$
No R&D	$0; p\pi^m - f$	$0; 0$

$1 \backslash 2$	R&D	No R&D
R&D	$p^2\pi^d + p(1-p)\pi^m - f; idem$	$p\pi^m - f; 0$
No R&D	$0; p\pi^m - f$	$0; 0$

- Both firms conducting R&D is a Nash equilibrium if:

$$f \leq p^2\pi^d + p(1-p)\pi^m \equiv f_2^{priv}$$

- From a public policy perspective, welfare can be measured by summing of firms' profits and consumer surplus.
  - Let $W^m = \pi^m + CS^m$ (resp. $W^d = 2\pi^d + CS^d$) denote the welfare in the monopoly (resp. duopoly) case.
  - In general, consumers are better off if the marketplace is more competitive: $CS^d > CS^m$.

- From society's point of view, it is optimal to have one research division rather than two if:

$$pW^m - f \geq p^2W^d + 2p(1-p)W^m - 2f$$

  - RHS: expected welfare if two divisions are active.
    - with probability p^2, both divisions are successful and a duopoly situation ensues;
    - with total probability $2p(1-p)$, only one division is successful and a monopoly situation ensues;
    - in any case, the fixed cost f is paid twice.

Socially Excessive R&D in Patent Race
Patent Race Analysis

- This condition rewrites as

$$f \geq p^2 W^d + p(1-2p)W^m \equiv f_1^{pub}$$

- Private (equilibrium) decision leads to (socially) excessive R&D when

$$f_1^{pub} \leq f \leq f_2^{priv}$$

- The condition $f_1^{pub} < f_2^{priv}$ rewrites as

$$p^2\left(\pi^m - \pi^d\right) > p^2\left(CS^d - CS^m\right) + p(1-p)CS^m$$

  - LHS: negative externality that a firm exerts on its rival when their R&D investments are successful.
    - with probability p^2: profit is reduced from π^m to π^d.
    - As this negative effect is ignored by firms but matters for society, it can lead firms to **overinvest**.

- $$p^2\left(\pi^m - \pi^d\right) > p^2\left(CS^d - CS^m\right) + p(1-p)CS^m$$
  - RHS: positive externality that a firm exerts on consumer surplus when the other firm also invests
    - with probability p^2, the other firm is successful, so welfare increases from CS^m to CS^d
    - with probability $p(1-p)$, the other firm is not successful, so welfare increases from 0 to CS^m.
    - such an opposite force may lead firms to **underinvest**.

Socially Excessive R&D in Patent Race
Patent Race Analysis

- Overall effect depends on whether the negative externality on competitor is larger than the positive externality on consumer surplus.

Lesson

Imperfectly competitive firms tend to overinvest in R&D when their investment decreases the other firms' profit more than it increases consumer surplus.

Socially Excessive R&D in Patent Race
Conclusion

- Imperfectly competitive firms tend to overinvest in R&D when negative externality on rivals' profit outweighs positive impact on consumer surplus.
- Balancing private incentives with social welfare remains crucial in patent races to avoid excessive R&D and ensure optimal outcomes.

R&D spillovers
Outline

R&D spillovers
Introduction

- In many innovative environments ideas are common knowledge rather than scarce.
  - E.g., in automobile industry, new models are continually being developed.
    - All firms in the industry have the simultaneous opportunity to achieve competing innovations.
- R&D exhibits many of the attributes of a public good.
  - R&D by one firm typically leads to spillovers which benefit other firms.

Brander, J. A., & Spencer, B. J. (1983). Strategic commitment with R&D: the symmetric case. *The Bell Journal of Economics*, 225-235.

Okuno-Fujiwara, M., and K. Suzumura, 1990. “Strategic Cost-Reduction Investment and Economic Welfare,” Discussion Paper Series

Spence, M. 1984. “Cost Reduction, Competition, and Industry Performance,” *Econometrica*, vol. 52(1), pages 101-21.

- We consider an industry of two symmetric firms which compete in a two-stage game.
  - Initially, both firms have the same marginal cost $c > 0$.
  - At the first stage, firms simultaneously conduct process R&D.
    - This allows them to reduce their individual marginal cost.
  - At the second stage, firms compete in quantity or price.
    - Both types of competition, Bertrand and Cournot, are analysed.

R&D spillovers
Model

- More precisely, at the first stage, each firm $i \in \{1, 2\}$ chooses an amount x_i by which it reduces his marginal cost.
  - $c_i\left(x_1, x_2\right) = c - x_i - \beta x_j$, where $\beta \in [0; 1]$ is the spillover coefficient.
    - ⋆ $\beta = 0$: R&D is a private good that benefits only the firm undertaking them;
    - ⋆ $\beta = 1$: R&D is a pure public good as a firm fully benefits from its rival's R&D.

- The associated expenditure is $r\left(x_i\right)$.
  - To avoid $c_i\left(x_1, x_2\right) < 0$, we assume marginal cost can at most be individually reduced by a half.
    - e.g., $x_i < \frac{c}{2}$; or
    - R&D activities exhibit decreasing returns to scale $r' > 0$, and $r'' > 0$ with $\lim_{x_i \to \frac{c}{2}} r\left(x_i\right) = +\infty$.

- At the second stage, upon observing (x_1, x_2), firms compete by choosing σ_i.
  - Under quantity (resp. price) competition, we have $\sigma_i = q_i$ (resp. $\sigma_i = p_i$).

- Firm i's profits write as

$$\tilde{\pi}_i = \pi_i \left(c_i \left(x_1, x_2 \right), \sigma_i, \sigma_j \right) - r \left(x_i \right)$$

where π_i denotes the firm i's net revenue from production and sales.

- We assume the second-order condition is satisfied: $\frac{\partial^2 \pi_i}{\partial \sigma_i^2} < 0$.
  - So, that F.O.C. ($\frac{\partial \pi_i}{\partial \sigma_i} = 0$) sufficies to maximize profit.
  - We obtain a unique Nash equilibrium at the second period, which we denote $\left(\sigma_1^* \left(x_1, x_2 \right), \sigma_2^* \left(x_1, x_2 \right) \right)$.

- We assume quantity (resp. price) competition yields to strategic (resp. complement) substitutes:

$$\frac{\partial^2 \pi_i}{\partial \sigma_i \partial \sigma_j} = \frac{\partial^2 \pi_j}{\partial \sigma_i \partial \sigma_j} \begin{cases} < 0 \text{ when } \sigma_i = q_i \\ > 0 \text{ when } \sigma_i = p_i \end{cases}$$

- At the first period, firm i chooses x_i to maximize its first-stage profit:

$$\tilde{\pi}_i\left(x_i, x_j\right) = \pi_i\left(c_i\left(x_i, x_j\right), \sigma_i^*\left(x_1, x_2\right), \sigma_j^*\left(x_1, x_2\right)\right) - r\left(x_i\right)$$

- F.O.C. for profit maximization is given by $\frac{d\tilde{\pi}_i}{dx_i} = 0$, which is equivalent to

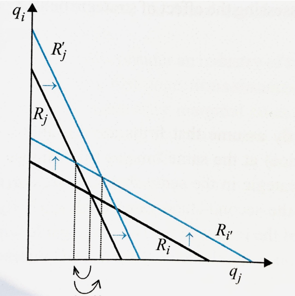
$$\frac{\partial \pi_i}{\partial c_i}\frac{\partial c_i}{\partial x_i} + \frac{\partial \pi_i}{\partial \sigma_i}\frac{\partial \sigma_i^*}{\partial x_i} + \frac{\partial \pi_i}{\partial \sigma_j}\frac{d\sigma_j^*}{dx_i} = r'(x_i)$$

  - $\frac{\partial \pi_i}{\partial c_i}\frac{\partial c_i}{\partial x_i}$: direct or "cost-minimizing" effect (x_i reduces c_i).
  - $\frac{\partial \pi_i}{\partial \sigma_i}\frac{\partial \sigma_i^*}{\partial x_i} = 0$ by the envelope theorem (since σ_i^* is chosen so that $\frac{\partial \pi_i}{\partial \sigma_i} = 0$).

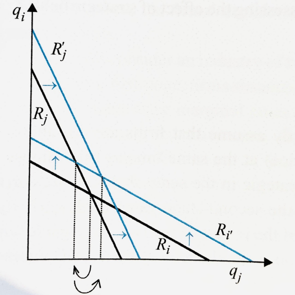
$$\frac{\partial \pi_i}{\partial c_i}\frac{\partial c_i}{\partial x_i} + \frac{\partial \pi_i}{\partial \sigma_i}\frac{\partial \sigma_i^*}{\partial x_i} + \frac{\partial \pi_i}{\partial \sigma_j}\frac{d\sigma_j^*}{dx_i} = r'(x_i)$$

- $\frac{\partial \pi_i}{\partial \sigma_j}\frac{d\sigma_j^*}{dx_i}$: strategic effect
  - It results from the combined influence of firm *i*'s investment on firm *j*'s second-stage action ($\frac{d\sigma_j^*}{dx_i}$) and of firm *j*'s action on firm *i*'s profit ($\frac{\partial \pi_i}{\partial \sigma_j}$).

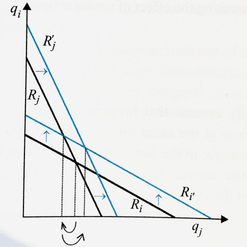
- Strategic substituability implies downward-sloping reaction functions:



- An increase in x_i allows firm i to move its reaction function to the right (from R_i to R_i').
  - Because firm i has a lower marginal cost, it reacts to any firm j's quantity by producing a larger quantity than before.



- In the absence of spillovers ($\beta = 0$), the analysis stops here.
    - Firm j's reaction function does not move and the new equilibrium is such that firm j produces a lower quantity as a result of the increase in x_i.



- However, for $\beta > 0$, firm *i*'s R&D investment also reduces firm *j*'s marginal cost.
  - This shifts firm *j*'s reaction function to the right (from R_j to R_j').
  - If firm *j*'s reaction function moves sufficiently outwards (i.e., if spillovers are large enough), the new equilibrium is such that firm *j* produces a larger quantity than before.

R&D spillovers
Quantity competition

- There exists thus a threshold value on the spillover parameter $\bar{\beta}$ around which the sign of the strategic effect changes.
  - If $\sigma_i = q_i$, then $\frac{d\sigma_j^*}{dx_i} < 0$ for $\beta < \bar{\beta}$ and $\frac{d\sigma_j^*}{dx_i} > 0$ for $\beta > \bar{\beta}$.

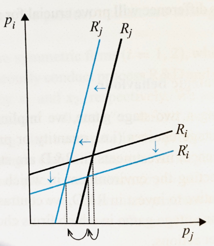
Lesson

Under quantity competition, the strategic effect of an increase in the R&D of one firm on its own profit is:

– positive for small spillovers ($\beta < \bar{\beta}$); and

– negative for large spillovers ($\beta > \bar{\beta}$).

- Strategic complementarity implies upward-sloping reaction functions:



- An increase in x_i shifts firm i's reaction function down (from R_i to R'_i).
- In the absence of spillovers ($\beta = 0$), the analysis stops here.
- However, for $\beta > 0$, firm i's R&D investment also reduces firm j's marginal cost.
  - By also reducing c_j, the increase in x_i shifts firm j's reaction function

- Hence,
  - if $\sigma_i = p_i$, then $\frac{d\sigma_j^*}{dx_i} < 0$ for all values of β.

Lesson

Under price competition, the strategic effect of an increase in the R&D of one firm on its own profit is always negative.

R&D spillovers
Conclusion

- An increase in its R&D expenditure makes the firm a tougher competitor.
- From a strategic point of view, it is then worth only if tough behaviour is met by a soft response of the rival firm.
  - This is only the case under quantity competition, provided that spillovers are small enough ($\beta < \bar{\beta}$)
- On the contrary, if the rival reacts toughly, both firm become tougher competitors.
  - This is the case under price competition, and under quantity competition with strong spillovers ($\beta > \bar{\beta}$)
    - Strategic firms choose optimally to invest less in R&D than they would do were they only motivated by cost minimization.

Outline

- Firms often cooperate in their choice of R&D levels to:
  - mitigate risks
    - pooling resources and expertise to spread uncertainties of R&D across multiple parties.
  - access to complementary resources
    - resources (expertise, knowledge, technology) owned by competitors
  - achieve cost efficiencies
    - economies of scale and scope
  - accelerate innovation
    - leveraging the collective knowledge and expertise of multiple firms.
  - reduce time to market and enhance market positioning.

R&D cooperation
Examples

In 2010, Toyota and Tesla collaboration agreement where:

- Tesla supply battery packs and powertrains for Toyota's electric vehicles
- Toyota provide engineering and manufacturing support to Tesla.

R&D cooperation
Examples

In 2020, R&D cooperation between Pfizer (leading pharmaceutical company) and BioNTech (German biotechnology company specializing in mRNA technology).

They shared scientific knowledge, research resources, and manufacturing capabilities to develop the Pfizer-BioNTech COVID-19 vaccine.

R&D cooperation
Model

- d'Aspremont, C., and A. Jacquemin (1988): "Cooperative and noncooperative R&D in duopoly with spillovers." *American Economic Review,* 78.5: 1133-1137.
- Leahy, D., & Neary, J. P. (1997): "Public Policy Towards R&D in Oligopolistic Industries." *American Economic Review,* 87(4), 642–662.
- Suppose now that firms cooperate in their choice of R&D levels
  - At the first stage, firms choose R&D to maximize joint profits.
  - At the second stage, firms compete in quantity or price.

- F.O.C. for joint profit maximization in the first stage is given by $\frac{d\left(\tilde{\pi}_i+\tilde{\pi}_j\right)}{dx_i} = 0$, which is equivalent to

$$\frac{\partial \pi_i}{\partial c_i}\frac{\partial c_i}{\partial x_i} + \frac{\partial \pi_i}{\partial \sigma_i}\frac{\partial \sigma_i^*}{\partial x_i} + \frac{\partial \pi_i}{\partial \sigma_j}\frac{d\sigma_j^*}{dx_i} + \frac{\partial \pi_j}{\partial c_j}\frac{\partial c_j}{\partial x_i} + \frac{\partial \pi_j}{\partial \sigma_i}\frac{d\sigma_i^*}{dx_i} + \frac{\partial \pi_j}{\partial \sigma_j}\frac{\partial \sigma_j^*}{\partial x_i} = r'(x_i)$$

  - $\frac{\partial \pi_i}{\partial c_i}\frac{\partial c_i}{\partial x_i}$: direct effect ($x_i$ reduces c_i)
  - $\frac{\partial \pi_i}{\partial \sigma_i}\frac{\partial \sigma_i^*}{\partial x_i} = \frac{\partial \pi_j}{\partial \sigma_j}\frac{\partial \sigma_j^*}{\partial x_i} = 0$ by the envelope theorem (since σ_i^* and σ_j^* are chosen so that $\frac{\partial \pi_i}{\partial \sigma_i} = \frac{\partial \pi_j}{\partial \sigma_j} = 0$).
  - $\frac{\partial \pi_i}{\partial \sigma_j}\frac{d\sigma_j^*}{dx_i}$: strategic effect 1

$$\frac{\partial \pi_i}{\partial c_i}\frac{\partial c_i}{\partial x_i}+\frac{\partial \pi_i}{\partial \sigma_i}\frac{\partial \sigma_i^*}{\partial x_i}+\frac{\partial \pi_i}{\partial \sigma_j}\frac{d \sigma_j^*}{d x_i}+\frac{\partial \pi_j}{\partial c_j}\frac{\partial c_j}{\partial x_i}+\frac{\partial \pi_j}{\partial \sigma_i}\frac{d \sigma_i^*}{d x_i}+\frac{\partial \pi_j}{\partial \sigma_j}\frac{\partial \sigma_j^*}{\partial x_i}=r'(x_i)$$

- $\frac{\partial \pi_j}{\partial \sigma_i}\frac{d \sigma_i^*}{d x_i}$: strategic effect 2
  - a change in x_i modifies firm i's second-stage action, which in turn affects firm j's profits.
  - this strategic effect is negative whatever the nature of competition:
    - by investing more in R&D, firm i gains a competitive advantage over its rival;
    - that is, firm i is able to produce more or to set a lower price in the second stage, which hurts firm j.
  - this negative strategic effect weakens when spillovers get stronger (since the competitors' efficiency is also enhanced).

$$\frac{\partial \pi_i}{\partial c_i}\frac{\partial c_i}{\partial x_i}+\frac{\partial \pi_i}{\partial \sigma_i}\frac{\partial \sigma_i^*}{\partial x_i}+\frac{\partial \pi_i}{\partial \sigma_j}\frac{d\sigma_j^*}{dx_i}+\frac{\partial \pi_j}{\partial c_j}\frac{\partial c_j}{\partial x_i}+\frac{\partial \pi_j}{\partial \sigma_i}\frac{d\sigma_i^*}{dx_i}+\frac{\partial \pi_j}{\partial \sigma_j}\frac{\partial \sigma_j^*}{\partial x_i}=r'(x_i)$$

- $\frac{\partial \pi_j}{\partial c_j}\frac{\partial c_j}{\partial x_i}$: spillover effect
  - an increase in x_i affects directly firm j's profit by decreasing its marginal cost.
  - this positive spillover effect increases with β.

- In sum, R&D activities in the presence of spillovers create two types of externality.
  - The first externality (strategic effect 2: $\frac{\partial \pi_j}{\partial \sigma_i} \frac{d\sigma_i^*}{dx_i}$) is negative
    - ⋆ It affects a firm's competitive advantage with respect to its rival
    - ⋆ Firms invest in R&D to become relatively more efficient than their competitors.
    - ⋆ This externality decreases with the level of spillovers β.

- The second externality (spillover effect: $\frac{\partial \pi_j}{\partial c_j}\frac{\partial c_j}{\partial x_i}$) is positive
  - It affects overall industry profits.
  - There is a temptation to free-ride on the other firm's effort.
  - This externality increases with the level of spillovers β.
- Both externalities are ignored when firms choose their R&D levels separately but are internalized when they act cooperatively.

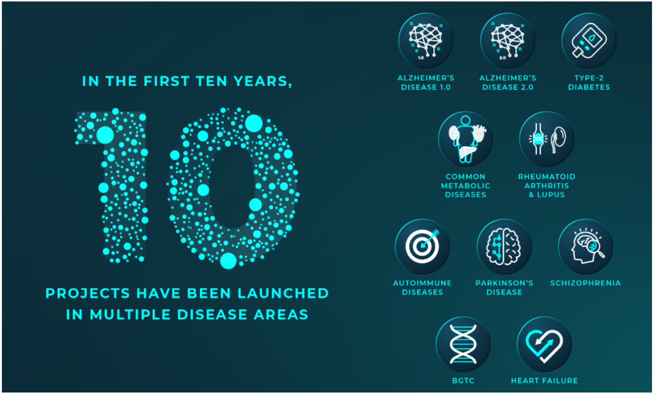
- Hence, there exists a pivotal spillover rate $\hat{\beta}$ above which the total effect of the two externalities is positive.
  - If spillovers are large enough ($\beta > \hat{\beta}$), the competitive advantage motivation for investing in R&D is weak, whereas the temptation to free-ride on the other firm's effort is high.
  - By internalizing these externalities, cooperation leads to larger investments in R&D, implying further reductions in unit costs and a larger output.

Lesson

- When firms behave strategically, R&D cooperation leads to:
  - more R&D when spillovers are large
    - $\beta > \hat{\beta}$: total effect of the two externalities is positive
  - less R&D when spillovers are small
    - $\beta < \hat{\beta}$: total effect of the two externalities is negative.

- The previous mode of R&D cooperation is called a **R&D cartel**.
- In practice, firms can also share their R&D information completely, so as to eliminate duplication of effort.
- Such a R&D cartel is called a **research joint venture** (RJV).
  - This corresponds to the case $\beta = 1$.

R&D cooperation
Research joint venture: Examples



Accelerating Medicines Partnership® program is a precompetitive partnership among US government, industry, and nonprofit organizations to develop new drugs. (Launched in 2014.)

R&D cooperation
Research joint venture: Examples

SEMATECH (SEMiconductor MAnufacturing TECHnology) is a U.S. consortium that performs R&D to advance chip manufacturing (started in 1987)

- Cooperation becomes then more attractive from a welfare point of view.
  - It can be shown[2] that a cartelized RJV yields a superior performance compared with a non-cooperative R&D in many criteria of interest:
    - propensity for R&D;
    - firms' profits;
    - consumer surplus; and thus
    - social welfare.

[2] See Amir, R., Evstigneev, I., & Wooders, J. (2003). Noncooperative versus cooperative R&D with endogenous spillover rates. *Games and Economic Behavior*, 42(2), 183-207.

- Many RJV members are rivals leaving open the possibility that firms may form RJVs to facilitate product market collusion.

Question

Do RJV serve a collusive function?

- Sovinsky (2022)[3] exploit the variation in RJV formation generated by a change in US antitrust policy that took place in 1993
  - The revision of the so-called 'leniency policy programme' made it more attractive for cartel members to report illegal behaviour, thereby making collusion harder to sustain (see Chapter 3).
  - She considers three industries:
    - petroleum manufacturing;
    - computer and electronic product manufacturing; and
    - telecommunications
  - that share two characteristics:
    - RJV participation is very high; and
    - there is a history of antitrust suits.

[3] See Sovinsky, M. "Do Research Joint Ventures Serve a Collusive Function?", *Journal of the European Economic Association*, Volume 20, Issue 1, February 2022, Pages 430–475

Question

Do RJV serve a collusive function?

Answer

- *Yes! The decision to join an RJV is impacted by the policy change in a very significant way.*
- *The revised leniency policy reduces the probability that firms join a given RJV by :*
  - *34% in telecom;*
  - *33% in computer and semiconductor manufacturers; and*
  - *27% in petroleum refining.*

- Public authorities should permit R&D cooperation among firms that compete in a product market.
- No direct action seems to be needed to encourage such cooperation as the firms' incentives for cooperation in R&D are clear.
  - Information sharing and coordination of R&D decisions yield higher profits
- Public authorities just need to provide the attending legal framework for such cooperative arrangements.

- This corresponds to what is currently done in the USA, the EU and Japan.
  - In USA, the National Cooperation Act passed in 1984 allows firms to cooperate in R&D provided they remain competitors on product markets.
  - In Europe, the EU Commission considerably extended the scope of the R&D Block Exemption Regulation in 2010 to allow for R&D activities carried out jointly
    - It also allow one party to finance the R&D carried out by another party.
    - Furthermore, public policies, such as the European Framework Programmes, explicitly encourage firms to pool their R&D activities.

- However, the antitrust authority should monitor firms to check that R&D cartels are not a disguised way to engage in collusive behavior.

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