# Economics of innovation

Valentina Chiariello

University of Naples “Parthenope”

DiSAE

Course of study: Fashion, Food and Art Management

# Textbooks

- Key textbook for this exam is:
- Swann, G. P. (2014). *The economics of innovation: an introduction*. Edward Elgar Publishing.
- But we will also have lectures from:
- OECD/Eurostat, 2005. Oslo Manual: Guidelines for collecting and interpreting innovation data. 3rd edition, OECD Publishing, Paris.
- OECD, 2015. Frascati Manual: Guidelines for collecting and interpreting innovation data. 3rd edition, OECD Publishing, Paris.

# Introduction concepts on innovation

# What is the economics of innovation about?

- ‘On top of everything else, why do I need to study the economics of innovation?’

1. Innovation is one of the most important economic and business phenomena of our time. Innovation has very widespread implications for our economy and society but few of us understand these implications in full.
2. The general principles of microeconomics take us some way in understanding the economics of innovation, but they are not sufficient. To develop a real understanding of the economics of innovation and a capacity to explore the many examples of innovation to be found in the real world, the student needs something more than standard microeconomics.

# The reasons to study the economics of innovation

In short, the reasons to study the economics of innovation, are that:

a. innovation is incredibly important in the real economy and
b. the right way to study the economics of innovation is a bit different from the conventional economists' training.

The economics of innovation has been concerned with five main groups of questions.

1. **Aspects of Innovation:** how should we categorise and classify the different aspects of innovation?
2. **How Firms Achieve Innovation**: how are innovations created?
3. **Innovation and the Consumer:** how do customers react to innovations?
4. **The effects of innovation:** what effects do innovations have on the broader economy?
5. **Innovation and Government:** what can and should governments do to support and direct innovation activity?

# 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** – this is not a course on advising firms how to innovate, but does include some insight into this

# Definition of innovation

## Basic definition

Introduction of new ideas that add ‘value’ to a firm’s activities

OECD *The Oslo Manual:*

- introduction of a new product or a qualitative change in an existing product
- process innovation new to an industry
- the opening of a new market
- development of new sources of supply for raw materials or other inputs
- changes in industrial organization

# Innovation: the realization of an invention and its commercial exploitation. Some definitions

**Innovation:**

- The act of introducing a new device, method, or material for application to commercial or practical objective
  - ➢ "The successful exploitation of new ideas"

**Invention**:

- It doesn't necessarly translates in innovation
- Is a long process, especially when it has the ambition of becoming a commercial product or an innovation.
- It does not necessarily have an economic motivation
- It does not necessarily need an organization of tasks
- It can be random (*serendipity)*

**Imitation:**

- Deprive of the requirement of originality
- Sources: industrial espionage, reverse engineering, patent licensing
- Accelerate the diffusion process

**Diffusion:** the spread of a new invention/innovation throughout society or at least throughout the relevant part of society.

"*the process by which an innovation is communicated through certain channels over time among the members of a social system*" (Rogers, 1962)

- Without this cannot gain full benefits
- Some of this represents 'spillovers' or 'positive externalities'

# Technical progress in history

# From the Antiquity…

- Technology in the ancient world

  - The beginnings—Stone Age technology (to c. 3000 BCE)
  - The urban revolution (c. 3000–500 BCE)
  - Technological achievements of Greece and Rome (500 BCE–500 CE)

# …to the Middle Age

- Middle Age: Techniques known in antiquity evolve
  - Progress in agricultural techniques (monasticism)
  - The exploitation of energy sources increases
  - Dispersion of production centers
  - Birth of the business bourgeoisie

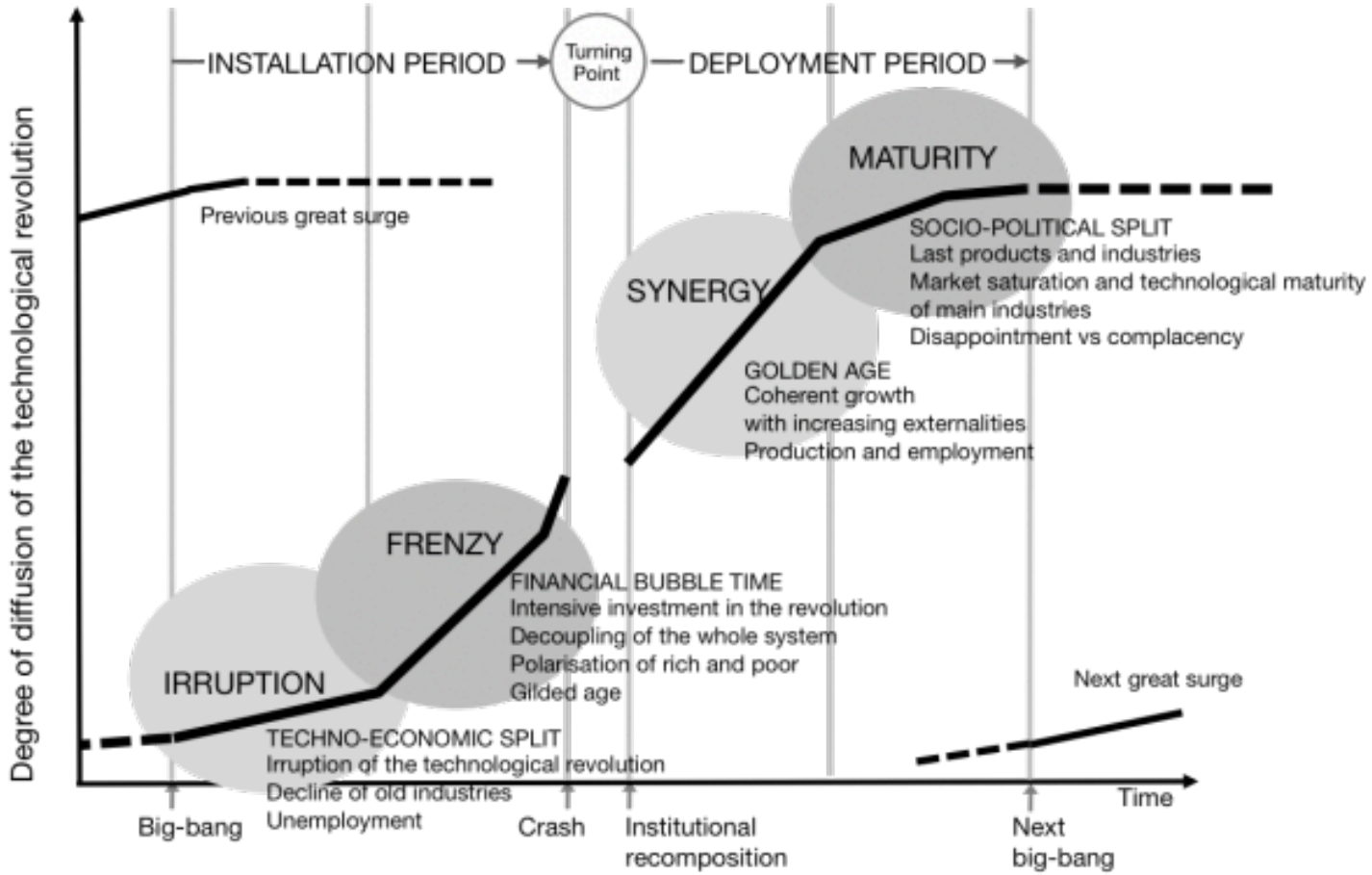
# Renaissance and humanism

- Renaissance
  - Progressive fusion between technique (practical problem solving) and science (theory)
  - Large artists' workshops flourish, which also deal with engineering
  - Treatises are born: description of technical knowledge learned practically (on the model of the classical era treaties)

# From the Galilean revolution to the industrial revolution

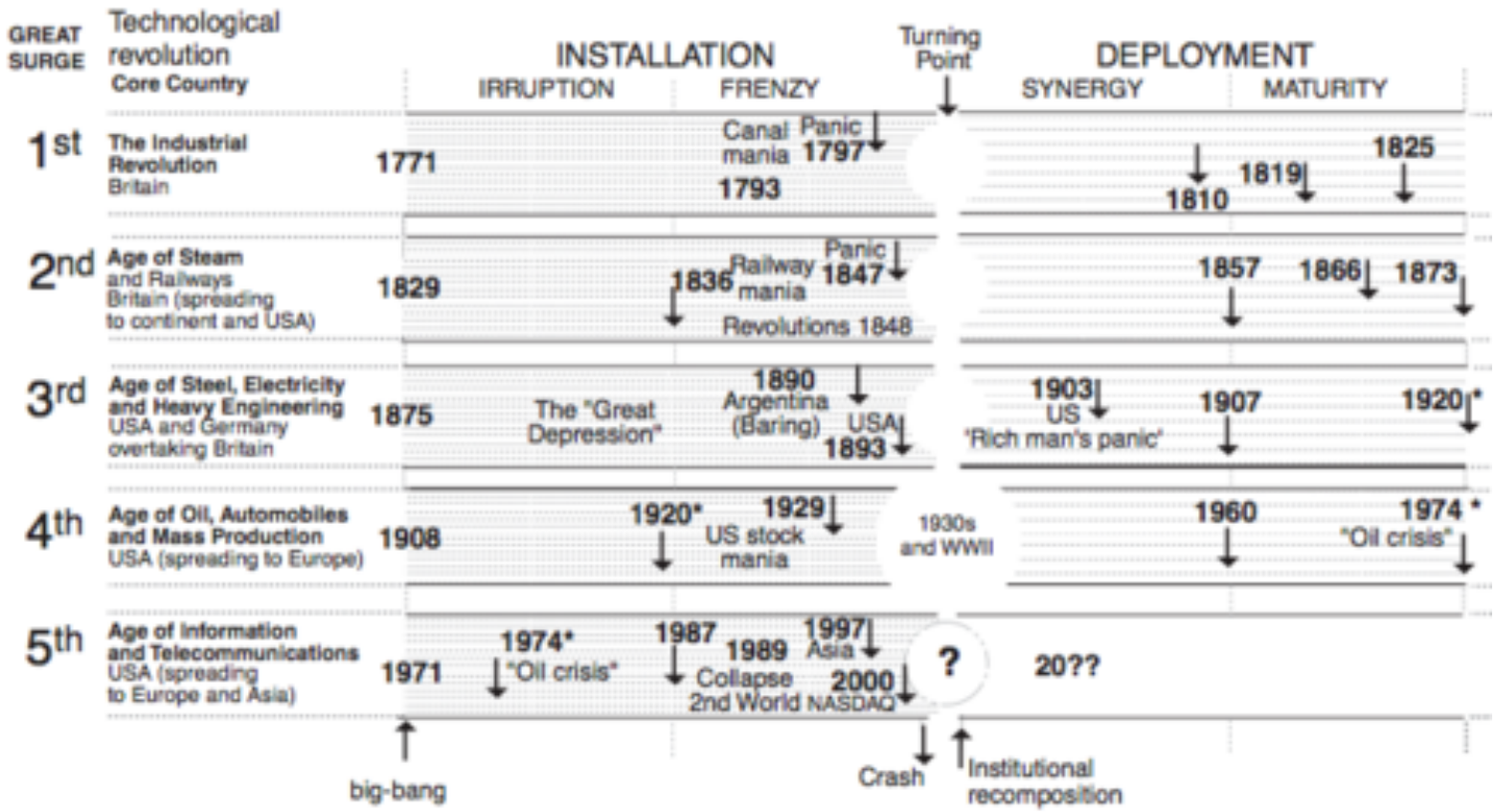
- Seventeenth century
  - Scientific revolution: Galileo Galilei's scientific method
  - Bi-directional relationship between science and technology
    - Scientific elements are derived from technical observation
    - Science explains the principles underlying the techniques
  - Limited impact on the economic system
- Second half of the eighteenth century
  - Industrial revolution in England
  - The role of itinerant specialized artisans in spreading the useful knowledge
  - Increasing codification and standardization of the languages of science and technology
  - Technique + Science = Technology

# From the eighteenth century to today: Technological revolutions



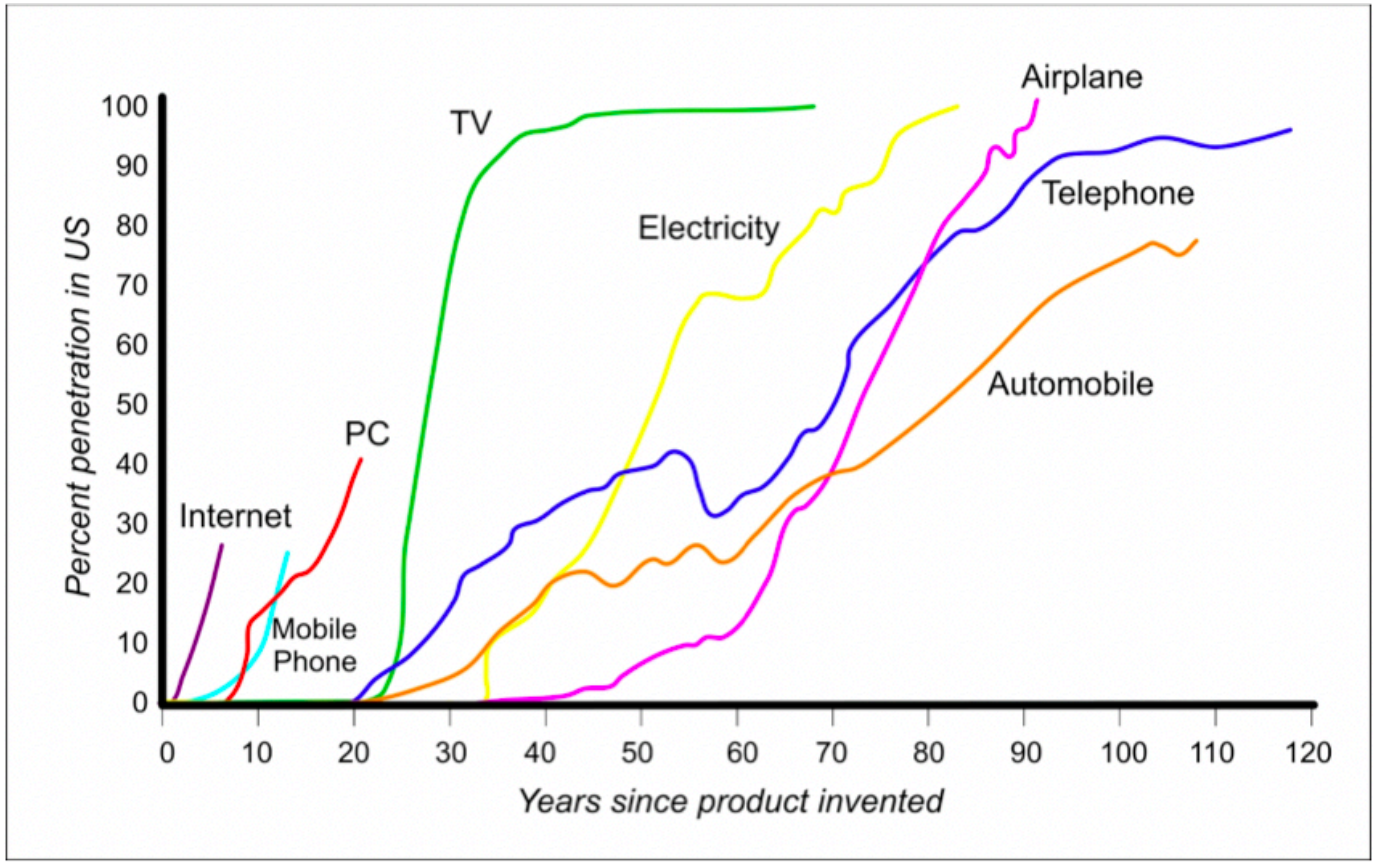

Source: Perez, Carlota. Technological revolutions and financial capital. Edward Elgar Publishing, 2003.

# Technological revolutions



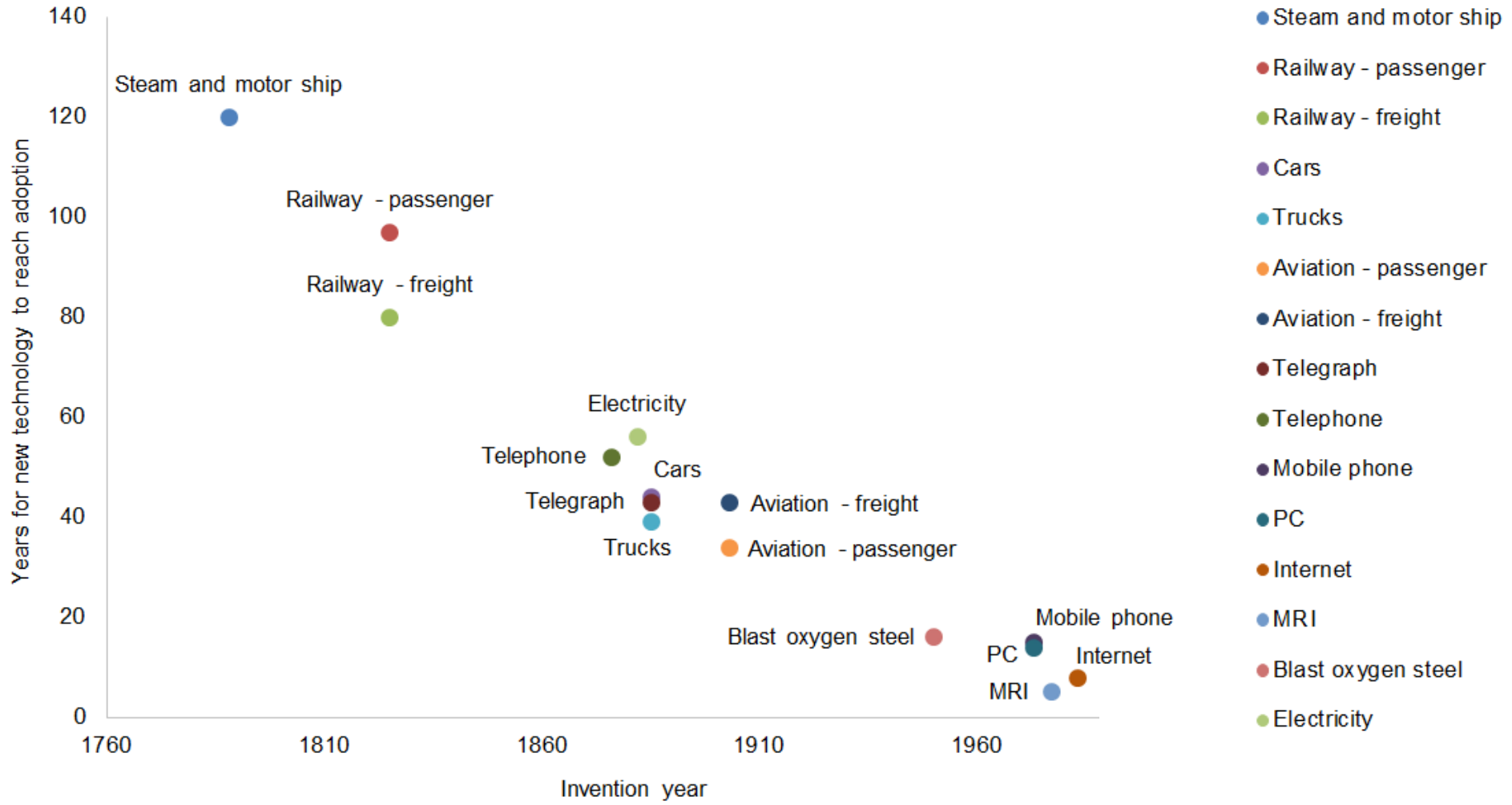

Source: Perez, Carlota. Technological revolutions and financial capital. Edward Elgar Publishing, 2003.

# Diffusion of technologies: historical cases




Source: Comin e Hobijn (2010, *American Economic Review*)

# Diffusion of technologies: adoption times



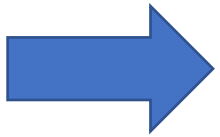
# The impact of technological innovation on society

- 1800—Electric battery
- 1804—Steam locomotive
- 1807—Internal combustion engine
- 1809—Telegraph
- 1817—Bicycle
- 1821—Dynamo
- 1831—Electric generator
- 1836—Five-shot revolver
- 1841—Bunsen battery (voltaic cell)
- 1842—Sulfuric ether-based anesthesia
- 1850—Petroleum refining
- 1867—Typewriter
- 1876—Telephone
- 1885—Light steel skyscrapers
- 1886—Internal combustion automobile
- 1895—X-ray machine
- 1902—Air conditioner (electric)
- 1903—Wright biplane
- 1906—Electric vacuum cleaner
- 1910—Electric washing machine
- 1927—Television
- 1928—Penicillin
- 1936—First programmable computer
- 1939—Atom fission
- 1943—Nuclear reactor
- 1957—Satellite
- 1958—Integrated circuit
- 1967—Portable handheld calculator
- 1971—Microprocessor

  1973—Mobile (portable cellular) phone
- 1976—Supercomputer
- 1981—Space shuttle (reusable)

  1987—Disposable contact lenses
- 1989—High-definition television

  1990—World Wide Web protocol
- 1996—Wireless Internet
- 2003—Map of human genome



**Imagine how different life would be without these innovations!**

# Innovation in the history of economic thought

# Innovation from Smith to Schumpeter

- 1776 A. Smith: division of labor
- 1817 D. Ricardo: technical progress, diminishing returns and unemployment
- 1832 C. Babbage: innovation and organization
- 1848 K. Marx: class struggle and technical progress
- 1912 J. Schumpeter: Theory of Economic Development
- 1921 A. Usher: on the innovative process
- 1925 N. Kondratieff: long waves
- 1942 J. Schumpeter: Capitalism, Socialism, and Democracy

# The neoclassical heirs

- 1951 G. Stigler: size of the market and division of labor
- 1957 Accounting for growth and Solow's residual
- 1962 Arrow paradox
- 1986 Romer's endogenous growth model
- 1987 Solow's paradox
- 1992 Neo-Schumpeterian growth model of Aghion and Howitt

# The evolutionary heirs

- 1949 Kaldor-Verdoorn Law
- 1960 NBER Conference (Nelson and Arrow)
- 1982 Technological paradigms and technological trajectories (Dosi) N. Rosenberg: book Inside the black box Nelson and Winter evolutionary growth model
- 1984 Taxonomy of Pavitt
- 1988 National innovation systems
- 2002 C. Perez: technological revolutions
- 2014 M. Mazzucato: the innovative state

# Classical economics: Smith, Ricardo, Marx

In the history of economic thought, innovation and technological change have occupied a growing importance:

- **Adam Smith** in Wealth of Nations of 1776 considers the relationship between technological change, division of labor and structural change of the economy. The incorporation of technological progress into capital favors the division and specialization of labor, which in turn reflects on productivity.

- **Ricardo** in the Principles of Political Economy of 1817 analyzes the effects of technological change on employment.

- **Marx** emphasizes the key role of technology in modern economies and stresses that innovation is a social rather than an individual process. The input for innovation comes from capitalist competitive pressure and the breadth of the markets.

# Innovation in the history of economic thought

**J. Schumpeter** (1883-1950) was the first to discuss the role of innovation in modern industrial economies in a broad, systematic and in-depth way. The best known and most important contributions are:

- Innovation is the main determinant of industrial change;
- Innovation is a creative response of the company, distinct from the adaptive response;
- Innovation can take place both in small companies (entrepreneur) and in large companies (R&D), even if size is neither a necessary nor sufficient condition for innovation;
- Innovation determines a temporary profit, which lasts over time if the innovative activity remains sustained. On the contrary, the profit disappears following the reaction of other firms;
- Innovation is a continuous process of change and accumulation of knowledge.

# The Schumpeterian approach

Schumpeter assigned the key role in economic growth to:

1. the disruptive activity of entrepreneurs,
2. to large corporations,

each of which fed a process of *creative destruction* by causing continuous disturbances in the economic system.

The source of these disturbances was innovation generated, as Schumpeter said:

> "competition from the new commodity, the new technology, the new source of supply, the new type of organisation, 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".

Schumpeter's analysis was descriptive rather than formal, but later economists developed formal growth models based on his insights, placing innovation at the heart of growth.

There is recent empirical evidence, to suggest that the extent of creative destruction is linked to the rate of growth.

# The central role of innovation in growth theory

**Economics has a range of growth theories, but all give a central role to innovation as a driver of growth.**

- Economists are widely held to disagree on more or less any topic.
- But they agree that **all long-term growth processes rest ultimately on innovation and technological change**.

This is especially important in advanced economies where innovation plays a key role in improving the quality of inputs and in how these are incorporated in the production process.

# Neoclassical exogeneous growth models

Robert Solow in the 1957 developed a formal neoclassical model of growth, based on the concepts of *production function* where output is a function of inputs (capital, labour, management services and materials), and reaches a *long run equilibrium*.

In the long run, growth in per capita output depends *only* on the rate of technological progress (resulting from improvements in outputs or the efficiency with which inputs are transformed into outputs.

- However the theory offered no account of how this occurred: technological improvements emerged from outside the economic system, and were not shaped by decisions within it.

Empirical applications of the theory, of Abramowitz and later Solow showed that US long-run economic growth derived from technological progress rather than increases in capital and labour inputs, a result which emphasised the importance of innovation.

# Neoclassical endogeneous growth models

Endogenous growth models provided a deeper analysis of the sources of long-run growth, by building knowledge-creating investment into the models.

Endogenous innovation models saw technological progress as the key to long-run growth, but made it internal to the economic process, dependent on investment in innovation, primarily through investment in R&D and human capital.

In these models:

- the basic process used to explain economic growth is the phenomenon of increasing returns to scale, which follow from the externality aspects of technological change;
- several of the most important approaches within this field involve modelling a specific "research sector" of the economy, which produces both specific new inputs, plus general scientific and technical knowledge;
- growth results partly from increases in the productivity of tools and equipment (intermediate inputs) resulting from technological change, and partly from "spillovers" of knowledge from one area to another.

# The Evolutionary approach

**The evolutionary approach to growth**  **innovation mechanism of economic change.**

Evolutionary theories ➢ firms innovate by technological competition, they constantly introduce:

- new varieties of products,
- new production technologies.

Innovation drives growth, but is accompanied by significant change in either the structure of the economic system.

A central contribution of recent evolutionary approaches to previous theories is the **'innovation system'**: the set of institutions and organisations which contributes to the development and diffusion of new technologies, processes, and organisations.

# A comparison between neoclassical and evolutionary approach

The thought of recent years has focused attention on the analysis of the characteristics, determinants and consequences of innovation and technological change, on which two schools, the **neoclassical** and the **evolutionary** one, are compared.

Both underline that:

- The **scientific and technological opportunities** of an industry affect the rate of technological progress
- Economic incentives and in particular the **appropriateness** of results greatly affect the innovative effort of companies
- **Demand** conditions affect the rate of innovation
- There is a relationship between **market structure** and **innovation**: a more (less) concentrated market structure generates a more (less) high rate of technological progress, which in turn significantly changes the market structure.

# A comparison between neoclassical and evolutionary approach

## But their approach differs in these aspects:

**Neoclassical school**

- Equilibrium and steady state
- Static and dynamic analysis
- Analytical solution of the models
- Substantive rationality and optimization.
- Exogenous preferences
- Heterogeneity in endowments
- Strategic behavior (game theory)
- Firm as a set of contracts
- Technology as information
- Codeable information
- Innovation as a response to incentives
- Independence from history
- Calculable uncertainty (risk)
- Invisible Hand / Pareto Efficiency Public intervention motivated by market failures and hampered by state failures

**Evolutionary School**

- Unbalance and transitions
- Dynamic analysis
- Numerical simulation of models
- Limited rationality and satisfactory behavior.
- Endogenous preferences
- Heterogeneity in decision making.
- Routine based behavior
- Business as a set of skills
- Technology as knowledge
- Codifiable and tacit information
- Innovation as problem solving
- Dependence on history (path dependence)
- Non-computable or radical uncertainty
- Public intervention that supports the creation of new markets and national innovation systems