Economics of Innovation and Technical Change

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April-May 2003

Some info about the course

1. Two modules

   - Stefano Breschi (20h) / Bruce Tether (10h)

2. Reading material available at the International Relations Office

3. Exam consists of two parts:

   - group presentation (35%)

   - short paper (5 pg.) on a specific topic (65%)

Group presentations

1. Choose one topic

2. Size of groups: min. 2 – max. 5

3. Presentation: max 15 min.

4. Presentations: first week of June

5. Some possible topics:
- Diffusion and standardisation (digital Tv, MP3 etc.)
- University patenting/patent system
- Science parks and technology transfer
- Innovative startups and venture capital

Four good reasons to study the <u>economics</u> of innovation

1) Economic growth and structural change
2) Industry dynamics and evolution
3) Business strategies
4) Public policies for science and technology

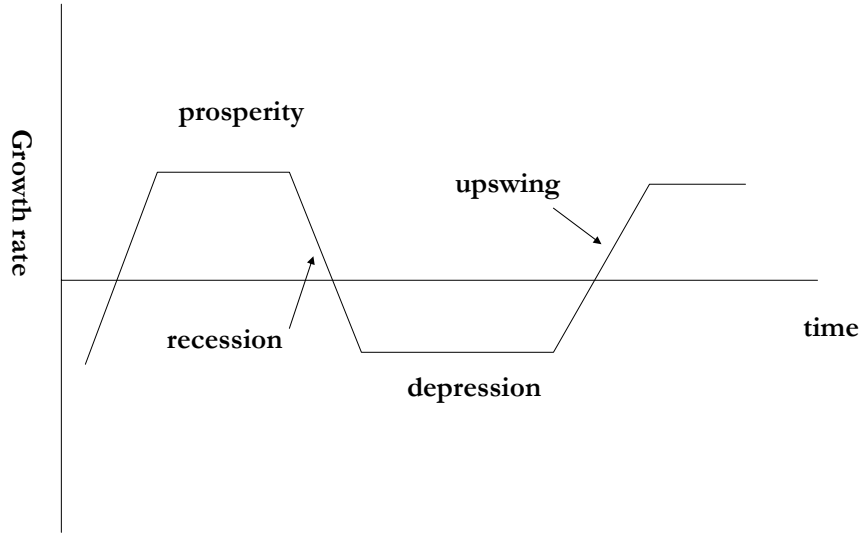
Economic growth…

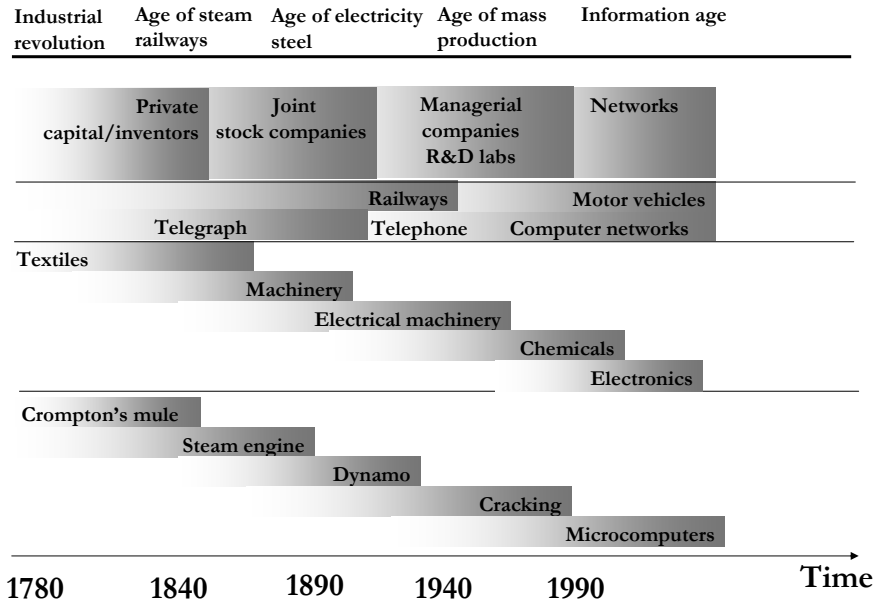
- Economies have grown over the past two centuries faster than during any previous period in recorded history….
- … increase in the variance in per capita income…
- … 'catching up'/'forging-ahead'/'falling behind'

→ Fundamental role of **intangible investments** in industrial R&D, public policies for education system and science and technology

→In a broader perspective:
- technical change (improved production methods(new products) account for > 50% of growth of output
- basic innovations associated to long 'waves' of growth

Schumpeter's long waves of growth





… structural change

- Stratification/replacement of old with new activities
- Catching up / change of specialisation
- Organisational changes

TWO big structural changes in the past century:

a) the large corporations
b) the professionalisation of R&D

→ *Today, firms actively search for change, pursue innovation sistematically and at considerable cost.*

Industry dynamics and evolution

- Who innovates more? Large vs. small firms.
- Entry of firms: startups, spinoffs
- Market selection and industry life cycle
- Innovation diffusion and network externalities

Business strategies

- Competition and co-operation
- Appropriability strategies
- Exploration vs. exploitation
- Choice of standards

Public policy

- Intellectual property rights: patents
- Funding of basic R&D
- Academic vs. industrial research
- Technology transfer to small firms
- Co-operation and competition policy

Basic issues

1) Basic definitions and concepts
2) Technology in economic models
3) Measurement issues

1) Basic definitions and concepts

1) Invention, innovation and diffusion
2) Research and development (R&D)
3) Science and technology
4) Sources of innovation: learning

Basic definitions - 1

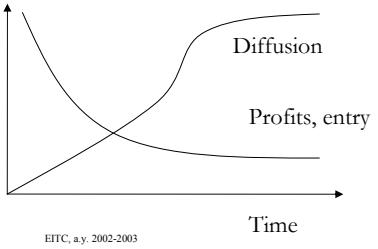
- **Invention**: new idea (profitability not yet verified)

- **Innovation**: new product / process commercially valuable ($\pi>0$, $\pi > \pi_{av}$), i.e. successfully developed inventions [new organisational forms, new markets etc. (new demand)]

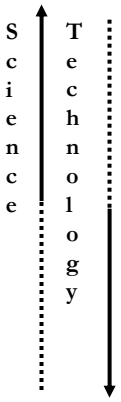
** radical vs. incremental* ** product vs. process*

- **Diffusion**:

adoption of the new technology by a large number of agents



Basic definitions - 2



Basic research: experimental/theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view.

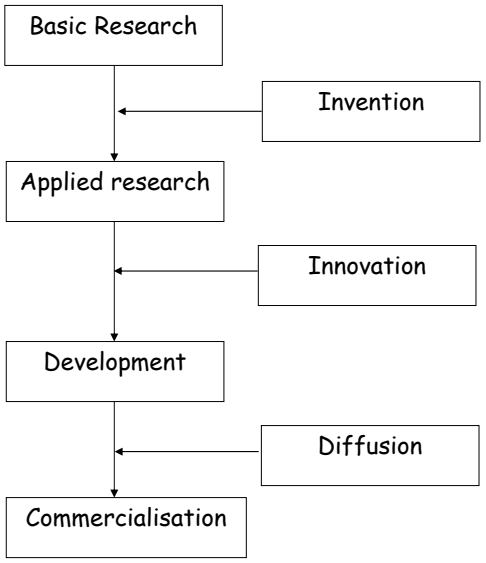
Applied research: original investigation undertaken in order to acquire new knowledge, directed primarily towards a specific practical aim or objective.

Experimental development: systematic work, drawing on existing knowledge gained from research and practical experience, directed to producing new materials, products and devices; to installing new processes, systems or services; to improving substantially those already produced or installed.

Interaction of technology and economy: demand pull or technology push?

- **Demand pull:** innovating firms gets the idea for an innovation from the market, e.g. WIN3.1 vs. DOS
- **Technology push**: engineers/scientists recognise that a piece of new technological/scientific knowledge may result in a new product

The linear model



Linear model

- Extreme version of T-Push model

- Technology policy in US/UK during the '40s-'60s (Big-science, defence oriented research)

- Key factor of US leadership (until the '70s)

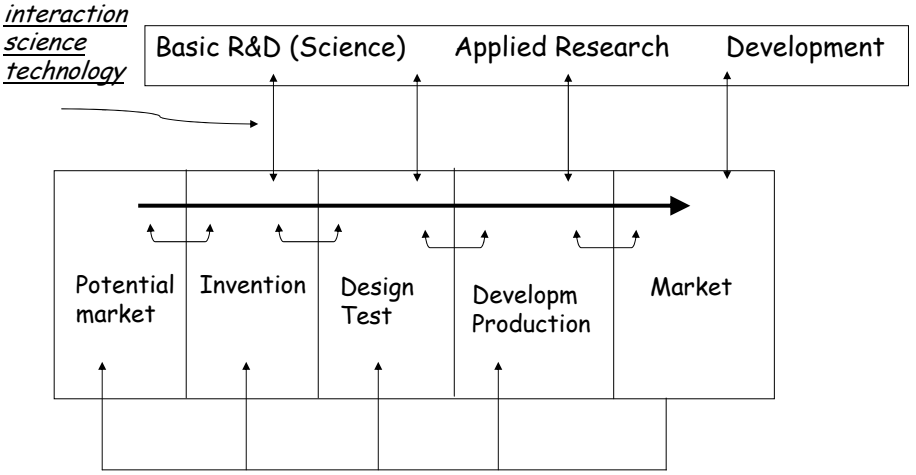
- 'Re-discovered' as a key explanation of US boom during the '90s (role of US Universities and boom of basic industrial research)

- Key conceptual framework for collection of statistical data

- Compatibility with neoclassical framework

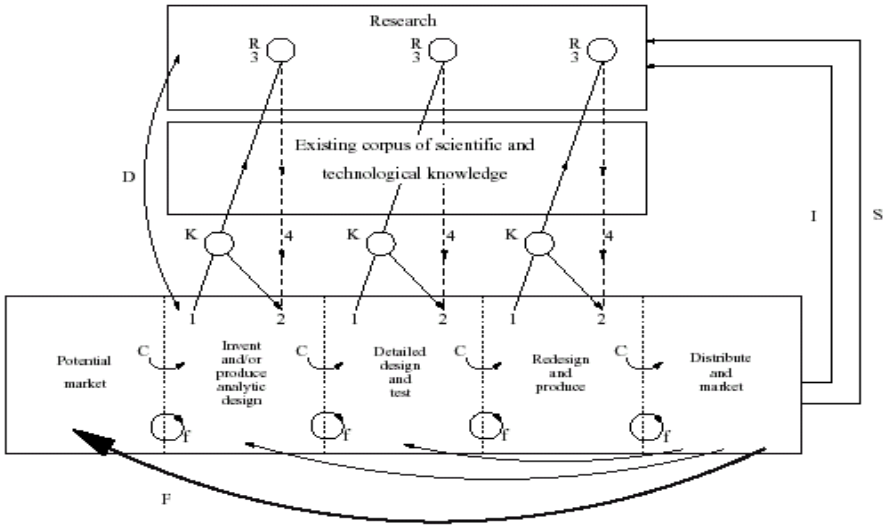
The chain-linked model

Two-way interaction science technology



Feedbacks between stages of innovation process

Figure 2. **An interactive model of the innovation process**
The chain-linked model



Individual firms and productive sectors at a more aggregate level

Chain-linked model

- Origins: - critiques to US e UK technology policies ('70s) + explanations of Japanese *boom* (same years)

- Implications:

a) innovation as an ***interactive*** and ***collective*** activity (firms as 'open' systems) → firms' strategies (vertical integration, networking etc.)

b) ***external*** and ***internal*** sources of knowledge *complementary*, rather than substitutes → importance of SMEs, clusters, districts

c) discovery of 'hidden sources' of innovation → **learning/design**

d) **ENDOGENEITY** of **SCIENCE** with respect to the economy: recently, impact upon collection of statistical data

Economics of innovation… and science?

1. S&T both exogenous — **Linear model**

2. T endogenous ⌫ what relation with S?

2a. S exogenous and public ⌫ T converts S in innovation

Chain model

2b. also S endogenous ← T influences S

Science and technology: complex relations

- **Nature of knowledge :** S = abstract/generic
  T = specific / finalised
- **Output**: S = generalisable and testable models
  T = projects, machines, products, embodied knowledge
- **Incentives (IPR)**: S = open science
  T = private technology
- **Actors**: S = University (public good)
  T = firms (market/vertical integration)

Impact of economic/technological factors on the directions of science

• Applied (technology) research in specific context → recurring problem → generalisation with the purpose of forecasting and testing → scientific model

• Technology as a "focussing device": impossibiliy to overcome a technical problem → start fundamental research (high-tech industries)

• Accumulation of technical advances starts/revitalises scientific disciplines for solving technical problems, e.g. laser

• Technological change modifies *economic incentives* for research

Sources of innovation

• Learning through dedicated activities (R&D)

• Learning by doing:
- learning as joint outcome of production → learning curve
- development of skills in production
- flow of incremental innovations

• Learning by using
- use of capital goods/components/materials leads to better understanding of performance/conditions of use → higher productivity/lower production costs