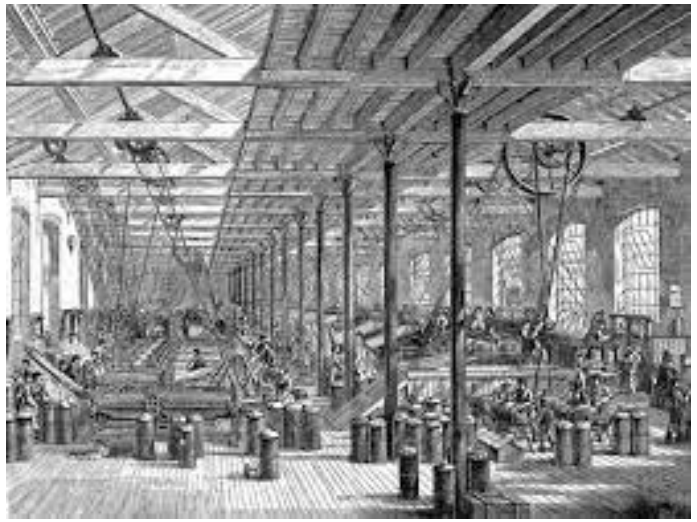
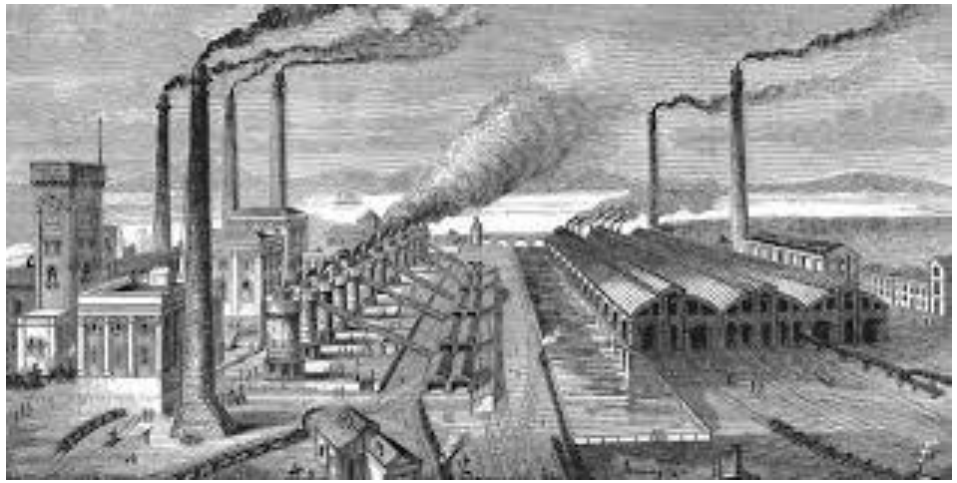
An industrial revolution?

Causes, consequences, and debates





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Advanced Economic History

Session 3

29/09/2025

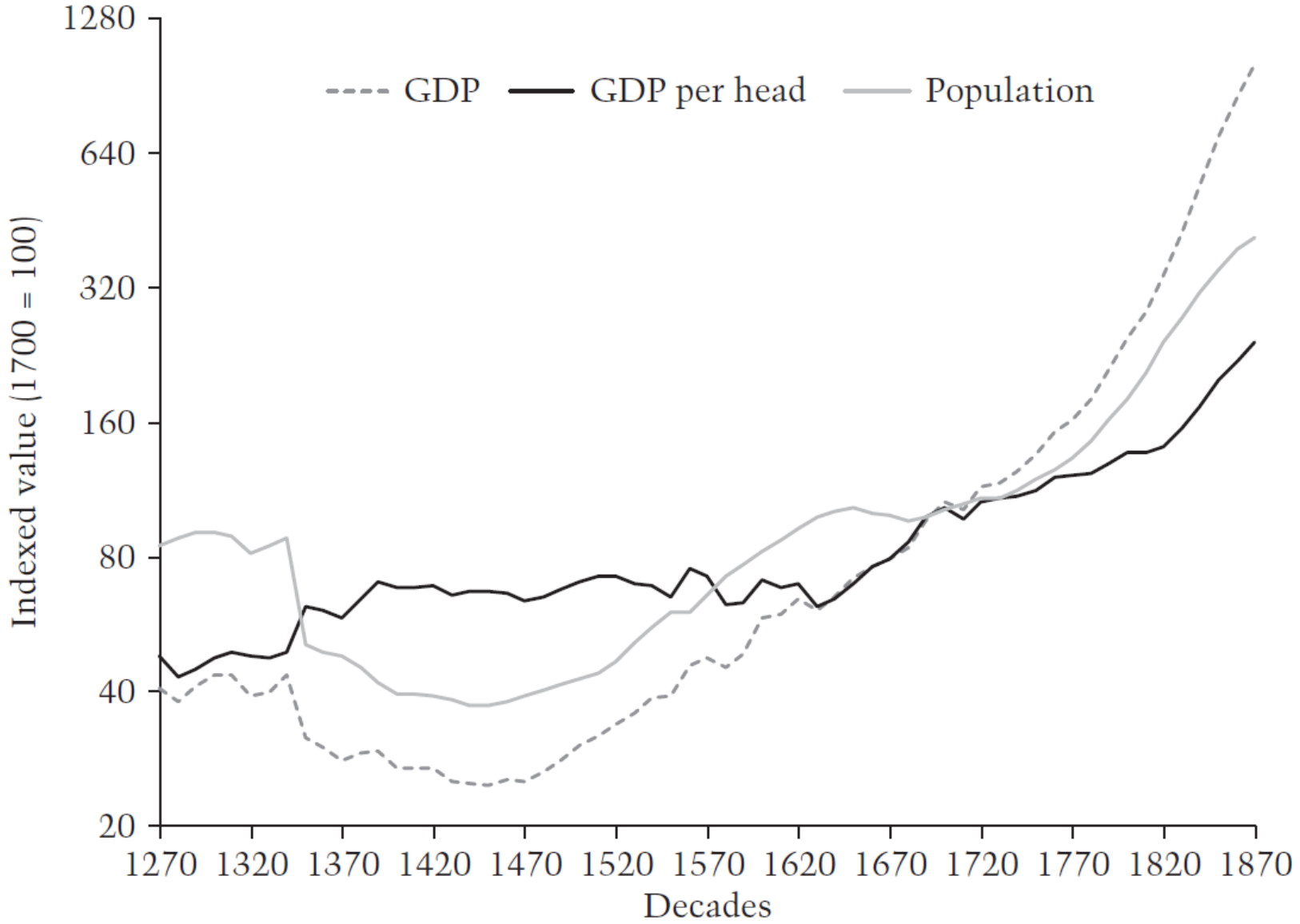
The Industrial Revolution and beyond: explanations and debates

- What caused the industrial revolution? Old and new explanations [Today]
  - Gradual or progressive? Accounting for the industrial revolution.
  - Cultural or material? Economic incentives for adopting new inventions.
  - Changing the narrative (1): from the local to the global.
  - Changing the narrative (2): women, children, and family in the IR.
- The material side of the industrial revolution [Wednesday]
  - Role of energy, resources and materials in the IR.
  - Another view of the IR: material flow analysis.
  - Environmental costs of the IR.
  - Human and social costs.

General settings: one path to economic growth?

- Explaining the Industrial Revolution
  - IR = decisive break in economic history, with growth of output, output per head and population.
  - Why Europe first? And in Europe, why Britain first?
  - Also: issues of measurement, accounting, etc.
- Do material causes explain the industrial revolution?
  - Ideas vs capital: What role did economic and financial incentives play?
  - Knowledge and techniques as motor for the IR.
- Changing the narrative: women and the IR
  - Role of women and children labour.
  - Limitations to mechanization.

Population and GDP in England (up until 1700) and Great-Britain



Broadberry, Stephen, Bruce M. S. Campbell, Alexander Klein, Mark Overton, and Bas van Leeuwen. 2015. *British Economic Growth, 1270–1870*. Cambridge: Cambridge University Press (Figure 5.5).

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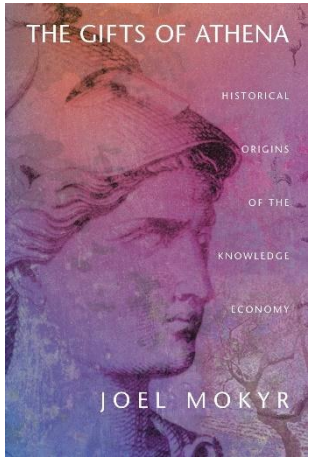
General settings (2) Definition and debates

- A popular but contested concept
  - The other side of the coin of the French Revolution.
  - A celebration of modernity, innovation, entrepreneurs… and capital.
  - Debates on the very existence of an IR: issues of scale, measurement and time.
- Industrialization as a process vs as a revolution
  - A peculiar view of modernity: linear, heroic, western-centric…
  - In reality, a long running process with setbacks, conflicts, winners and losers.
  - Connotations of the word varied over time, in relation with economic conditions of the present.
- The long shadow of a myth
  - Persistence of the concept until today (second, third, fourth… IR).
  - Used to promote technology as a solution to social problem (or: technology as a remedy to politics).

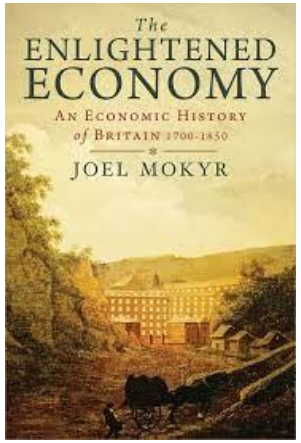
What explain the IR? Or: why Britain first?

- Ideas
  - The rise of ideas (Mokyr): change of values: generate a "technology-friendly" environment.
  - Cultural argument (Mccloskey): change of values: "searching for profit" becomes the norm.
- Machines
  - Decisive inventions and they implementation, capital accumulation…
  - Material argument (Allen): Britain's high wages that oriented the adopted technology to energy-using technology.
- People
  - The rise of manufacture (Berg): decisive transformation of way to organize labor (and labor-machine interactions).
  - Industrious revolution (De Vries): people started to work more because of their desire for marketed goods.
  - Role of women and children (Berg, Humphries…): increase in paid labor that fed the industrial development.
- Institutions
  - Institution argument (North & Weingast): solving the commitment issue allows investments to flow.
  - Institution argument (Acemoglu): efficient economic institutions are key to growth, but determined by (and determining) political power.
  - The rise of the fiscal state (Brewer, Hoffman): expansion of war favor development of a fiscal state promoting economic growth.
- Resources
  - Geographic argument (Pomeranz): ecological constraint in China (lack of land) and lack of coal.
  - Colonization: compensate for lack of resources (land, wood…)
  - Or accidental (cf abundance of coal in Britain).

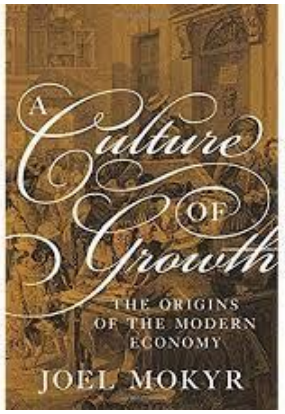
Ideas explain the industrial revolution (Mokyr)



2002



2009



2017

The importance of access to knowledge

- Decline in access costs to science: diffusion of knowledge
  - Network of knowledge.
  - Republic of letters.
  - A culture of growth.
- A painful and progressive transformation of the way people saw technology: change in the way people see the natural world.
- Need not only invention but also skilled workers.

- And material causes?
  - Productivity in England is already higher than on the continent as better nutrition and agriculture.
  - Too much changes to be explained by one single factor.

Technology during the industrial revolution

- A linear model
  - → Straight way to think about technology and science.
- Knowledge and techniques
  - Effective or not.
  - Consensual or not.
- Technical singleton
  - Limits the efficiency of R&D.
  - Dominates before the IR.

Knowledge market

- The key role of access
  - Knowing what is known.
  - But also where to find it, how to access it, how to verify it, etc.
- Knowledge market
  - Technology to access it.
  - Institutions (experts, etc.).
  - Culture of knowledge.
- Mokyr: strong decline in access cost
  - Codifiable knowledge: Encyclopedia, journals, patents, etc.
  - Non-codifiable knowledge: Academia, scientific society, experts, industrial spying, etc.

The enlightenment: culture and technological change

- Why would culture matters?
  - Trust.
  - Positive institutions and social externalities.
  - Technological friendly environment.
- Transformation of the way people see knowledge
  - More circulation of knowledge, more openness.
- Specificity of Europe?
  - Open to invention from abroad.
  - Fast adoption of others' innovations: No cultural arrogance.
  - Some kind of rebellion is necessary to invent: No respect for previous inventions.
  - Less true in other part of the world?

Why is it different in Europe?

- The role of Christianity (Lynn White)
  - Relationship between man and nature.
  - Medieval Christianity turned anthropocentric: creator rational (and not erratic or capricious).
  - Need to understand the logic of the way the world work and use it to our advantage.
- Monks
  - Worked and thought.
  - Monastic culture.
  - Making clocks (Mumford).
  - "The first intellectual to get dirt under his fingernails"

The Baconian program

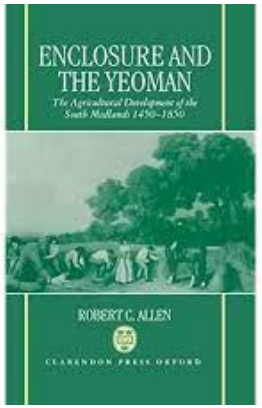
- Roger Bacon (1214-1294) and Robert Grossetête (1168-1253)
  - Utilitarian view of science vs speculative view.
- Francis Bacon (1561-1626).
  - *The Advancement of learning*, 1605.
  - "Human knowledge and human power meet in one, for where the cause is not known the effect cannot be produced. Nature to be commanded must be obeyed" (Bacon 1620 quoted in Spolaore 2020).
- A pragmatic program.
- Concrete influence
  - Royal society, *L'Encyclopedie*, etc..

The cultural argument: what matters is how people see the world

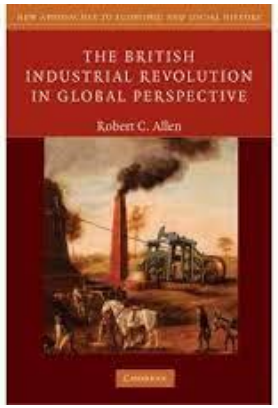
- The gift of Athena: Role of "useful" knowledge in the IR. Changing view of science.
- The Enlightened Economy: describes the changes in all sectors of the economy (and society) and links them to the Enlightenment.
- A culture of knowledge: frames the evolution in change in culture and discuss the global model.

- But…
  - The culture of knowledge concerns a (very) tiny minority of the population.
  - The link with actual inventions/improvements is uncertain.
  - The link with economic growth is strongly contested.

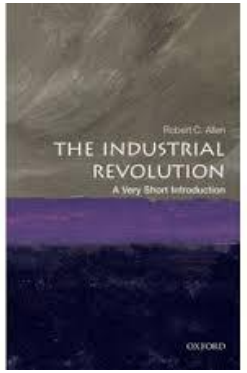
Material causes <u>do</u> explain the industrial revolution (Allen)



1992

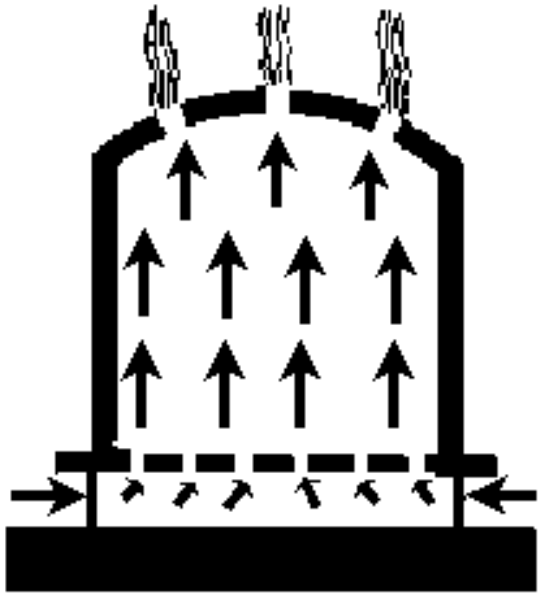


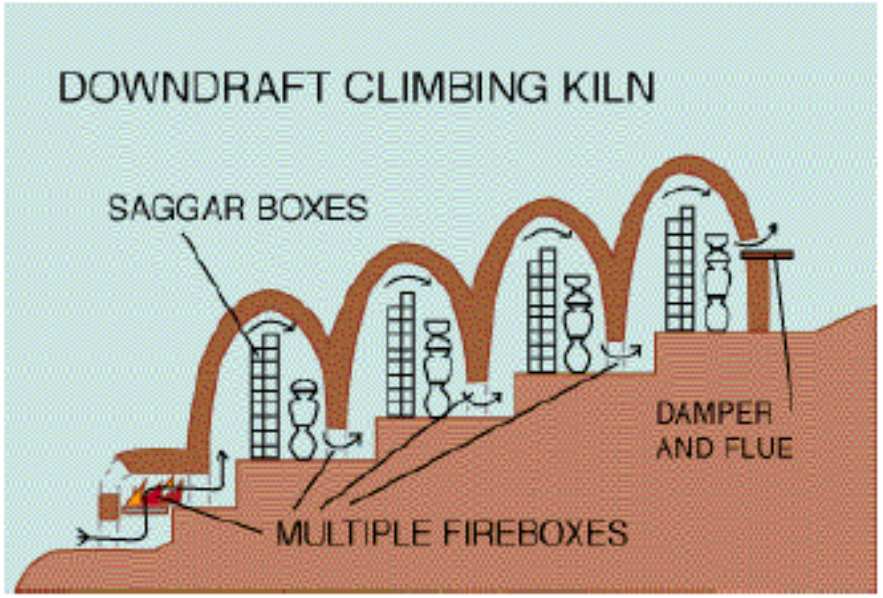
2009



2017

Technology and labor intensity: Pottery in Britain and China (Allen)



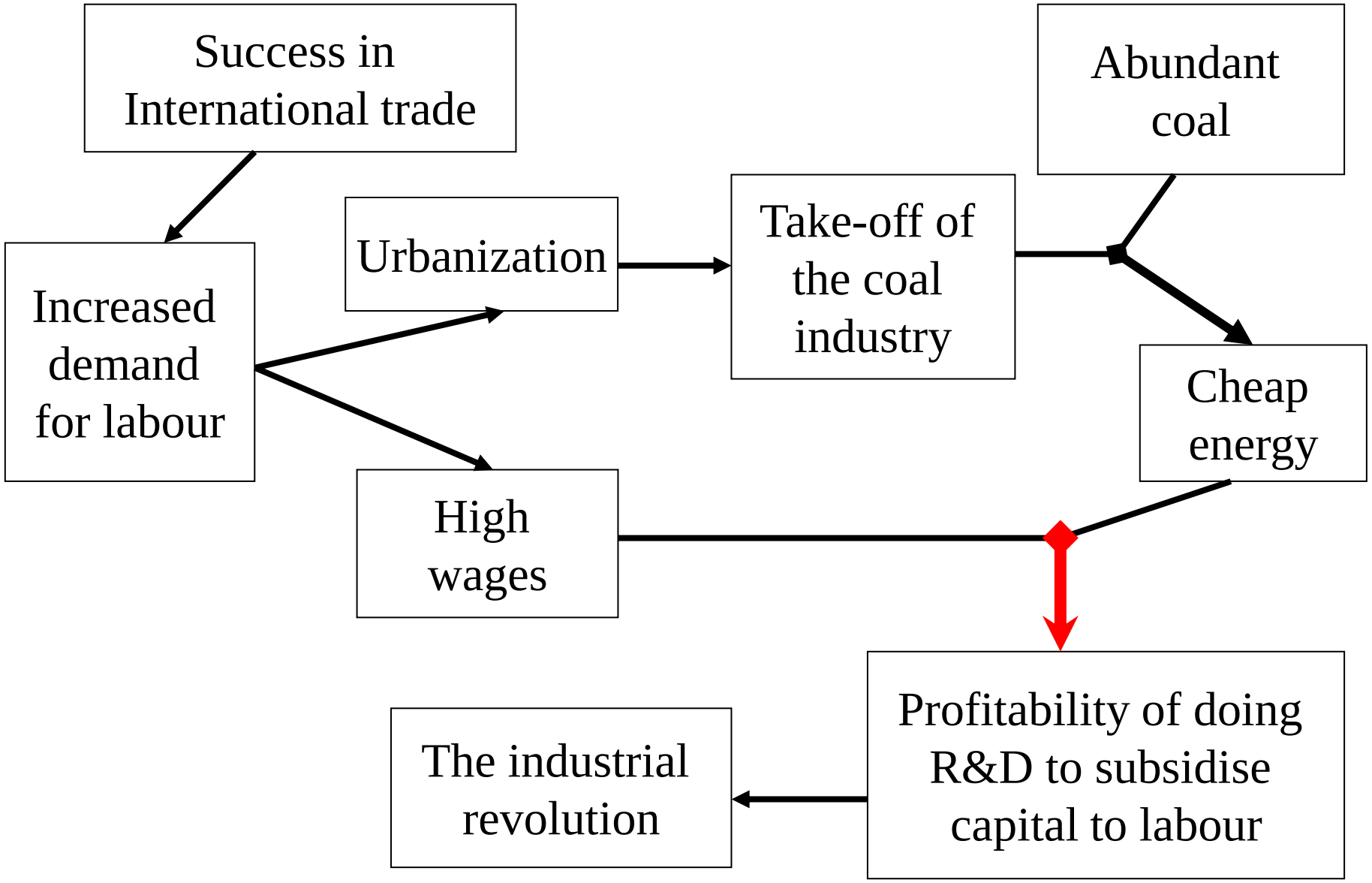


Material causes <u>do</u> explain the industrial revolution (Allen)

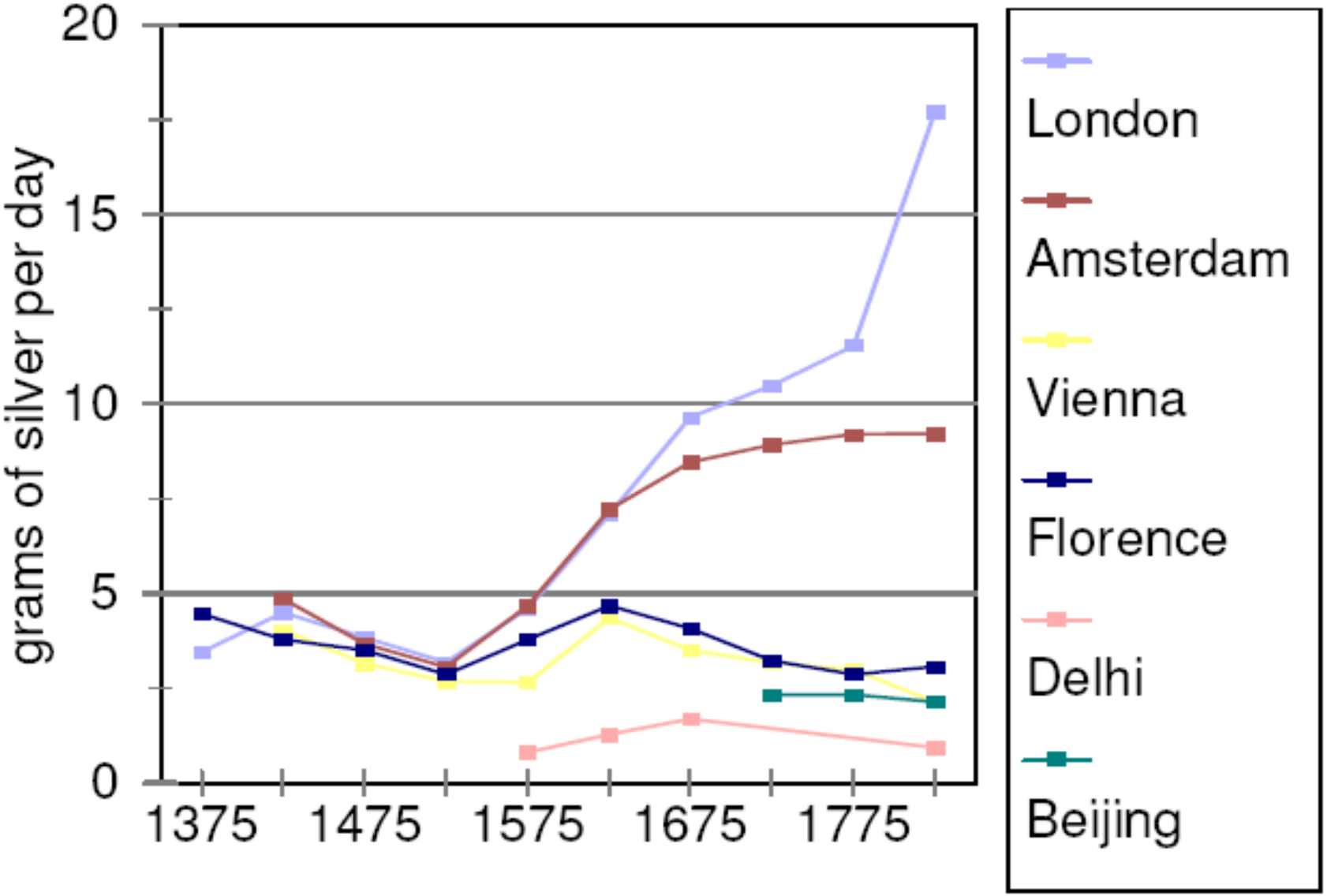
<u>Key argument</u>: Capital-labour substitution drives the IR

- Capital accumulation is a consequence and a complement of technological changes.
  - A simple macro-economic model of Britain 1760-1860.
  - Counterfactual analysis of the IR.
  - Technology improvement goes together with capital accumulation.
  - This explain why inequalities rise during the IR.
- High wages explain technological progress
  - Britain is a high wage, cheap energy country.
  - This promotes technologies that substitute capital for labour.
  - Which lead to the technological revolution that produces the IR.

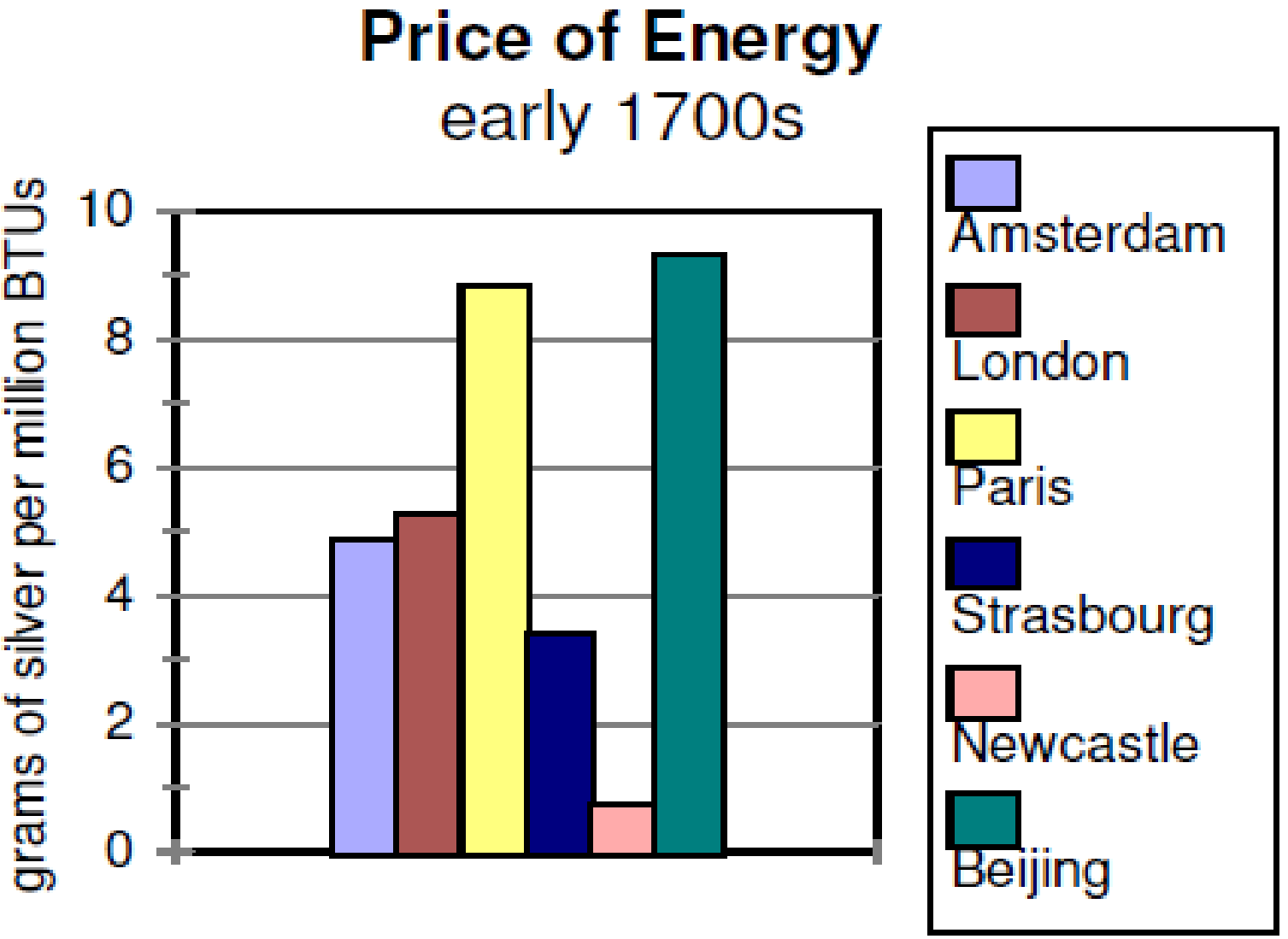
The origins of the British industrial revolution (Allen)



Labourers' wages around the world



Price of energy around the world



Why was Britain unique?

- Success in the international trade
  - Result from a state policy.
  - Wages increased.
  - Demand for new goods and import substitution.
- Coal abundant and *cheap*.
  - Relative price of labour to energy is high.
  - Fast growing of coal industry (London).

The consequences of Britain's uniqueness.

- High wages and cheap energy incited to replace labour by capital
  - British inventions are labour saving + energy and capital using.
  - Cost reductions were greatest with British factor prices.
- R&D was profitable in Britain
  - The new inventions were made only in Britain.
- These inventions were then improved
  - They become cost-effective elsewhere and thus were adopted.

Why are “culture” explanations wrong?

- Technological breakthrough were macro-inventions?
  - No, they came from improving existing techniques.
- Scientific discoveries --that lead to technological advances-- were made for scientific rather than economic reasons.
  - No causal relation between science and technology.
- There was a spread of a new scientific culture.
  - Explains why in Europe but not why in Britain.
  - The industrial enlightenment is mainly a upper class phenomenon.

    → Elite vs popular culture.

Some famous inventions

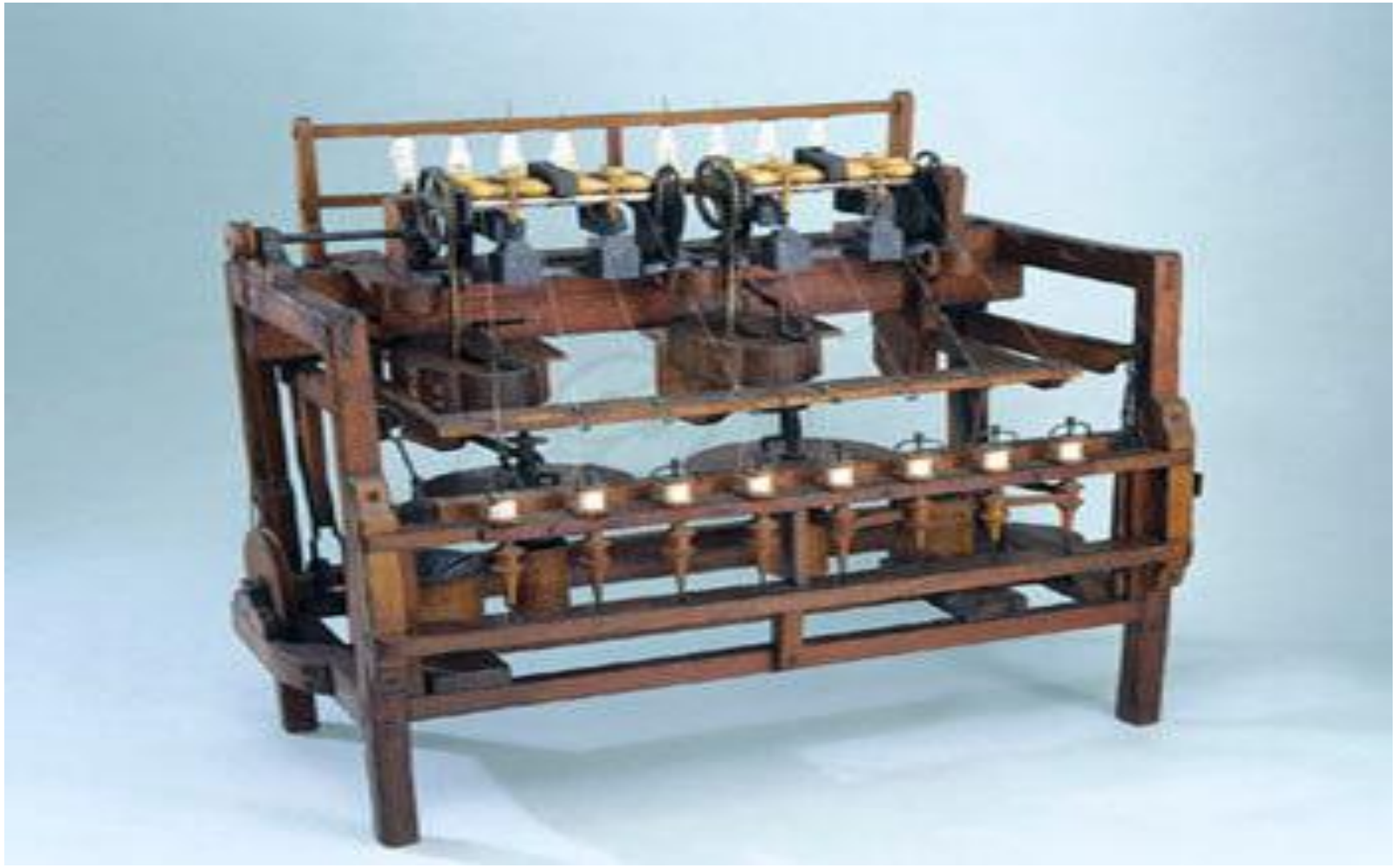
- Were they macro or micro? An act of genious or a progressive discovery?
- How were the financial cost of their development covered? Financing R&D.
- What were the specificities of these inventions in the British high wages, cheap energy context?
- Were they profitable only in Britain and not elsewhere in Europe?

Cotton spinning (1)

- Two tasks to perform:
  - Drawing the roving (cotton fibres) to make it thinner.
  - Twisting it to make it stronger.
- Hargreaves' spinning jenny is nothing more than an upgraded spinning wheel.
- Arkwright's water frame is more original…
- … but it borrows a lot to Wyatt and Paul's rollers…
- … who indeed take them from metallurgy.

A spinning wheel

Arkwright's "water frame" (roller spinning)



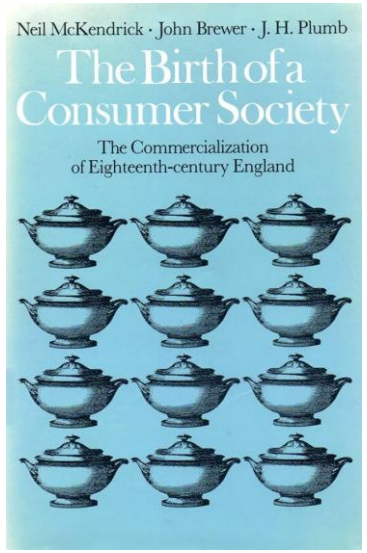
Arkwright's "water frame": the clockwork

Humphries, Jane, and Benjamin Schneider. 2019. "Spinning the Industrial Revolution." The Economic History Review 72 (1): 126–55.

Cotton spinning (2)

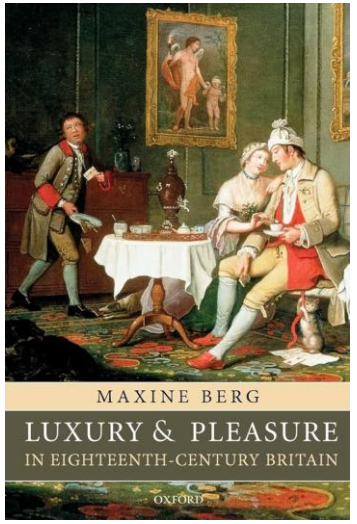
- A series of micro-inventions.
- It was motivated by competitiveness because English wages were high.
- And motivated by growing domestic and foreign markets.
- The same was true in France… But:
  - The cost of the technology wasn't worth the labour saved:
    - 373 days labour in France.
    - 140 days labour in Britain.

The industrial revolution is a consumer revolution

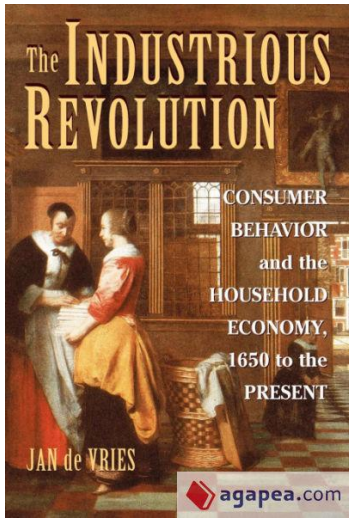


1982

2000



2007



2008

Putting people to work

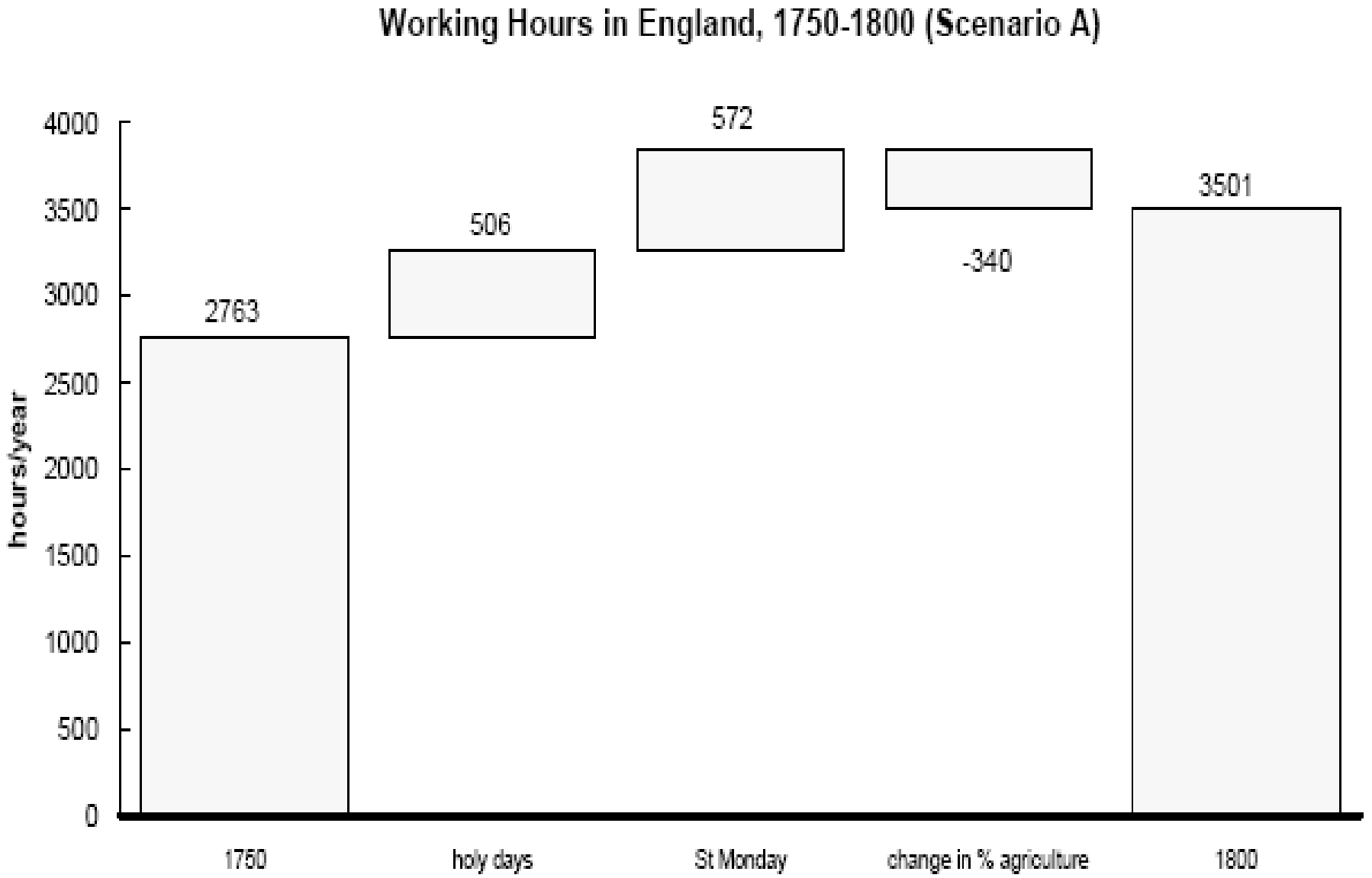
- A set of changes from mid-17e century
  - Stagnation of real wages and increase in consumption for large share of the population.
  - Increase in population and urbanization.
  - Increase in women and children work.
  - Cultural change on the demand side: affirmation of desire for goods.
  - Overall: development and better integration of the labor market.
- Two (main) conflicting interpretations
  - Constraint: the role of enclosure (Marx) and the control of the labor force (Thompson, Foucault…).
  - Incentive by consumption : the Industrious revolution (De Vries, Voth…).
  - Link with proto-industrialization?
- Measuring the industrious revolution
  - Hans-Joachim Voth (2001): testimonies from judiciary records.
  - Allow to reconstruct the activities of a typical day, and hence duration of work.

Working more to buy more

> "In this framework the industrious revolution, for which evidence can be found from the mid-seventeenth century into the early nineteenth, consisted of two transformations: the reduction of leisure time as the marginal utility of money income rose, and the reallocation of labor from goods and services for direct consumption to marketed goods— that is, a new strategy for the maximization of household utility."
>
> De Vries (1994)

- A two-side transformation: industrious revolution & consumer revolution.
- The industrious revolution (A. Hayami)
  - Decision making is at the family level: decision to work more. This decision is voluntary.
  - Why? "Consumer desire": increased desire for marketed goods (substitute of family production), link to both a decrease in their relative prices and changes in preferences.
  - Rise of new products: "old and new luxury".
  - Two mechanisms to increase intensity of labor: more days of work and more members of the household work (outside of it).
- Voth: increase in time at work through more days of labor.
  - Overall, duration of work per day is relatively stable.
  - But, changes in the number of day worked: « saint Monday » disappears; same for other days off.
  - Results depend on strong assumption on day off and variations in pay. Also, possible issue of representativity.

Measuring the industrious revolution: Voth (2000)



Voth, Hans-Joachim. *Time and Work in England 1750-1830*. Clarendon Press, 2000

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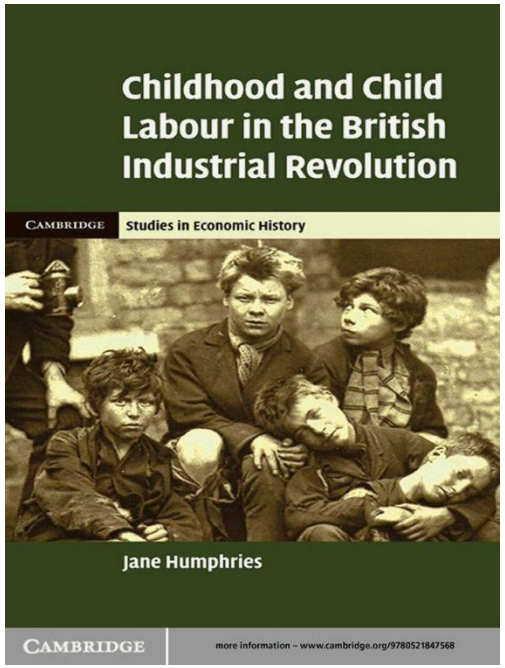
Women and children in the IR

- Humphries, Jane. 1987. "'…The Most Free From Objection …' The Sexual Division of Labor and Women's Work in Nineteenth-Century England." *The Journal of Economic History* 47 (4): 929–49.
- Horrell, Sara, and Jane Humphries. 1995. "Women's Labour Force Participation and the Transition to the Male-Breadwinner Family, 1790-18651." *The Economic History Review* 48 (1): 89–117.
- Horrell, Sara, and Jane Humphries. 1995. "'The Exploitation of Little Children': Child Labor and the Family Economy in the Industrial Revolution." *Explorations in Economic History* 32 (4): 485–516.
- Humphries, Jane. 2010. *Childhood and Child Labour in the British Industrial Revolution*. Cambridge: Cambridge University Press.



Age of starting to work

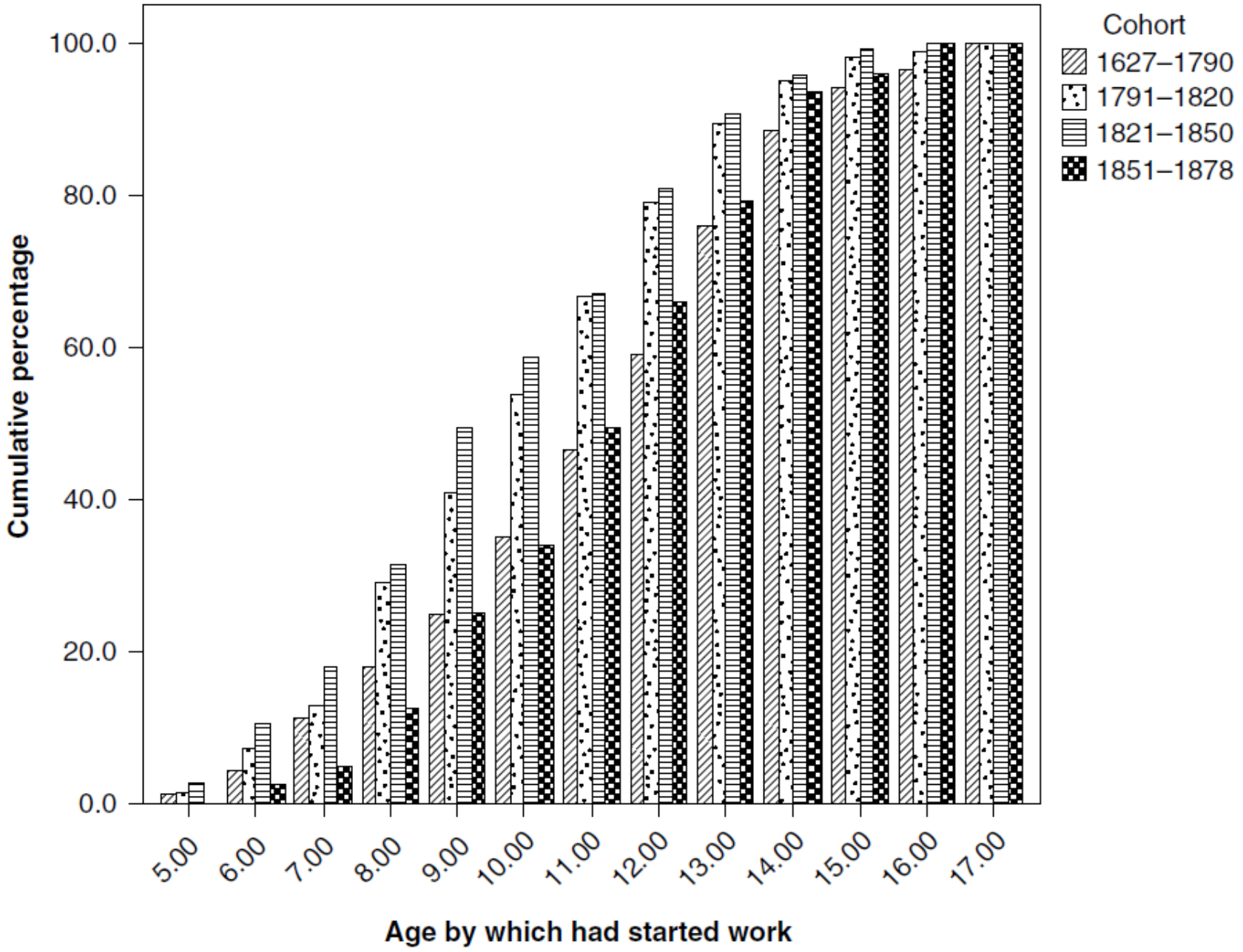


Figure 7.1 Percentage of boys at work, by age

Humphries, Jane. 2010. *Childhood and Child Labour in the British Industrial Rev*

A high wage economy? Whose wages are we talking about?

"The hidden bias in all the existing estimates of productivity growth and distribution of the labor force is that they are based on male occupational categories. A male industrial revolution has been presented to us as the general experience."

Berg (1994)

"But this consensus is based on trends in indices of the real wages of males calculated from surviving labour and product market data. […] Measuring the impact of industrialization on family living standards merely by changes in the male wage, with no recognition of the importance of these issues, leads to distortion of the complex transition that occurred and neglects vital factors in the determination of family welfare."

Horrell and Humphries (1995)

- The story of women participation in the labor market is not a complement to the history of (men) labor, it is the history itself.
- Role and place of both women and children work during the IR neglected by mainstream historiography.

Women and children contribution to the high wage economy

- Humphries, Jane, and Benjamin Schneider. 2019. “Spinning the Industrial Revolution.” *The Economic History Review* 72 (1): 126–55.
- Allen, Robert C. 2020. “Spinning Their Wheels: A Reply to Jane Humphries and Benjamin Schneider.” *The Economic History Review* 73 (4): 1128–36.
- Humphries, Jane, and Benjamin Schneider. 2020. “Losing the Thread: A Response to Robert Allen.” *The Economic History Review* 73 (4): 1137–52.

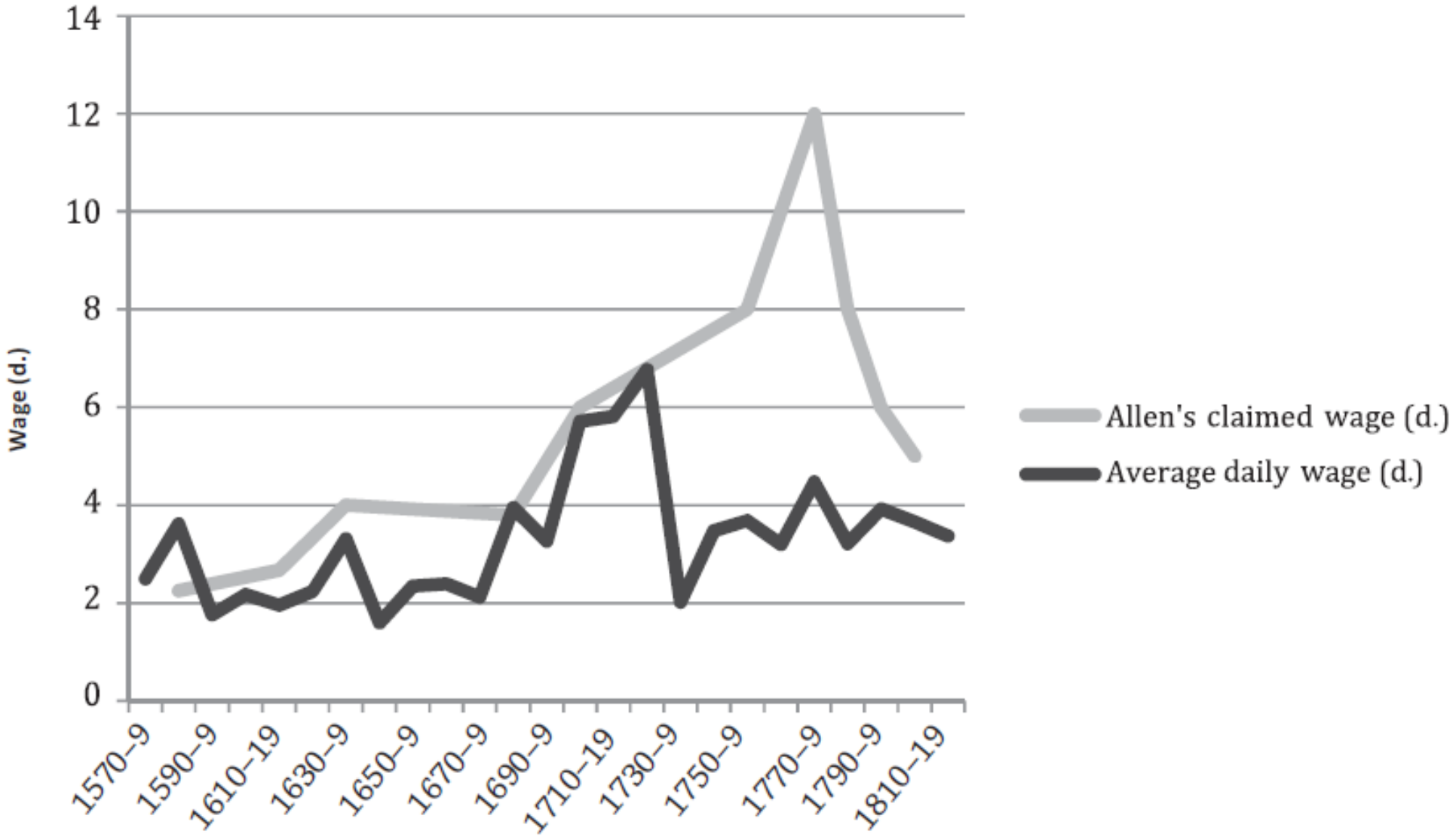
Spinning the Industrial Revolution

- Key argument of Allen is substitution labor-capital
  - Textile is one of the key area where is should be observed.
  - But proof is difficult to assess due to the many constraints for evaluating wages, and their evolution.
  - Allen (and Muldrew) argue that hand spinning wages increased precisely at the time of adoption of the jennys.
- But evidence is scarce
  - Mainly piecework at home. True quantity of labor is difficult to assess.
  - Variations in the quality of fiber, in the techniques employed (more skilled than most people think), etc.
- More importantly, estimates come from indirect observation from people involved in the trade.

Spinning the Industrial Revolution (2)

- A better evaluation of wages, through actual production data
  - Estimating productivity based on parish account books (lbs of yarn per week).
  - Estimating remuneration based on record of payments and merchants' account book.
  - Comparing single and married women to get a sense of working time.
- Overall, both productivity and remuneration are much lower than previously thought.
- More importantly, little change over time.

Evolution of daily wages by decades



Humphries, Jane, and Benjamin Schneider. 2019. "Spinning the Industrial Revolution." The Economic History Review 72 (1): 126–55.

Spinning the Industrial Revolution (3)

- Spinners were not included in the high wages economy of Allen.
- A lot of the increase in production is linked to the extensive margin (and not mechanization or productivity gain).
- Costs were kept low by delocalization (North of GB and then Ireland).
- Important role of pauper labor, under constraint (workhouses).
- Strong dependency on employers.

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Wrapping up: explaining the IR

- Need to relativize the very idea of an industrial revolution
  - More a continuous (but not linear!) process than a "Revolution".
  - A very western centric view.
- Ideas vs machines
  - The rise of ideas and the birth of a "technology-friendly" environment (Mokyr).
  - Britain's high wages oriented the adopted technology to energy-using technology (Allen).
- Demand vs supply side
  - Industrious revolution: the desire for marketed goods (De Vries).
  - Role of women and children cheap labor to fed the industrial development (Berg, Humphries).
- Resources and energy
  - Geographic constraint: China vs Britan (Pomeranz).
  - The rise of coal and the motor of the industrial revolution.