Economics of Technical Change

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University of Teramo and Harvard University C.E.S.

Pescara, November 23 2020

Your attitude in this class

It goes without saying: you are PhD students, so: ask, cast doubts and criticisms on everything, participate, stop me if:

1. I am boring (or you are getting bored)
2. too much math or too little math
3. you'd like me to pursue a specific path
4. you are not with me or you wouldn't buy what I'm saying
5. you are lost (or I am)
6. you name it.

All that said, make yourself comfortable, feel free to take with you coffee, drinks, breakfast and whatever is not prohibited (by customs, moral, academic integrity) and does not annoy your colleagues.

My attitude in this class

1. I hate slides as a teaching device, so I shall not use them but for data
2. I am aware I have the deplorable tendency to run very fast and anyway faster than optimal, so: stop me whenever it's necessary (yell out loud if necessary). . . . I hate slides as they make me run faster than I would normally do.
3. I'll do my best to be useful and not deadly boring (our subject is however immensely fascinating, though, and that will help).

Lectures Plan

1. The neoclassical model, the Schumpeterian Model, IP
2. Technology's Role in Economic Growth
3. Technology and the Labor Market
4. ...

Today's plan

1. Super quick review section (math and economics fundamentals)
2. Orthodox (neoclassical) model of tech innovation
3. Schumpeterian model(s)
4. IP

What is this course about?

- Applying economic analysis to the understanding of the innovative process
  1. Determinants
  2. Consequences
  3. Market failure (are optimal resources devoted to innovation)
- Some key questions
  1. What drives innovation?
  2. How does intellectual property influence innovation?
  3. Which market structures yield more or better innovations?
  4. Why are some countries rich and some poor?
  5. Is economic regulation good or bad for innovation?

Classics

Shame on you if you don't read them
(at least one classic per year!)

- Smith (focus: division of labor, specialization, market extension)
- Ricardo (focus: embodyment in K, demand, employment)
- Marx (focus: codification, incentives). Must read: Fragment on Machines in the Grundrisse!

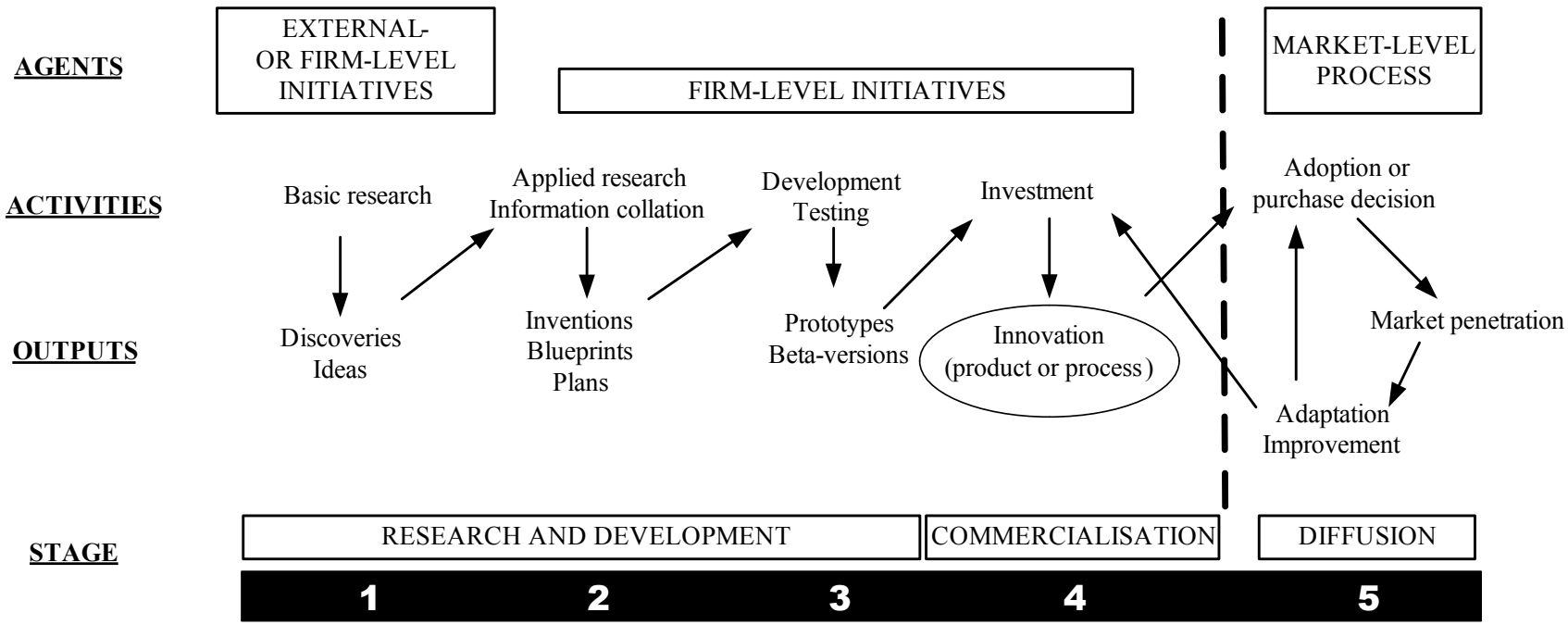
What is the Economics of Innovation?

- Microeconomics – understanding processes, including how incentives affect firms
- Macroeconomics – 'innovation' drives economic growth.. and economic growth drives living standards, environmental, political...
- Economic Policy – are there market failures in the innovation process and what, if anything, should the government do?
- Business Strategy – not really our business here :-)

Definition of innovation

- Basic definition: Introduction of new ideas that add value to a firm's activities
- OECD The Oslo Manual (1997, p.28)
  1. introduction of a new product or a qualitative change in an existing product
  2. process innovation new to an industry
  3. the opening of a new market
  4. development of new sources of supply for raw materials or other inputs
  5. changes in industrial organization

The innovation process



Invention, Innovation, Diffusion

- Invention: creation of an idea to do or make something (profitability not yet verified)
- Innovation: new product/ process commercially valuable i.e. successfully developed inventions.
- Diffusion: the spread of a new invention/innovation throughout society or at least throughout the relevant part of society.
  - Without this cannot gain full benefits
  - Some of this represents spillovers or positive externalities.

Product and Process Innovation

- Product innovations
  - product used by consumers:
  - e.g. Microwaves, computers, mobile phones, etc
  - Products used by firms:
  - e.g. Shipping containers, computers, robots, etc
- Process innovations
  - Used by consumers:
  - e.g. Fast food, air travel
  - Used by firms:
  - e.g. Assembly lines, software

Defining an Innovation

- Can be defined as new to
  - Firm
  - Market (industry)
  - World
- No universal agreement of which
- Radical vs incremental
  - Radical (steam, internal combustion engine, computers, internet)
  - Incremental (constant improvements)
  - Both important in driving economic growth

Innovation and Market Failure

- Innovation as a public good
  - Non-rival and non-excludable
- Externalities from innovative activity
  - R&D spillovers
- Indivisibilities, uncertainty, and capital markets
  - Fixed costs, uncertainties
  - Do capital markets cope with these?
- Patent races and duplication

Restoring Incentives to innovate

- Public provision of a public good
- Club provision of a local public good
- Pigouvian subsidies
- Definition of property rights
- The trade-off between incentives and monopoly power

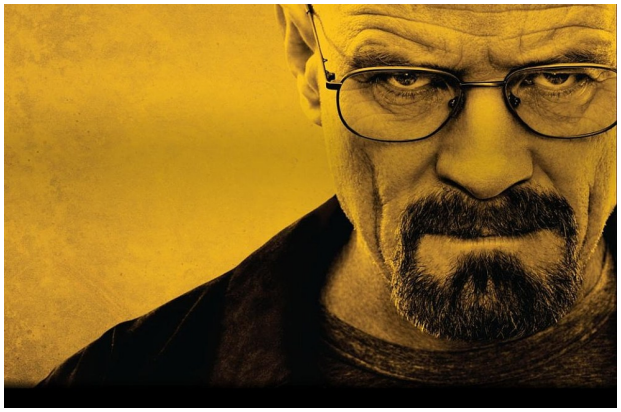
END OF THE INTRODUCTION: NOW WE GET GOING!

Back to blackboard

Incentive to innovate?

Pablo Emilio Escobar Gaviria (monopolist in the dope market)

Incentive to innovate?



Walter White aka Heisenberg (great innovator)

Wrap Up

- We investigated the relation between mkt structure and incentives to innovation
- First finding: competition is better than monopoly (replacement effect):
  - in competition, innovator appropriates a non-null profit starting from a null one;
  - under monopoly, the additional profit replaces a profit that the monopoly already got.

Motto: *In general, it is not the owner of stage-coaches that builds railways.* (J. Schumpeter).

Wrap Up

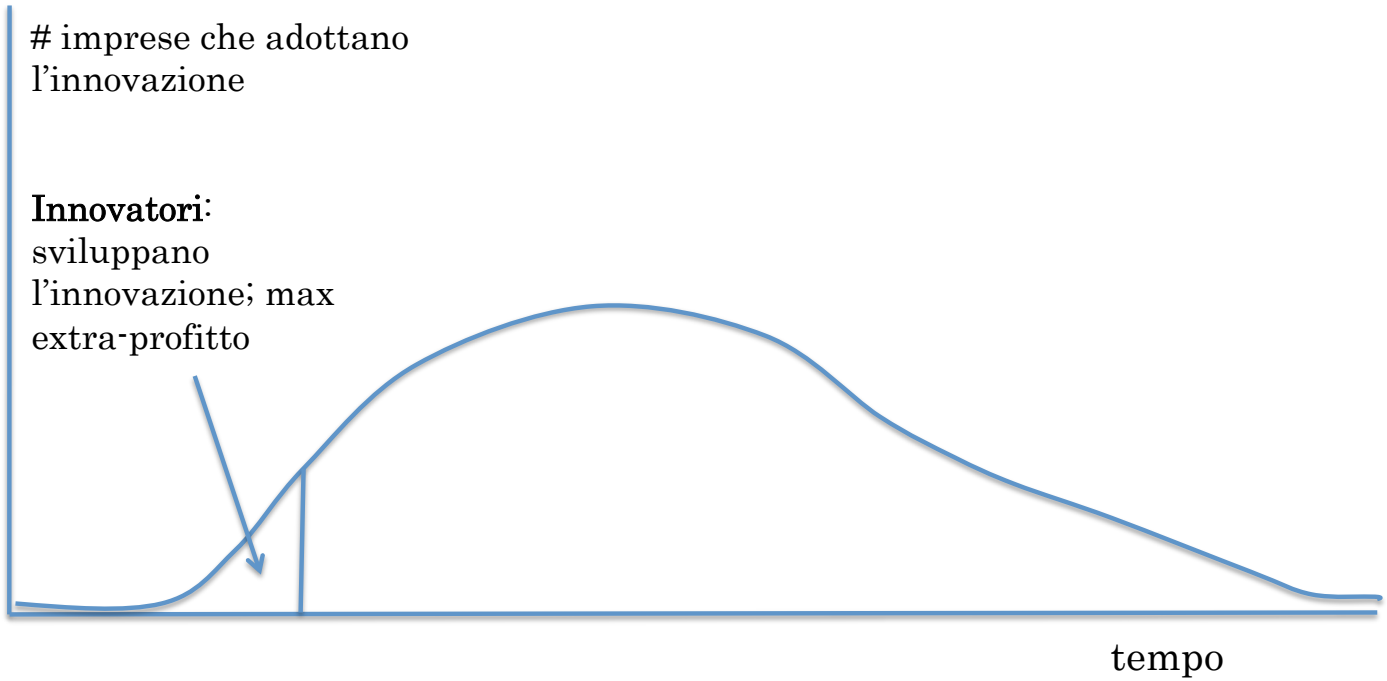
- A monopolist might have a higher incentive to innovate if (s)he is threatened by a possible entrant
- Efficiency effect: incentive to innovate deriving from the desire to hold to monopoly profits.
- Non drastic innovation (i.e. 2 firms in the mkt ex-post)
  - entrant expects a duopoly profit which is smaller than monopoly's
  - incumbent has a greater incentive (i.e. the difference between monopoly's and duopoly's profits).
- Drastic Innovation (1 firm in the mkt ex-post)
  - for both firms the incentive is given by monopoly profit ex-post
  - however, for the incumbent replacement effect holds true!!!!!

Want a proof? Meet the X-Box!

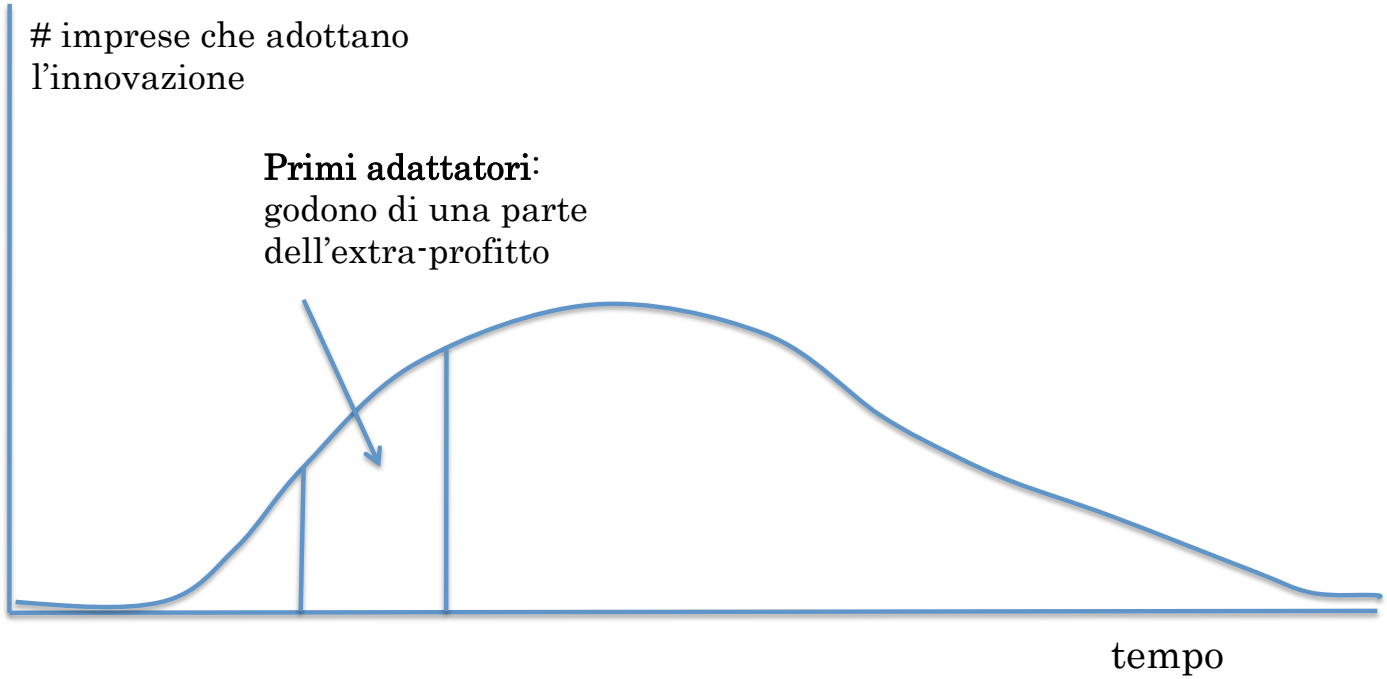
It is surely no coincidence that Microsoft's hidden ability to innovate has become apparent only in a market in which it is the underdog and faces fierce competition. Microsoft is far less innovative in its core businesses, in which it has a monopoly (in Windows) and a near monopoly (in Office).

("The meaning of XBox" *The Economist*, November 24, 2005)

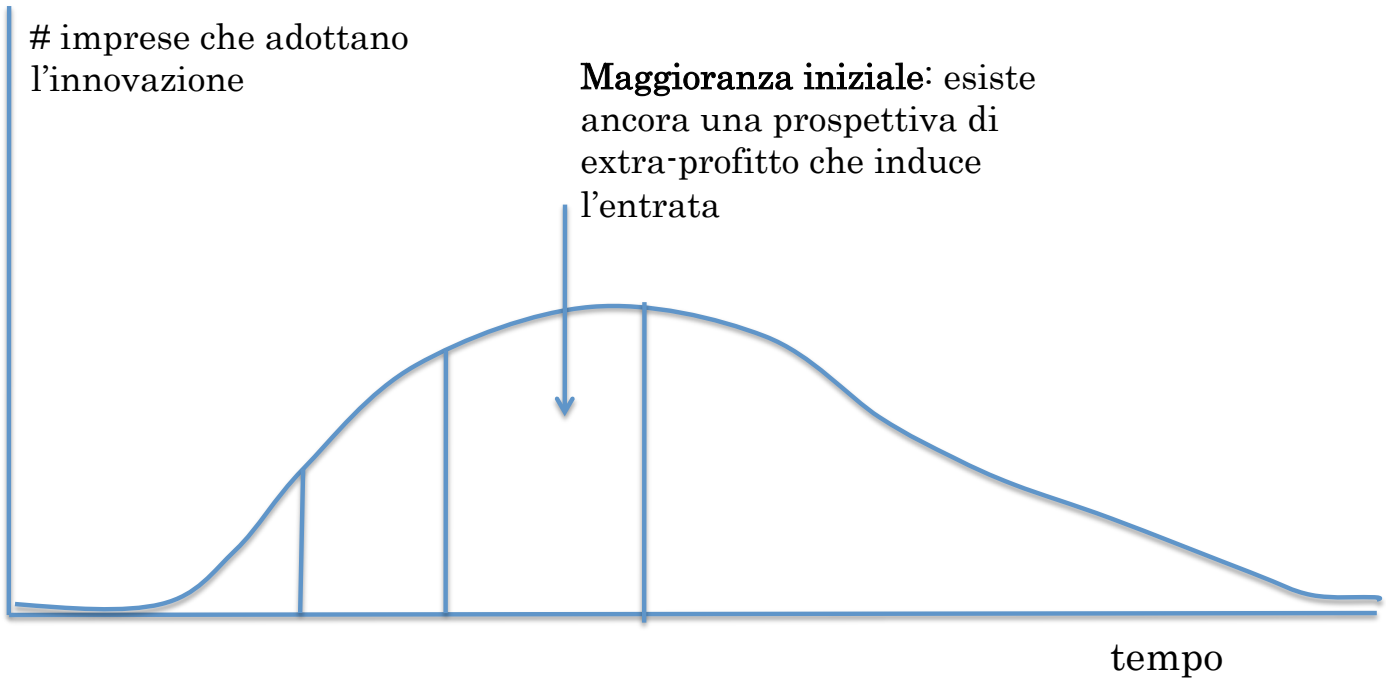
Diffusion


imprese che adottano l'innovazione
Innovatori: sviluppano l'innovazione; max extra-profitto
tempo

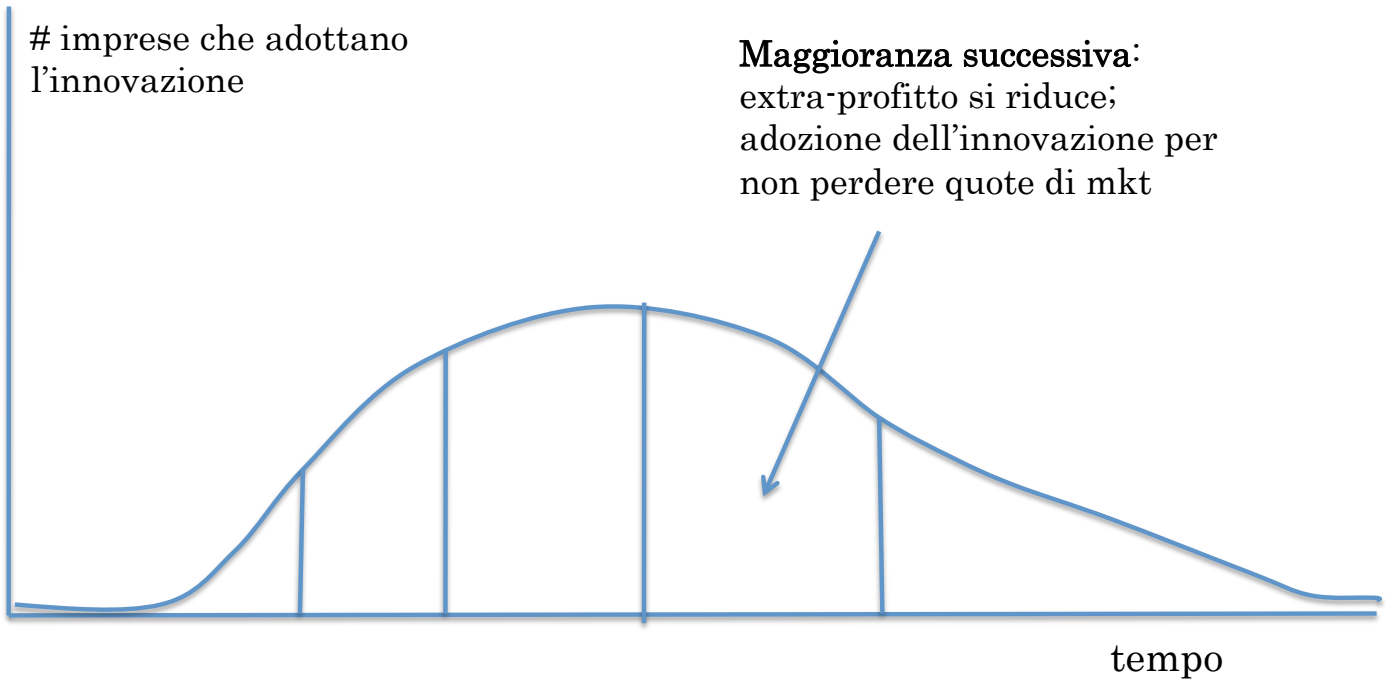
Diffusion


imprese che adottano l'innovazione
Primi adattatori: godono di una parte dell'extra-profitto
tempo

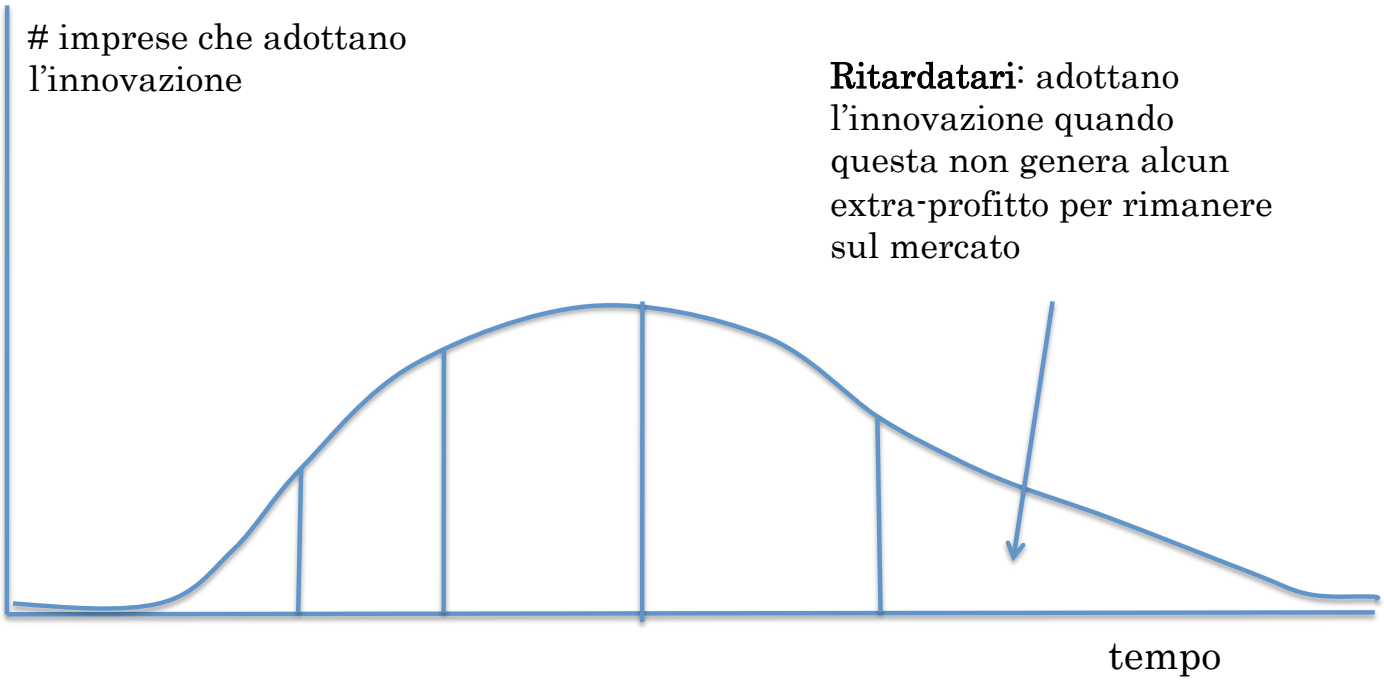
Diffusion


imprese che adottano l'innovazione
Maggioranza iniziale: esiste ancora una prospettiva di extra-profitto che induce l'entrata
tempo

Diffusion


imprese che adottano l'innovazione
Maggioranza successiva: extra-profitto si riduce; adozione dell'innovazione per non perdere quote di mkt
tempo

Diffusion


imprese che adottano l'innovazione
Ritardatari: adottano l'innovazione quando questa non genera alcun extra-profitto per rimanere sul mercato
tempo

Intellectual Property: Institutions

Some Institutional Issues:

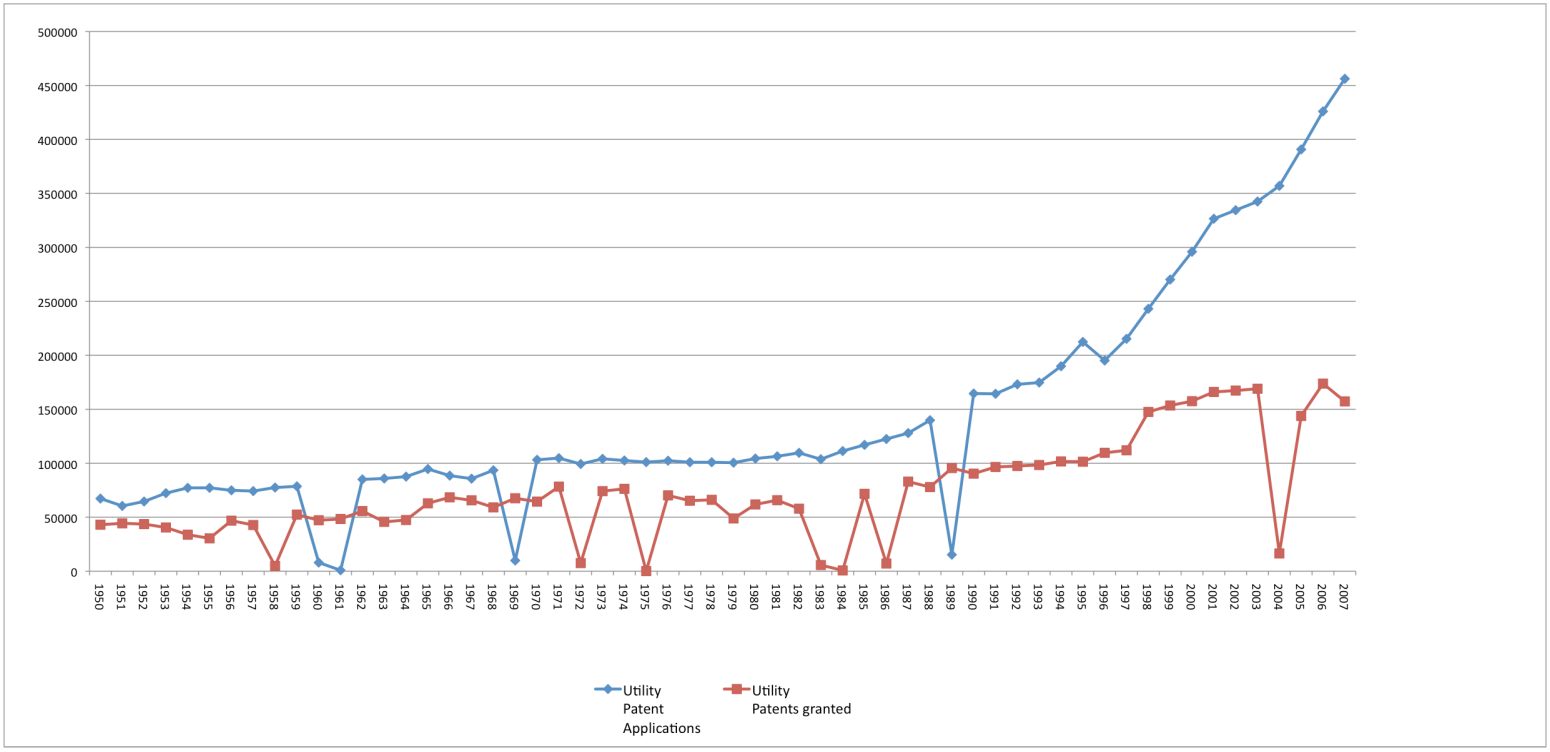
- 1982: creation of the CAFC (strongly pro-patent, more likely to get patents, more value to patents)
- Change of orientation of U.S. Department of Justice
- Lobbying (big Pharma, show-biz, electronics)
- 1980: Bay-Dole Act: patent federally funded research
-

Intellectual Property: Institutions

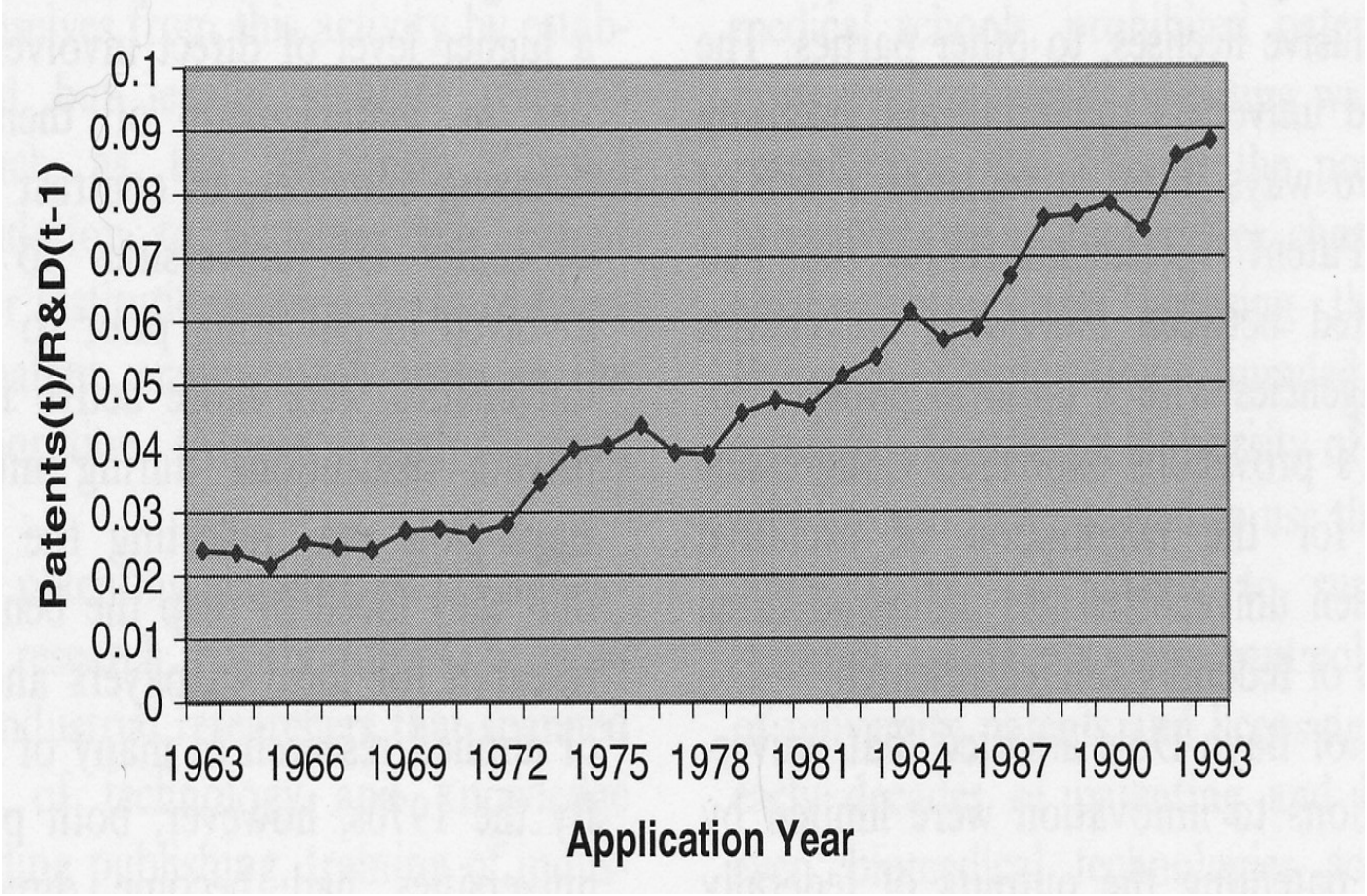
TRIPS (1994): Trade Related Aspects of Intellectual Property Rights:

- Uruguay Round
- New links between commercial and trade policies and IP protection
- Fixation of minimum standards of protection
- Enhancing of global enforcement

Patent Surge



Patent Surge: University Patents



An old (wise) quote

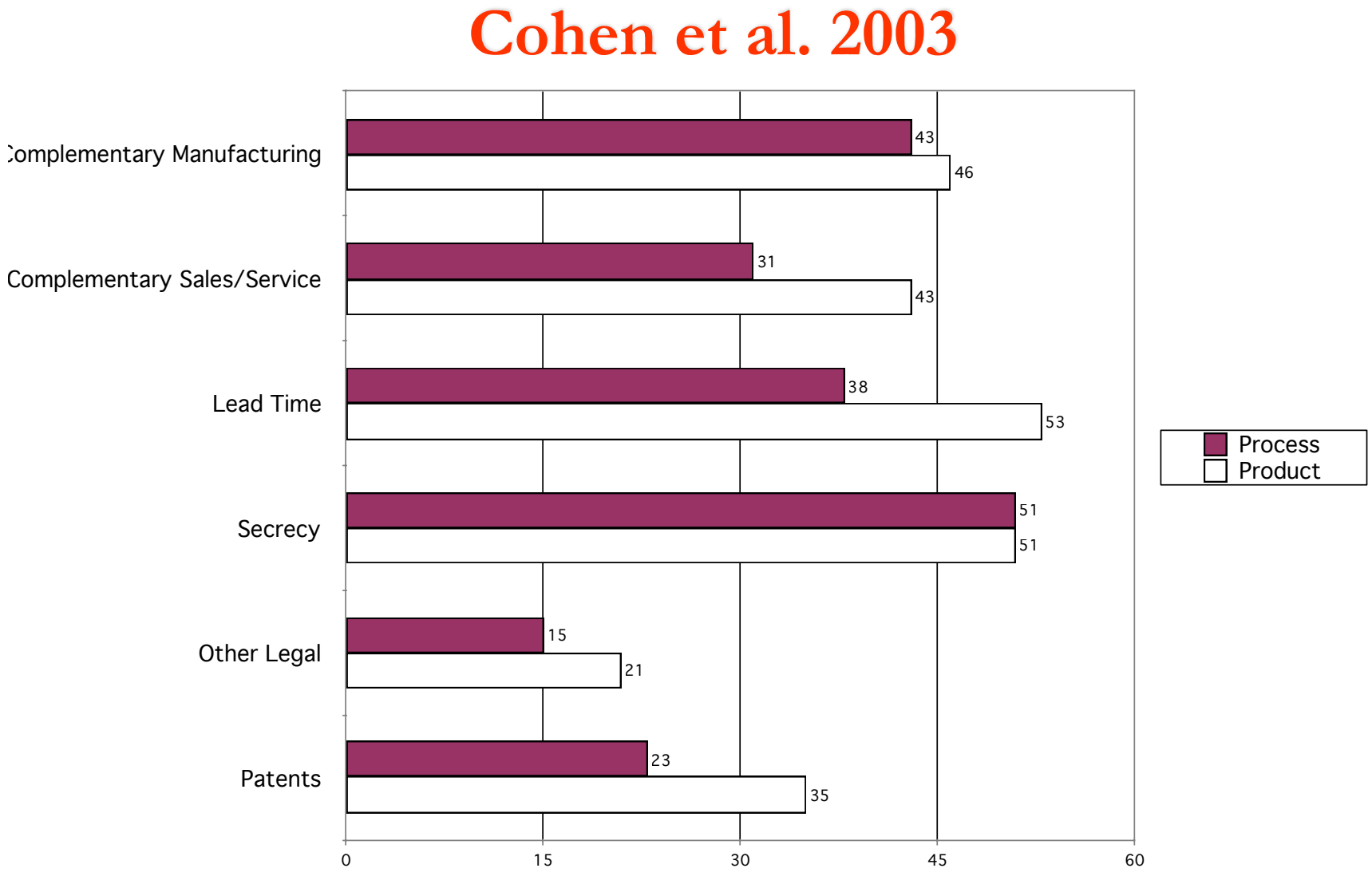
If we did not have a patent system, it would be irresponsible, on the basis of our present knowledge of its economic consequences, to recommend instituting one. But since we have had a patent system for a long time, it would be irresponsible, on the basis of our present knowledge, to recommend abolishing it.

Machlup (1958)

Petra Moser (2003)

- No evidence that countries with stronger IP protection produced more innovations than those with weaker IP protection.
- Strong evidence of the influence of IP law on sectorial distribution of innovation:
  - I.e. in strong IP countries people do innovate in those sectors in which IP is the most relevant protection form
  - In weak IP countries people do innovate in sectors in which other forms are used (secrecy, lead time?)

Cohen et al. the Yale Report I

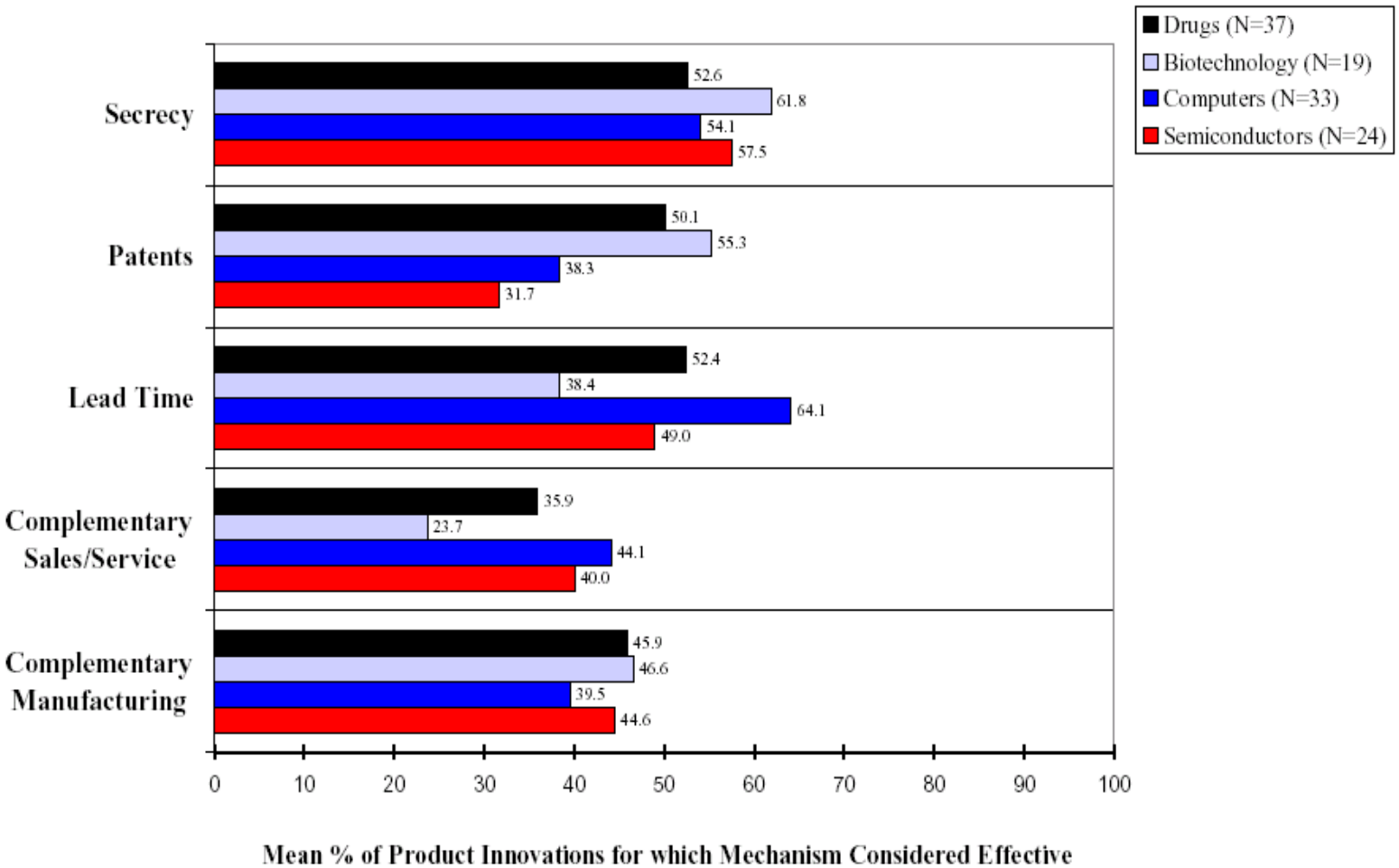


Strasbourg March 2006

Mean % of Product/Process Innovations for Which Mechanism Considered "Effective"

Cohen et al. the Yale Report II

Cohen et al. (2003)



Complex products I

- Complex products are those made of many different components whose production typically involves different underlying bodies of technological knowledge.
- Most artifacts in electronic, computer, ICT, automotive, aerospace, software industries belong to this category.
- Complex products, because of their multi-components and multi-technology nature, tend to involve multiple patents belonging to many different companies determining what has been called the "tragedy of the anti-commons" (i.e. a way too thin partitioning of property rights) (Eisenberg and Coase again).

Complex Products II

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- The presence of many property rights insisting on complementary components may hinder innovation and, in particular, systemic innovation which involves many components and modules.
- These industries are often characterized by fast radical innovation in the initial stages under weak IPR protection, whereas patents assume a prominent role in the firms' competitive strategy in later and less innovative stages.

Complex Products III

- A huge (and fast growing) literature:
  1. recognizes that in complex technologies, patents are a mainly defensive activity used to prevent hold-up and to acquire a stronger bargaining position.
  2. underlines the need of adopting a sectoral stance as to the evaluation of questionable behavior involving patents, they suggest that competition authorities should be given the possibility of reducing the scope of individual exclusion rights,
  3. observes the increasing importance of licensing agreements in complex technologies where patent thickets only can be unravelled with the help of licensing contracts.

Evidence

- It is robustly documented how a wide variety of industries while having been among the most innovative ones in the last forty years, have historically worked under a weak patent protection regime and experienced a rapid imitation and profit reaping of their innovative efforts and investments.

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- After a robust strengthening of patent protection in the 80's, the same cohorts of industries "far from unleashing a flurry of new innovative activity, went through a period in which R&D spending leveled off and innovation rates declined in the most patent-intensive industries and firms" (Bessen & Maskin 4014).

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- In such industries (i.e. innovative activities are characterized by a relevant degree of sequentiality and complementarity) imitation might be promoting innovation while strong patents might inhibit it.

Hypotheses

- It might well happen that firms would be better off in an environment characterized by easy imitation. Imitation would indeed reduce current profits but it could also raise the probability of further profitable innovations to be realized.

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- It might well happen that firms would be better off in an environment characterized by easy imitation. Imitation would indeed reduce current profits but it could also raise the probability of further profitable innovations to be realized.
- In addition, the generation of streams of diversified and complementary products, obtained by combinations of innovation and imitation, often increases the overall size of the market, increasing profit opportunities for early innovators.

Our model I

- We develop a model of product innovation and industry evolution in complex product industries showing that strong patent regimes are likely to hinder rather than foster innovation.

Our model II

- Such outcomes are driven by two major properties of technologies and markets for complex products:
  1. First, both innovative and imitative search are costly and difficult, with complementarities and interdependencies among components putting heavy constraints on possible search paths. If many of these possible paths are blocked by pending patents, very few opportunities for further innovation might be left open.
  2. Second, competition in these complex product spaces typically proceeds through the creation of sub-markets: demand is heterogeneous and firms can diversify products by offering different combinations of components and characteristics.
- Competition is not a winner-takes-all process, but is mainly a never ending creation of new sub-markets.

Our model III

- We represent products as systems composed of a number of discrete components.
- We then endow the products' space with a metric structure that allows us to compare two products and identify their degree of diversity.
- We define a notion of "patent coarseness" (possibility of establishing IPRs on entire products, on products' sets of components or on single components).

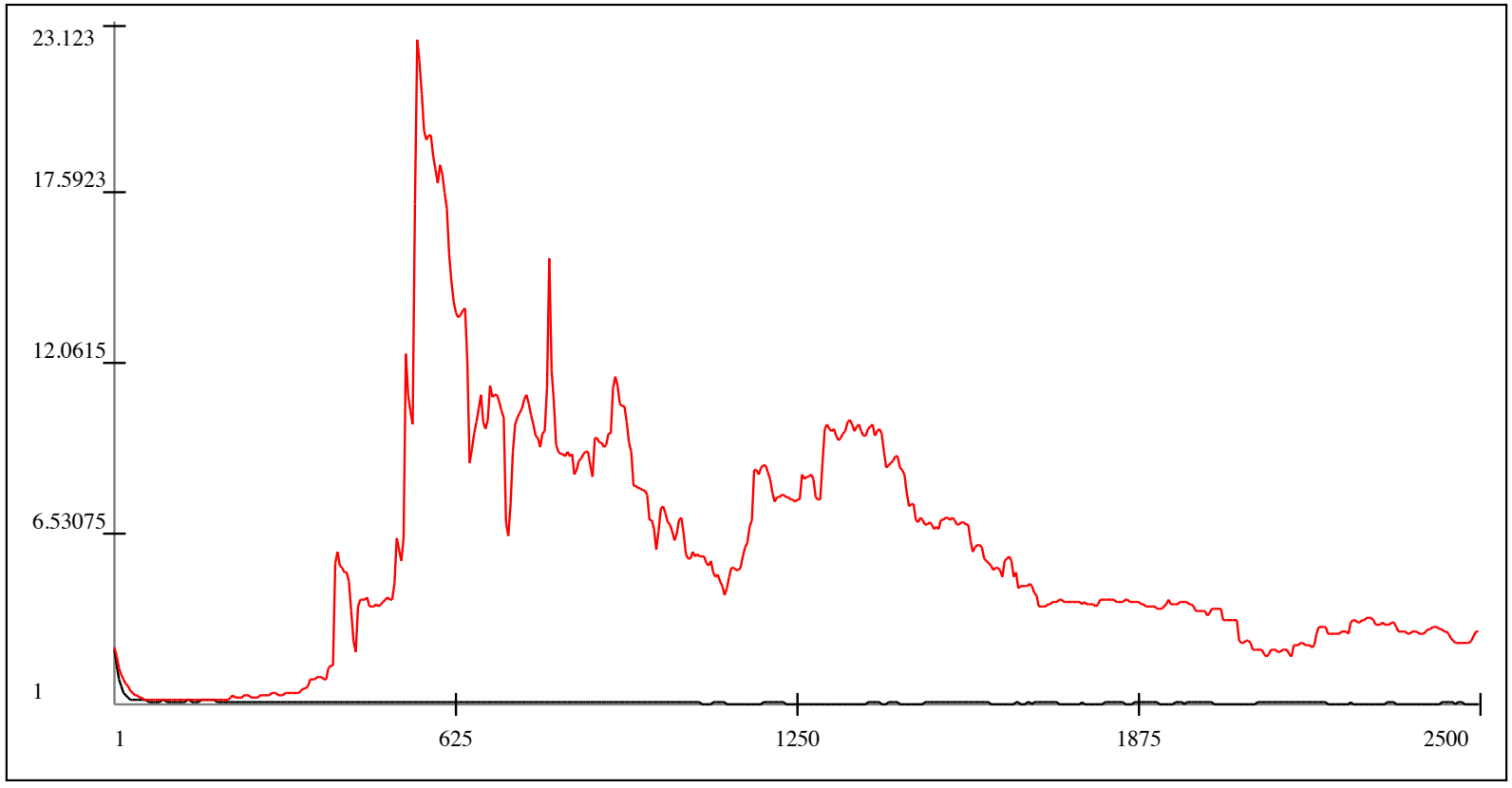

Figure: **Average price**, with patents (red) and without patents (black). (N=10, no interdependencies)

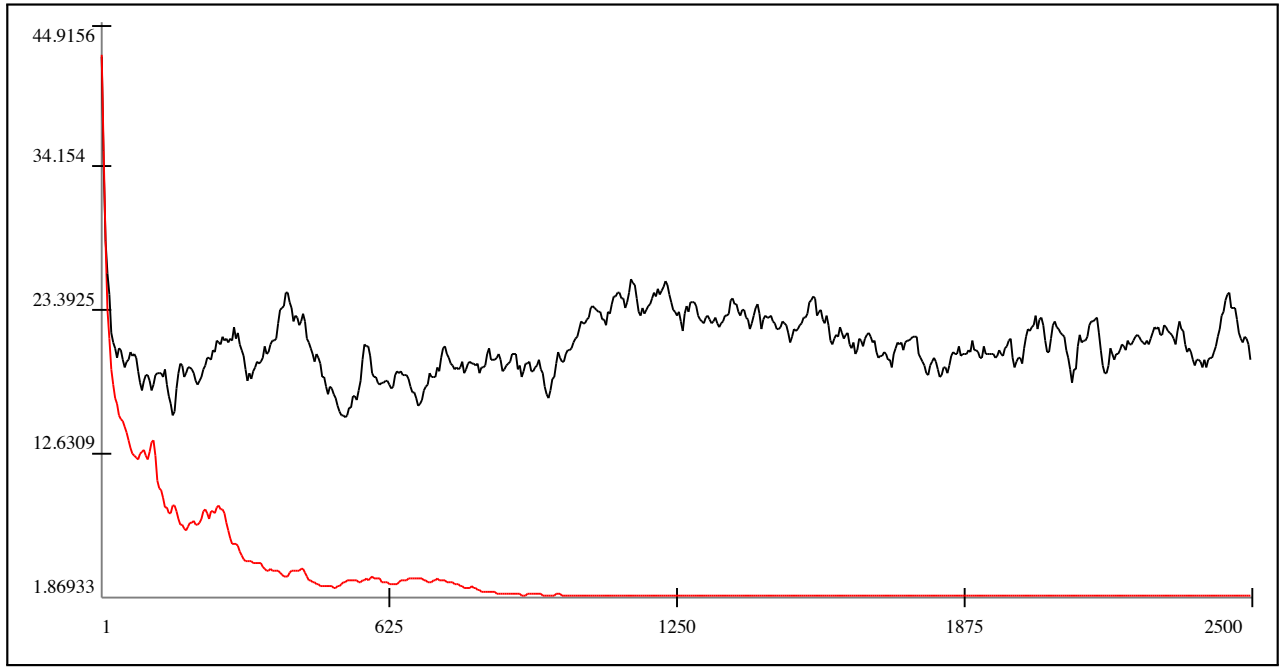

Figure: **Industry concentration** (inverse Herfindal index), with patents (red) and without patents (black). (N=10, no interdependencies)

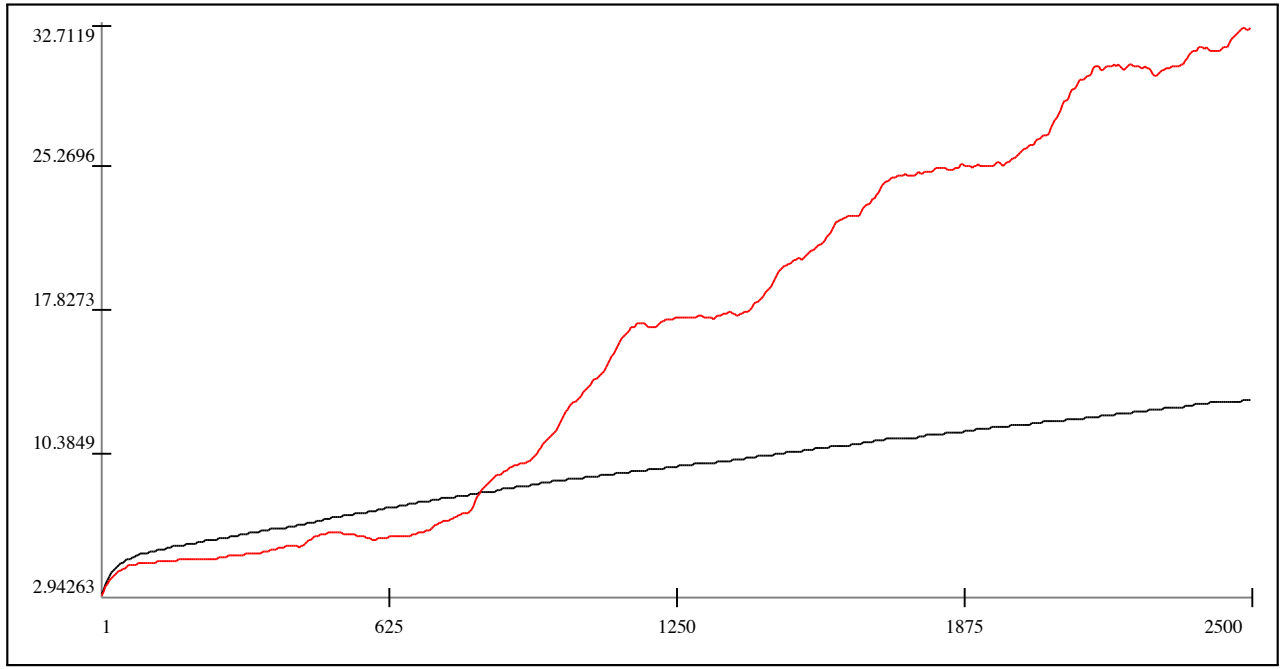

Figure: **Consumers' welfare**, with patents (red) and without patents (black). (N=10, no interdependencies)

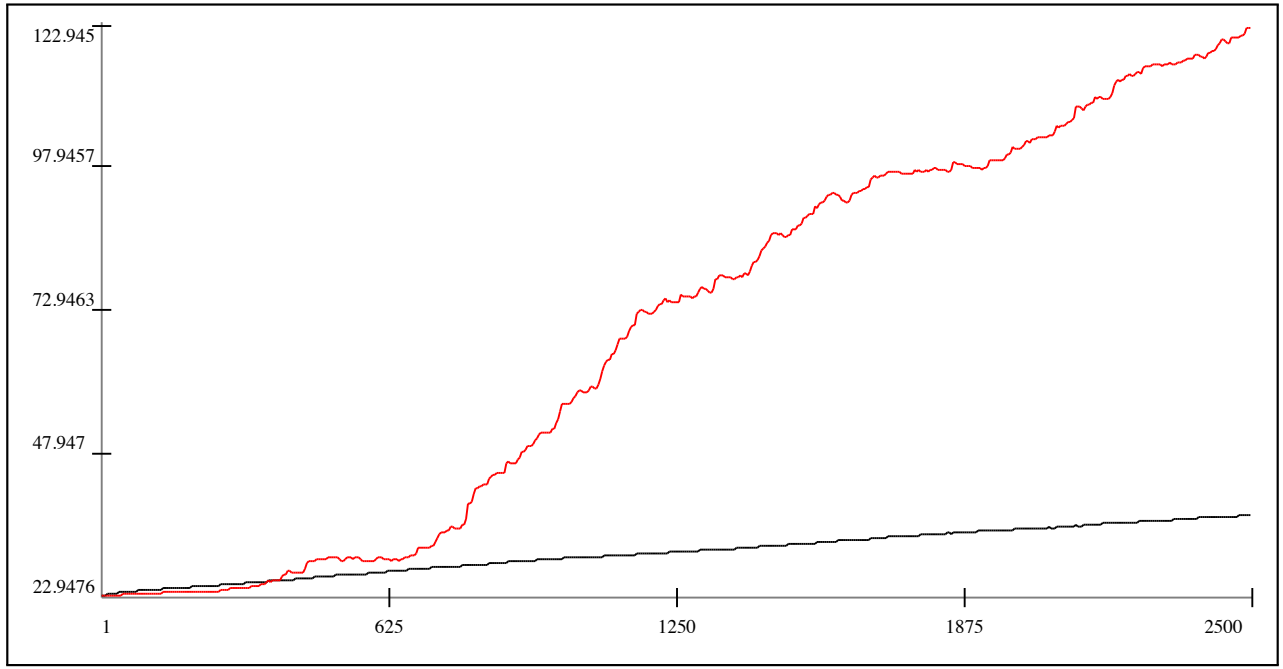

Figure: **Average product quality**, with patents (red) and without patents (black). (N=10, no interdependencies)

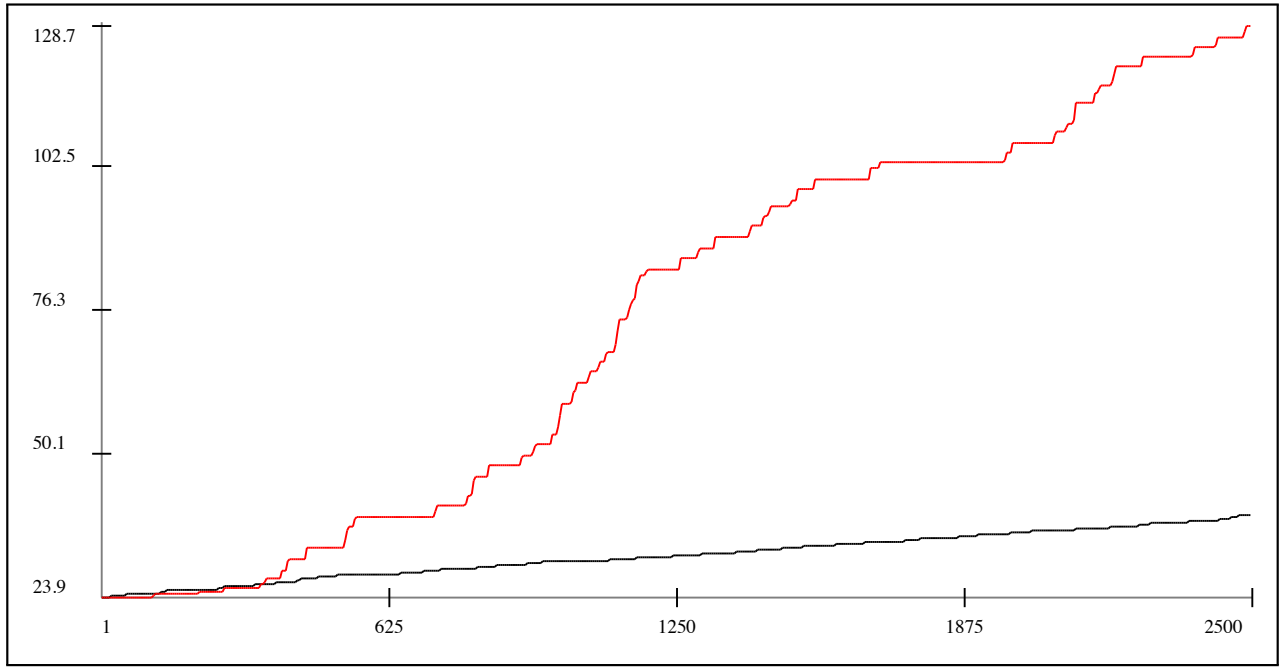

Figure: **Maximum product quality**, with patents (red) and without patents (black). (N=10, no interdependencies)

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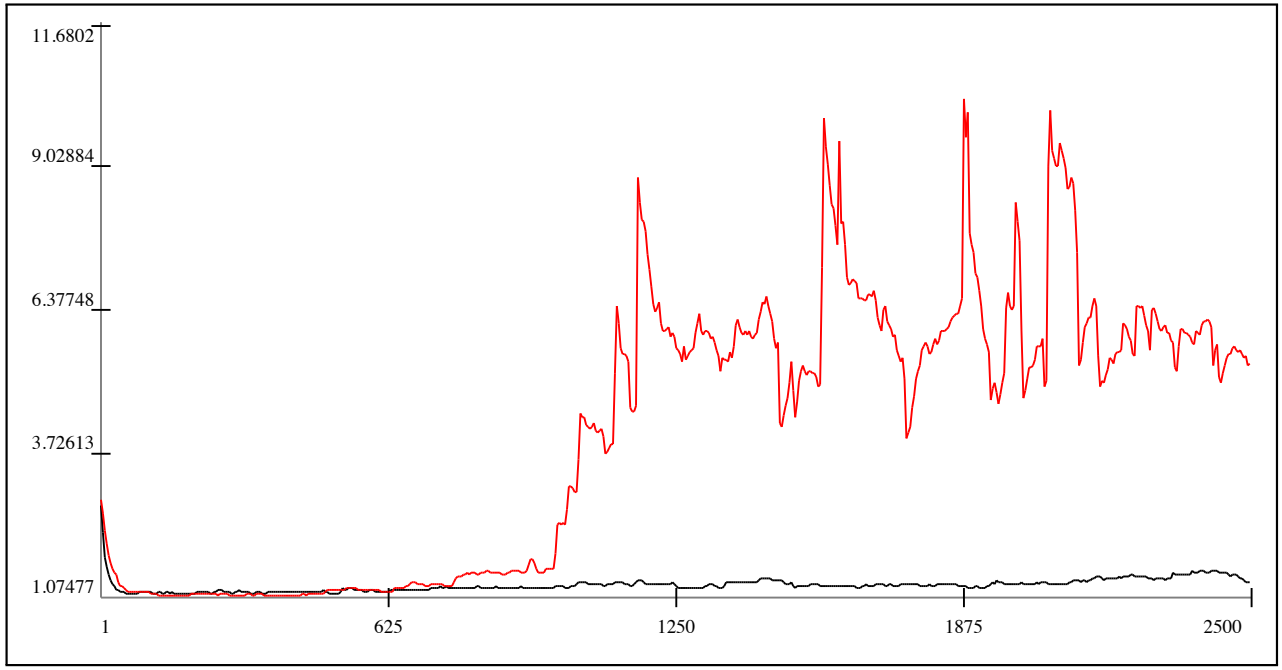
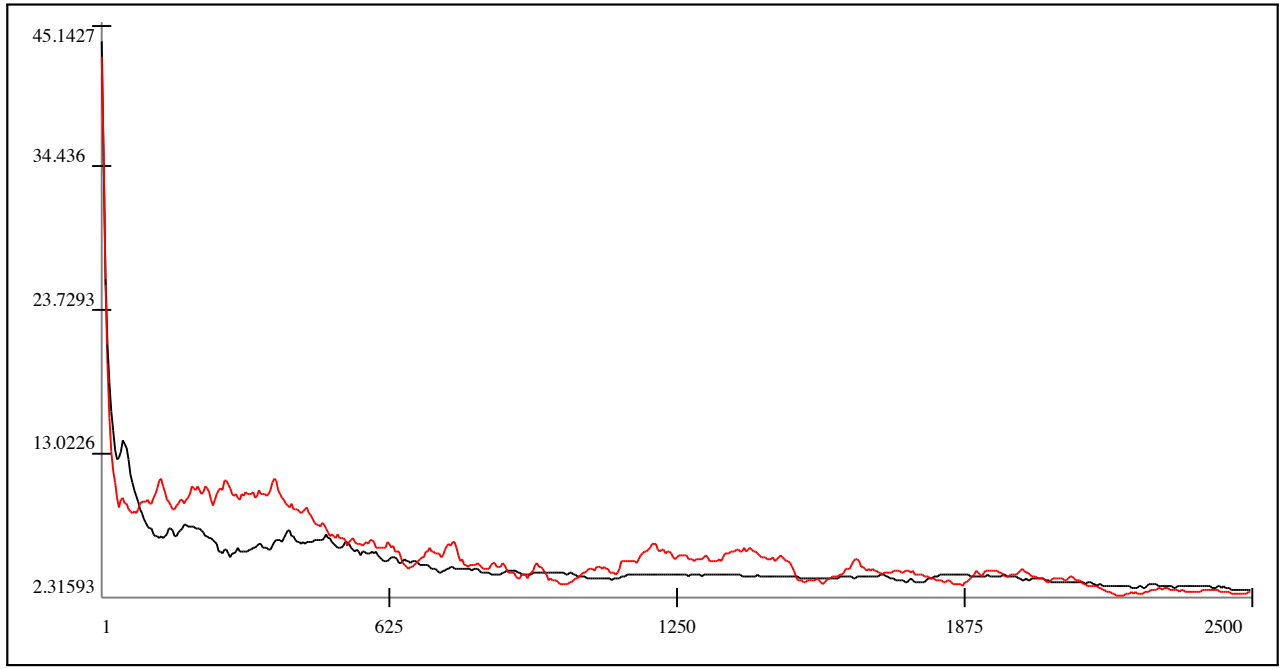


Figure: **Average price**, with patents (red) and without patents (black). (N=10, high interdependencies)



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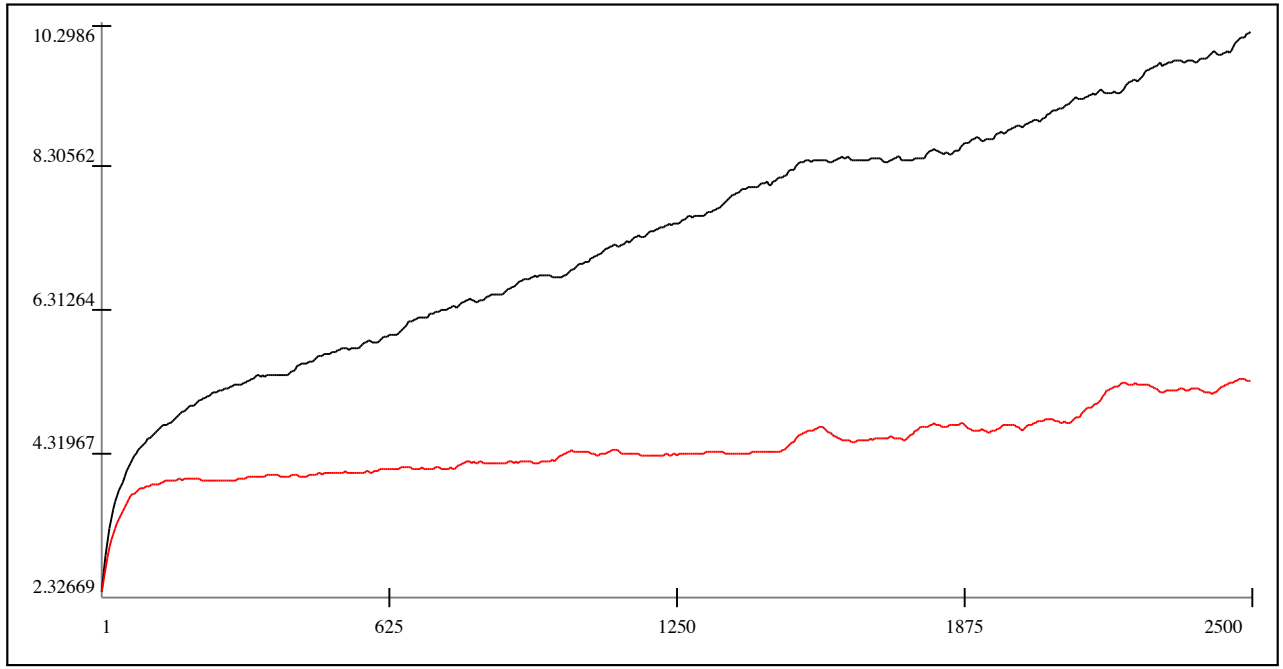

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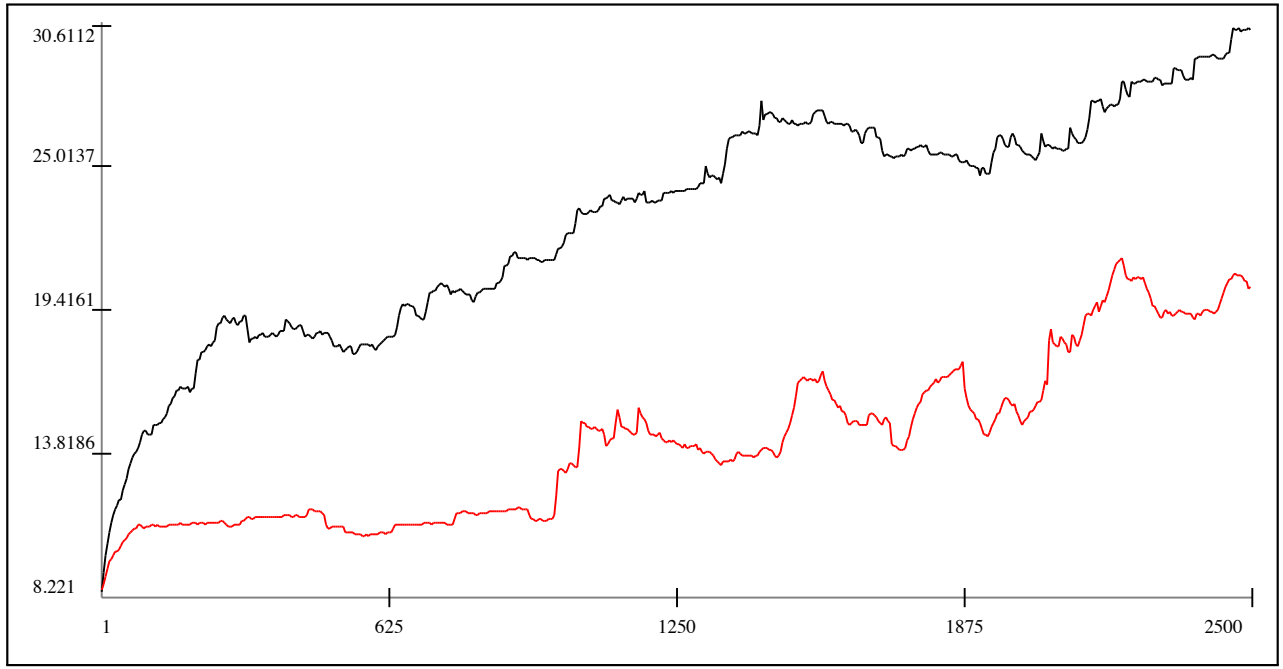

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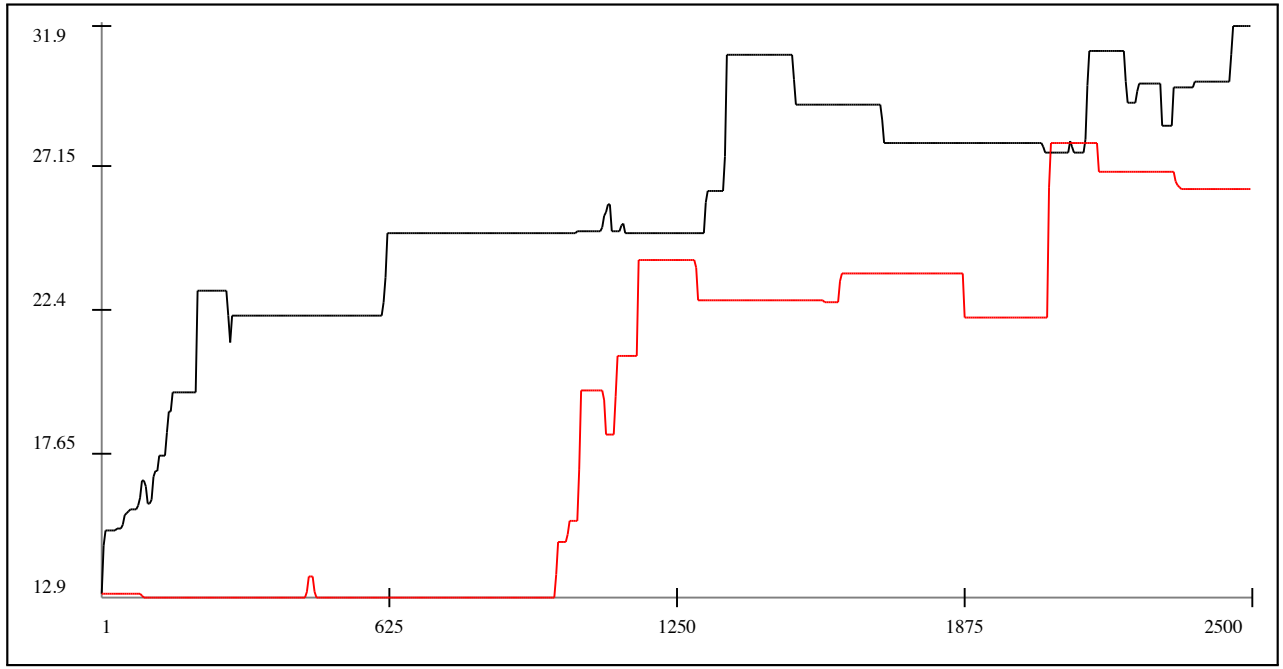

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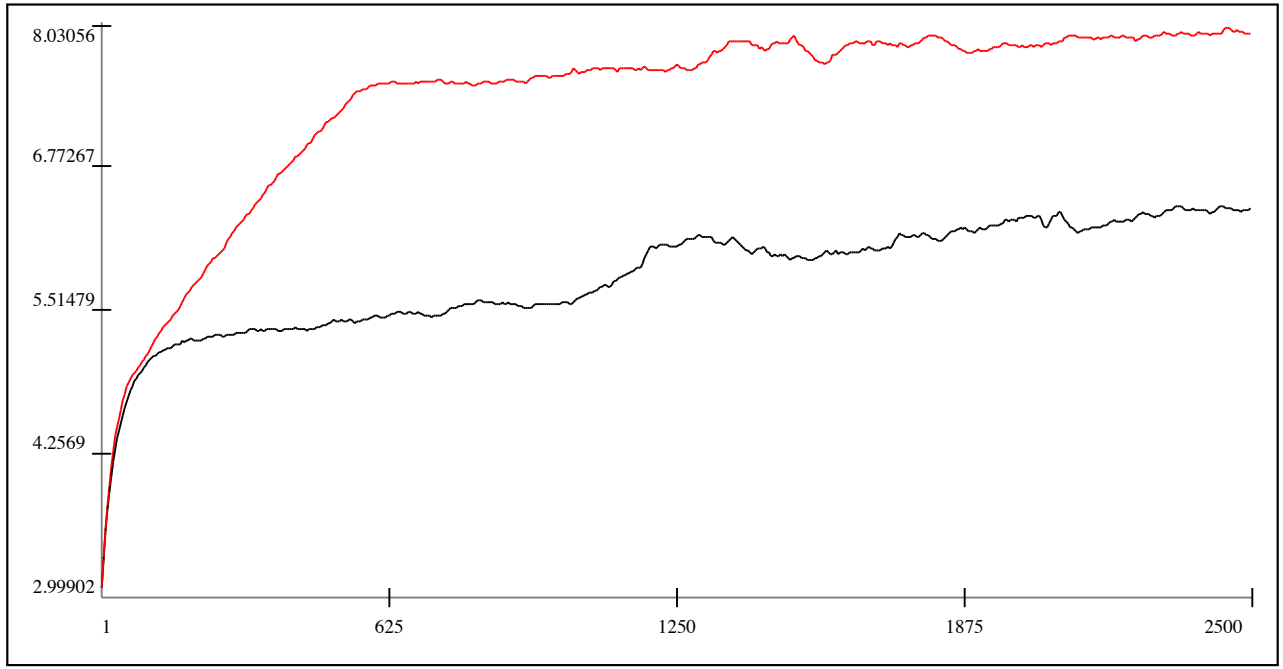
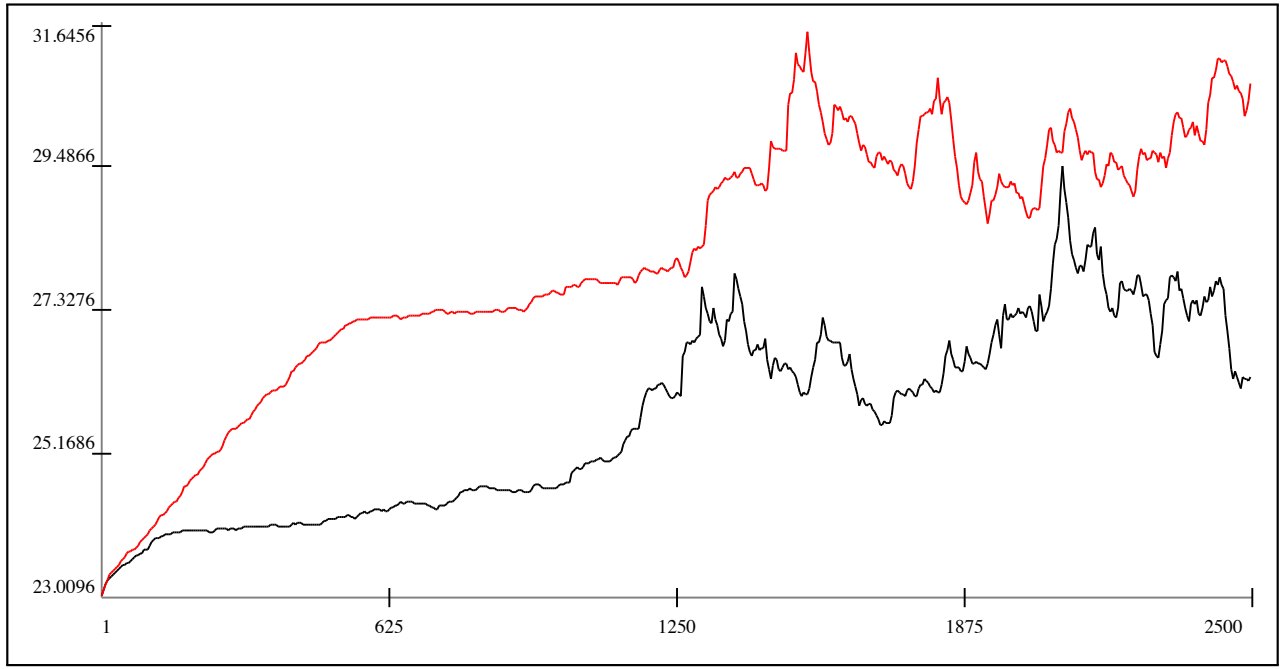


Figure: **Consumers' welfare**, with coarse patents (red) and fine patents (black). (N=10, low interdependencies)



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Conclusions

The diversity of technologies and markets should therefore be taken into primary consideration when addressing the problem of incentives to innovation (as such an issue overemphasized in the current literature). A mix of specific policies, rather than universal property rights, could better serve this purpose: diversity of problems requires diversity of solutions.