

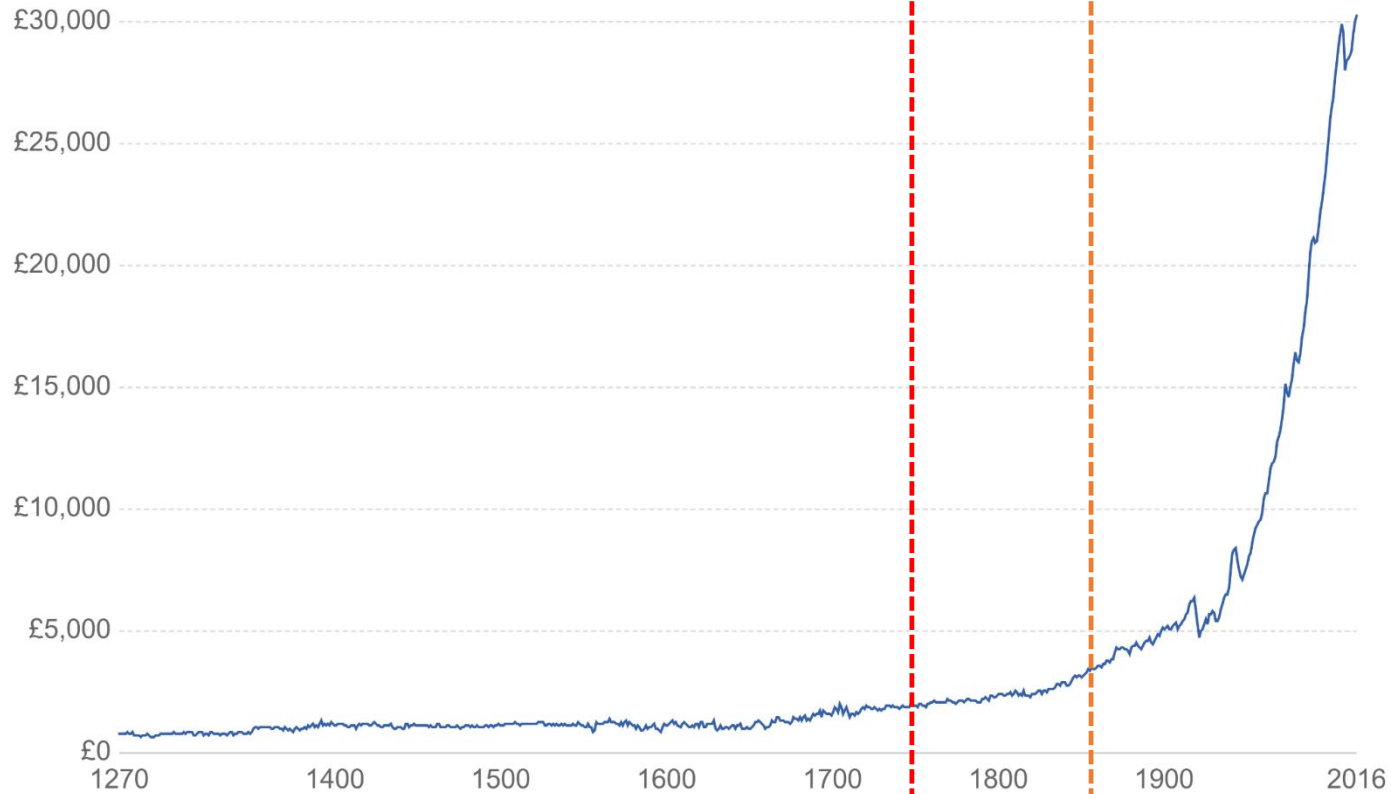
# An hystorical perspective on innovation

Economics of Innovation – LM Economia, Mercati e Management

# Growth before the 18<sup>th</sup> century

GDP per capita in England since 1270  
Adjusted for inflation and measured in British Pounds in 2013 prices

Our World  
in Data



Source: GDP in England (using BoE (2017))  
Note: Data refers to England until 1700 and the UK from then onwards.

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## MALTHUS:

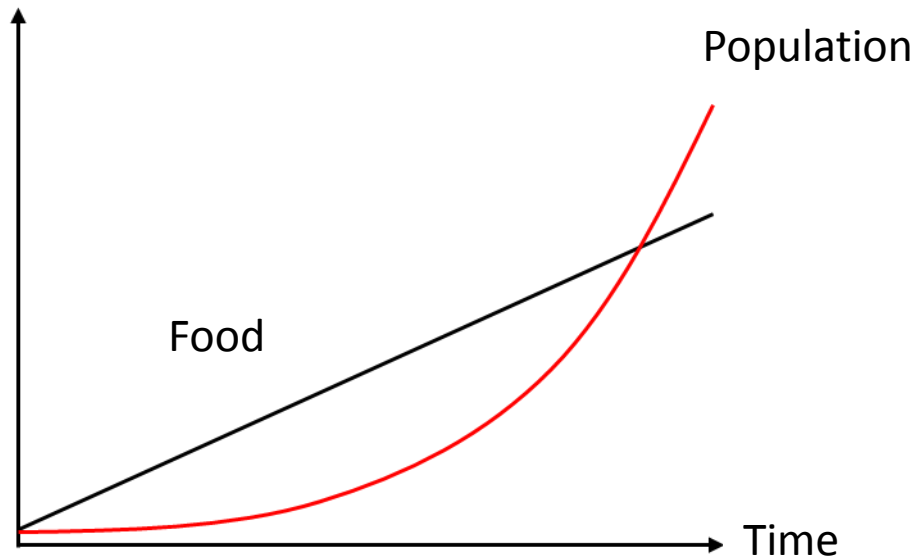
- Essay on the principle of Population, 1798
- Demographic approach: highlights that scarcity of resources limits economic and population growth
- Two assumptions:
  - Food is necessary to mankind and it grows following an arithmetic progression
  - Population growth increases following a geometric progression

Industrial Revolution

1770

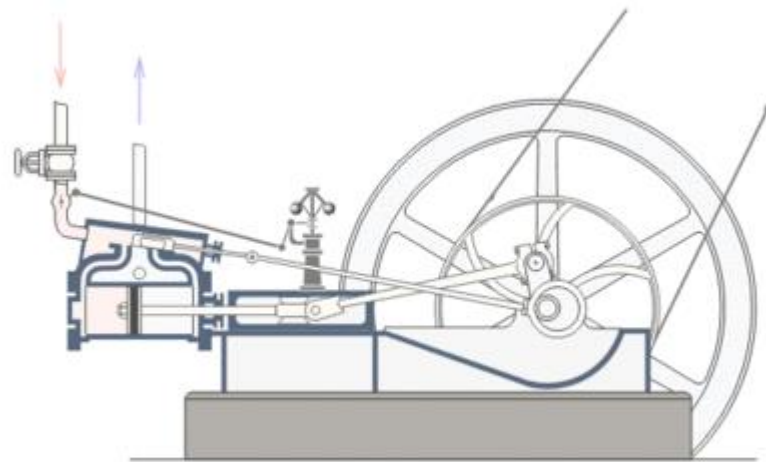
Life standards are determined by population growth

Life standards are determined by technological change



# Economic modernity

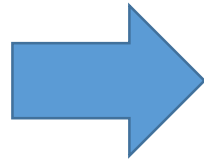
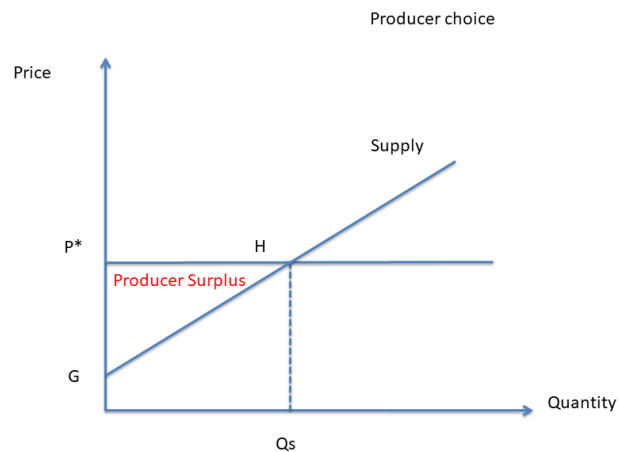
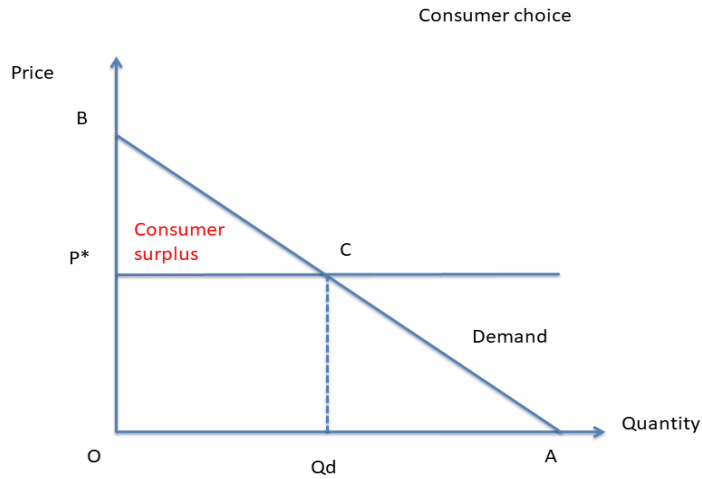
- What has determined growth during industrial revolution?
  - «Convergence club» view
  - «Expansion of production market» view
  - «Factories and labour increase» view
- **But...changes in technology was fundamental!**



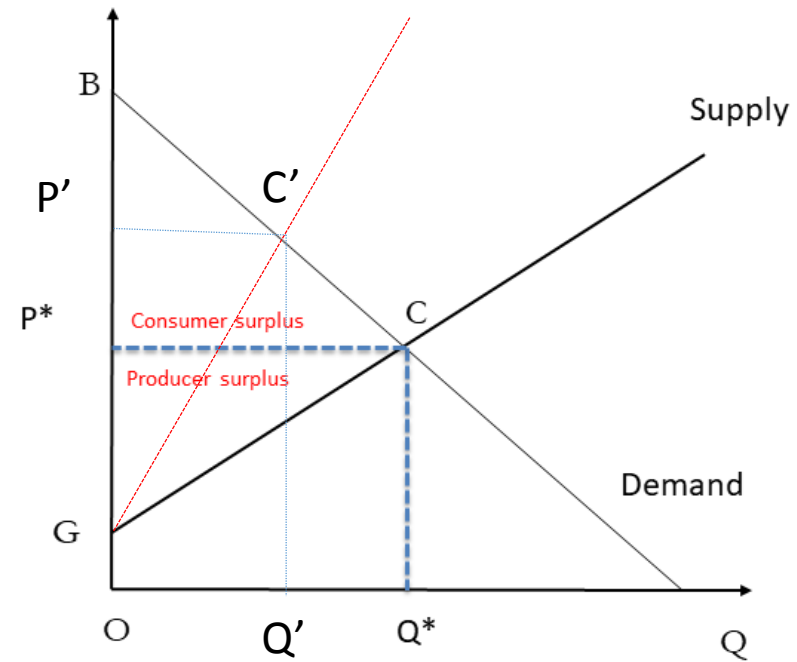
# How does technological change happen

- [Endogenous growth theories](#)
- “Technology does not descend down on us like “manna,” or better perhaps, is not given to us like the ten commandments. It was produced within the system by men and women whose purpose was normally to achieve some kind of improvement to the process or product they were interested in” (Mokyr, 2010)
- Positive externality and uncertainties might be major brake to technological change

# Innovation as an externality



## Market balance



# Innovation as an externality

- Technology, like all forms of knowledge, is non-rivalrous so that the social marginal cost of sharing it is zero.
- Since the social marginal product is positive, the optimal static solution is one in which it is made accessible freely to all able and willing to use it.
- Yet under these conditions no one has much of an incentive to engage in the costly and risky R&D in the first place.

# Innovation as an externality

- **Property rights:** define ownership and control over a resource or a good.
- Effective structure
  - **It is exclusive:** costs and benefits from owning the resource/good are held only by the owner
  - **Can be transferable:** property rights can be transferred from one subject to the other through voluntary exchange
  - **It is applied:** the owner is protected towards requisition or usurpation from other individuals
- **We will back to this later in the course**



# Innovation is uncertain

- Technology is produced under the kind of uncertainty that can be characterized as a combination of unintended consequences and unknown outcomes (Rosenberg, 1996)
- technology is normally developed when the exact modus operandi of the physical, biological, or chemical processes on which it is based are at best understood very partially
- many innovations are often combined with other techniques in ways not originally intended
- Uncertain outcome, positive or negative

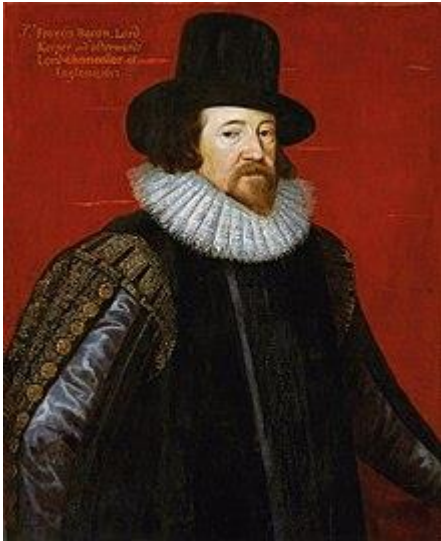
# What was different during industrial revolution?

“The Industrial Revolution and the subsequent developments did not just raise the level of technological capabilities; **they changed the entire dynamics of how innovation comes about and the speeds of both invention and diffusion.** For much of human history, innovation had been primarily a byproduct of normal economic activity, punctuated by a periodical flashing insight that produced a macroinvention, such as water mills or the printing press. But sustained and **continuous innovation resulting from systematic R&D carried out by professional experts was simply unheard of until the Industrial Revolution**”. (Mokyr, 2010)

# A menu for economic growth during industrial revolution...

- During the Enlightenment → Baconian scientific method was reclaimed
- Institutional development occurred → the three «C»
- Taxation
- Entrepreneurship
- Change in the input costs (induced innovation)

# The role of experimentation



Sir Francis Bacon (1561 – 1626)

«For we cannot command Nature except by obeying her»

- Before: very scarce knowledge of mechanism underlying phenomena; Pre-1800 society, both in Europe and in other parts of the world, was able to develop many extremely useful techniques without, usually, understanding why and how they worked
- The transition that took place in the eighteenth century was from a world in which useful knowledge was empirical, unsystematic, more often than not little more than a tacit set of “understandings” of how nature worked and how materials behaved and reacted to heat and motion, to a technological paradigm in which **this kind of knowledge was collected and analyzed in a systematic and organized fashion and useful knowledge increasingly became the dynamic agent that changed the economy.**
- Baconian method, which is based on experimentation and inductive reasoning, was reclaimed by the scientific community.
- Empirical methods has been the primary tool for knowledge expansion

# Institutional developments

- Secure property rights, and limits on the predatory behavior of people in power are seen as the root of economic growth → expansion of commerce, credit, and more labor mobility were the main propulsive forces
- At the same time created favorable condition from transitioning from a trade-driven economy to a innovation-drive economy
- “Market for ideas” → knowledge exchange
- Three criteria:
  - Consensus
  - Contestability
  - Cumulativeness

# Consensus

- Knowledge can be characterized as tight when it is held by a wide consensus and with high confidence, in which case it is more likely to lead to applications
- Laws of nature were viewed as firm and there was little interest in miracles or magic
- In the eighteenth century, the assessment of experimental data, mathematical logic, and improved observation tools to bear on deciding what could be widely accepted was right matured

# Contestability

- Implies limit to intellectual authority
- It is represented by suppression of new ideas (notions of heresy or black magic) which could undermine the status quo
- By the beginning of the century such episodes were rarer, allowing new ideas to flow

# Cumulativeness

- Is the effective passage of knowledge from generation to generation
- Depends strongly on institutions, that have to be effective in the provision of knowledge storage device such as books or other artifacts.
- «The age of Enlightenment took a special delight in compiling books that summarized existing knowledge, added sophisticated and detailed drawings that elaborated the operation of technical devices, and placed these books in public libraries. The growth of scientific books and periodicals in the eighteenth century was impressive. An analysis of the topics of the books published in the eighteenth century presented shows that the proportion books published on “Science, Technology and Medicine” increased from 5.5% of the total in 1701–1710 to 9% in 1790–1799. As the absolute number of books published in the British Isles tripled over this period, this implies a quintupling of the total number of such books» (Mokyr, 2010)



# Cumulativeness

- Cumulativeness of tacit knowledge depended on both formal and informal intergenerational transmission mechanism
- «In the eighteenth century, Oxford and Cambridge had little impact in this regard, but the Scottish Universities taught many useful topics and trained many of the key figures in the Industrial Revolution. **But artisanal skills and that mixture of intuition and experience that may best be called a technological savoir faire were accumulated and passed on from generation to generation by means of personal relationships, usually father–son or master–apprentice.**» (Mokyr 2010)

# Access cost

- Knowledge exchange and its cumulation were possible thanks to decreased access costs
- Are the costs incurred by anyone seeking knowledge by another person or storage device
- Can be physical (e.g. the cost of the book) or institutional (e.g. development of schools and universities)
- It has been affected by the development of the market for ideas and the decline of secrecy in the generation of useful knowledge
- Technological advancements itself (especially in communication and transportation sectors) provided further decline of this costs

# Taxes

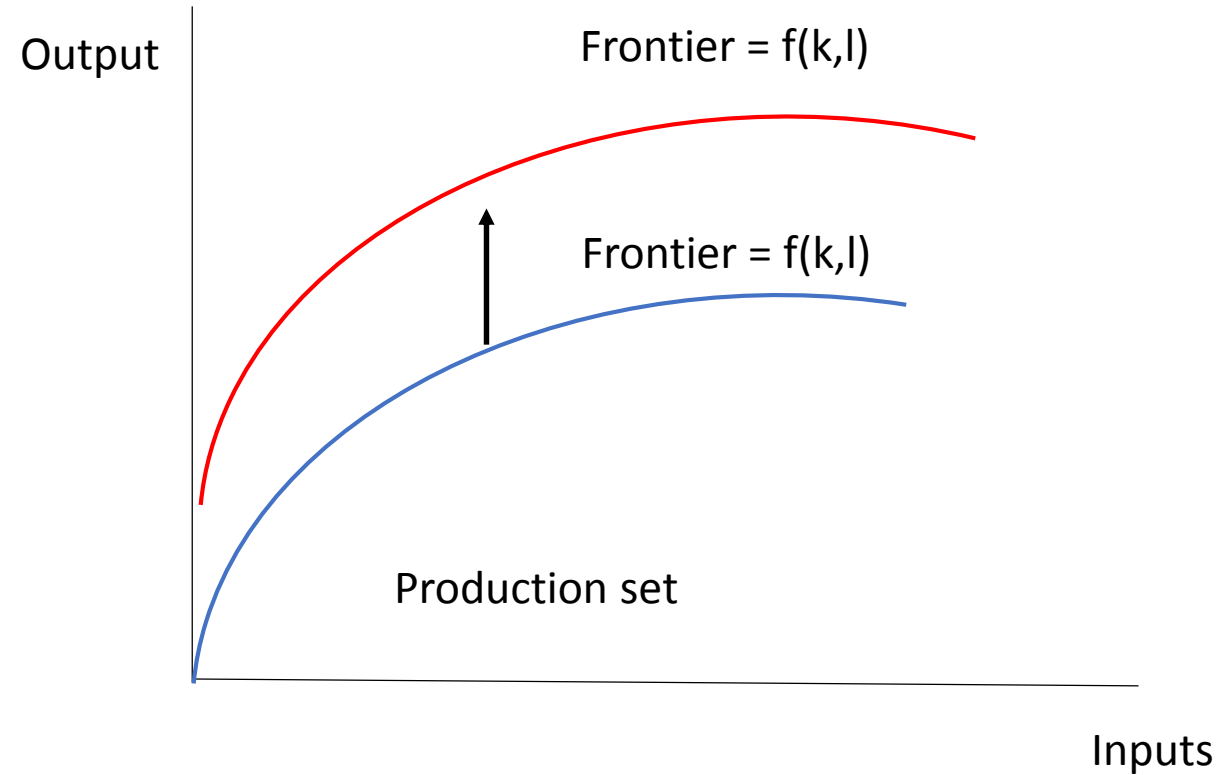
- Institutions were not expropriating profits of innovation and entrepreneurs
- Tax income came from middle class goods such as sugar, tobacco, alcoholic beverages (trade was taxed)
- Profits were usually employed by industrialist to advance their social status
- Taxation started after Napoleonic wars, but economy continued to expand in the direction of innovation

# Entrepreneurship

- Innovators were excluded from long term credit
- Access to credit came in the form of informal networks where a businessman could invest in different projects
- These private networks allowed the creation of partnerships between innovators and businessmen based on trust → no opportunistic behaviour because of reputational concerns
- More and more often the innovator and the entrepreneur were two distinct figures (more on this with Schumpeter...)

# Induced Innovation

- $y = f(k, l)$
- Where:
  - $y$  = output
  - $k$  = capital (input)
  - $l$  = labour (input)



Additional Slides

# Properties of technology

- Decreasing marginal product; only one input, *ceteris paribus*; short run
- Return to scale (constant, increasing and decreasing); all the inputs; long run
- The effect of technology in the long run are of interest in this course

# Innovation

- Innovation is a new idea, device or process which can be viewed as the application of better solutions that meet new requirements, inarticulated needs, or existing market needs.
- This is accomplished through more effective products, processes, services, technologies, or ideas that are readily available to markets, governments and society.
- The term innovation can be defined as something original and, as a consequence, new, that "breaks into" the market or society.
- From the firm point of view, innovation affects return to scale...



- Technological progress manifests itself in different ways:
  - Increase in production, capital and labour being equal
  - Creation of new products
  - Improvement of consumption goods
- If we make explicit the effect of technology:
$$y = f(k, l, a)$$
- Its effect is not direct, but can influence the productivity of the inputs (k,l)
- What happens in the economy if TC increases the productivity of capital or labour? (we assume CRS)