# Why the industrial revolution was British: commerce, induced invention, and the scientific revolution

By R. C. Allen

*Revolution time: about 1760 to 1840*

# Main Reasons

**High wages:**

Increased the supply of technology by enabling British people to acquire education and training

**Cheap energy:**

Cheap to use fuel for machines

This configuration led British firms to invent technologies that substituted capital and energy for labour.

# Approach

- Focus on the sources of invention and analyse these in terms of the demand and supply of new technology.
- Use international comparisons of wages and prices.
- Wages were exceptionally high compared with parts of Europe and in Asia, while prices of capital and energy were exceptionally low

# Approach

- **Demand:** by giving British an exceptional incentive to invent technology to substitute capital and energy for labor
- **Supply:** technology was also augmented by high real wage. Population was better placed to buy education and training

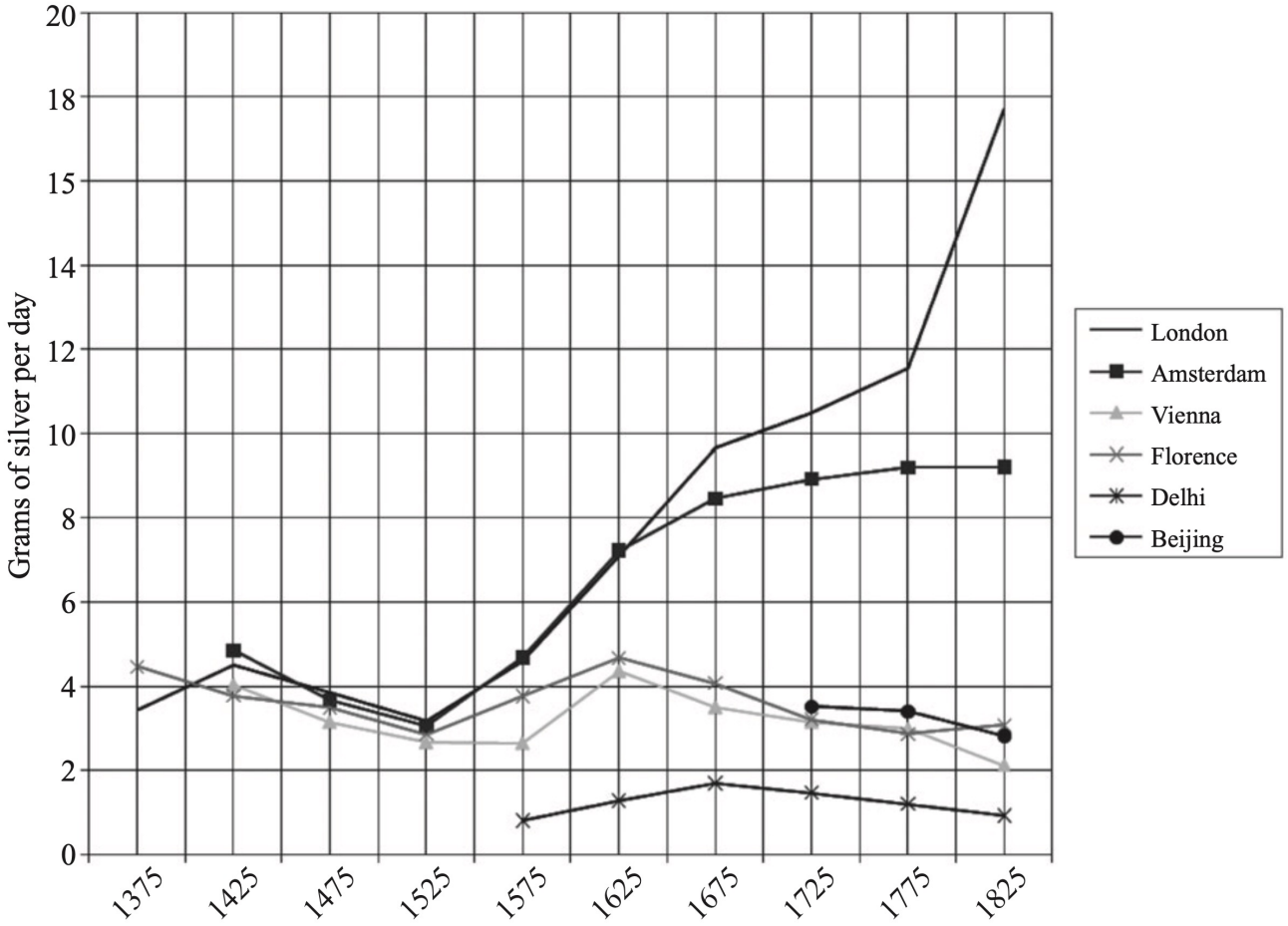



Figure 1. *Labourers' wages around the world*

divergence in nominal wages was minimal in Europe at the end of late middle age

In Beijing, Canton, Japan, and Bengal, labourers earned between one and two grams of silver per day—less than half the wage in central or eastern Europe

Did Britain's high nominal wages translate into high living standards or were they offset by high prices in Britain?

Welfare ratios are defined as full-time annual earnings divided by the cost of a basket of consumer goods sufficient to keep a family at a specified standard of comfort—in this case at minimal subsistence.

Baskets are constructed with most spending on the grain that was cheapest in each locality

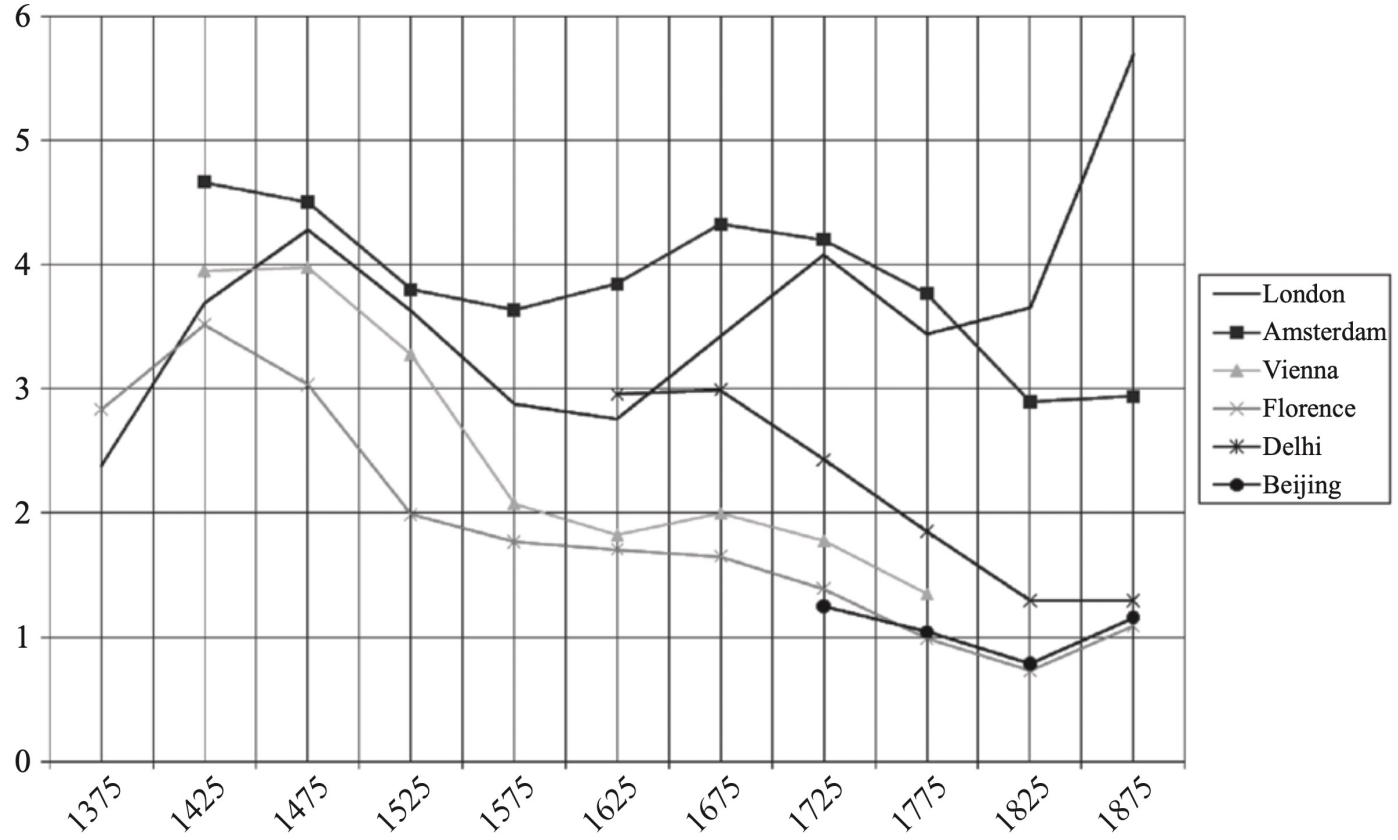



Figure 2. *Subsistence ratio for labourers: income relative to cost of subsistence basket*
*Source:* See text.

real incomes were high everywhere in the fifteenth century : Black Death

Earned three to five times of living cost then bought luxuries food or non-food
In contrast, real living standards fell dramatically across the Continent, reaching a level of about one.


*Wage rate relative to price of capital*

In England, labour became increasingly expensive relative to capital from 1650 onwards. This rise reflects the inflation of nominal British wages at the time.

In contrast, the ratio of the wage to the price of capital declined gradually in Strasbourg and Vienna

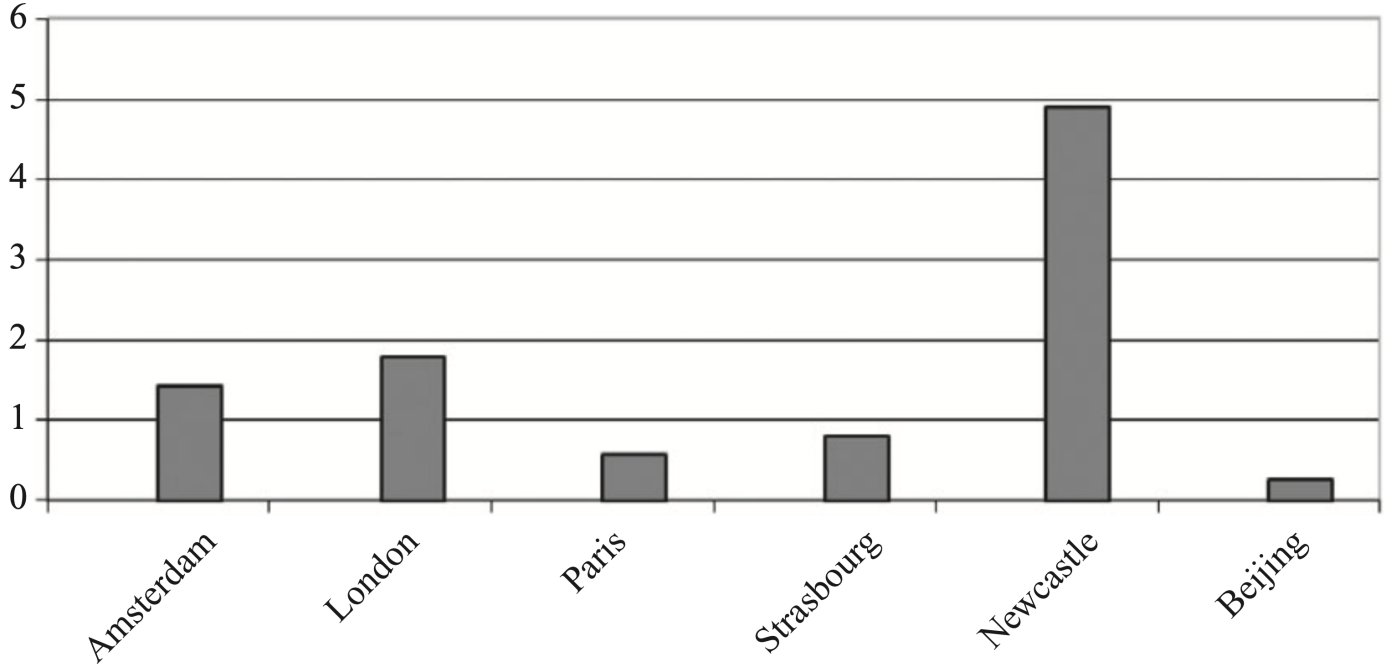



Figure 4. *Wage rate relative to price of energy*

The ratio is calculated for the cheapest fuel available in each city—coal in London and Newcastle, peat in Amsterdam, charcoal or firewood in the other cities.

The high cost of labour relative to fuel created a particularly intense incentive to substitute fuel for labour in Britain.

# Explanations of unique wages

- Success in the global economy, which was in part the result of state policy.
  - International trade and colonial trade and markets
- Geographical—Britain had vast and readily worked coal deposits.
  - Coal industrial took off with population growth which made coal much cheaper compared to elsewhere

# Explanations of unique wages

**International trade:**

began with the export of ‘new draperies’ in the late sixteenth century.

exported woollen cloths to the Mediterranean

Labor demand Resulted in population growth: 1500-1600-1700, population of London grew 5k to 200k then to 400k (80 times)

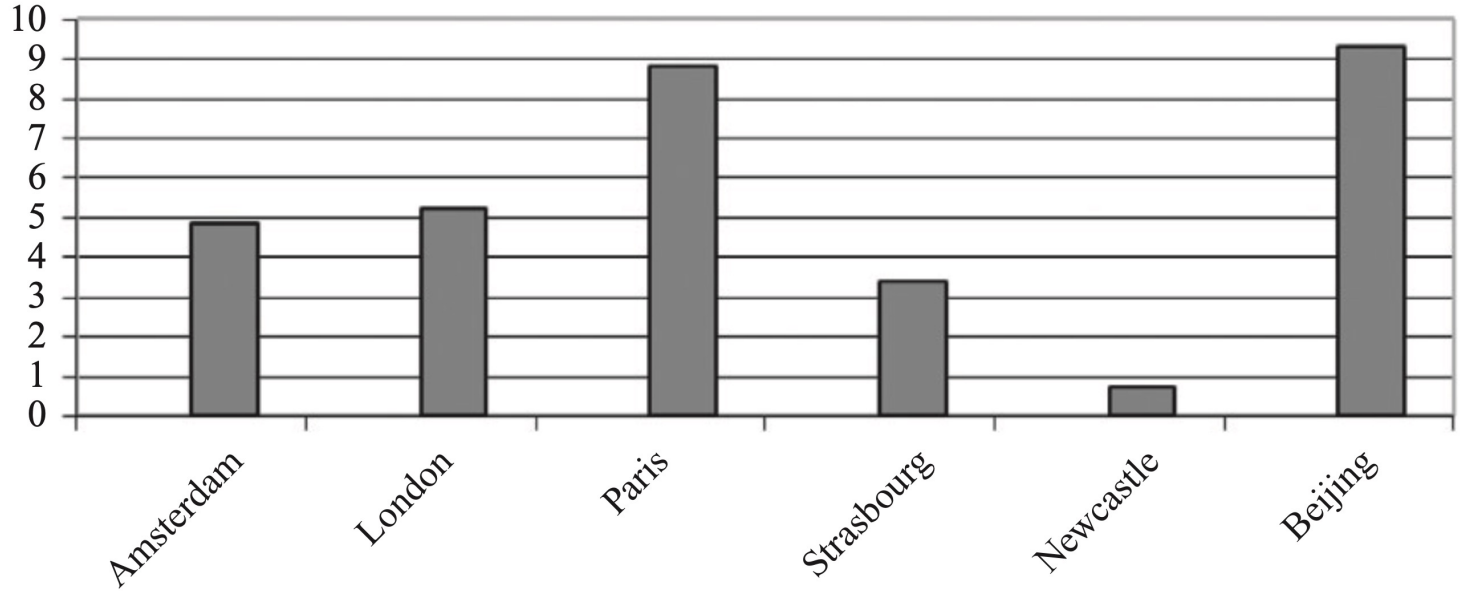
Colonial trade increased and markets expanded

# Explanations of unique wages

**Coal deposits:**

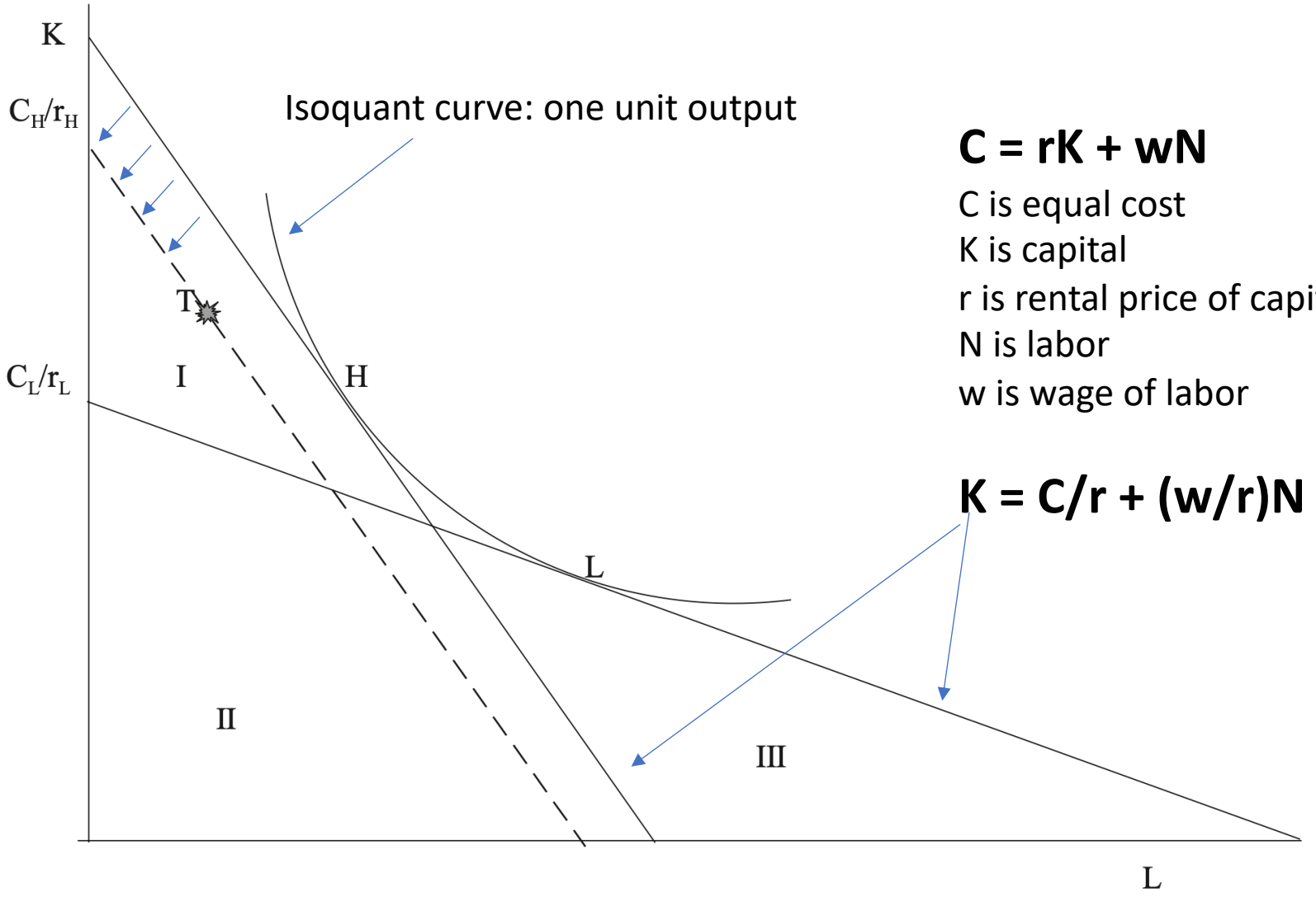
- First, coal was not just abundant in Britain—it was cheap
- inexpensive coal raised the ratio of the price of labour to the price of energy (figure 4)
- Cheap energy contributed to the fall in capital prices relative to wages, and thus contributed to the incentive to substitute capital for labour.
- Secondly, coal was a ‘natural’ resource, was available in unlimited supply at constant real cost from the fifteenth to the nineteenth century.
- shipments of coal from Newcastle to London began their rapid growth.

# Price of energy, early 1700s




5. *Price of energy, early 1700s*

# Adopted new technology



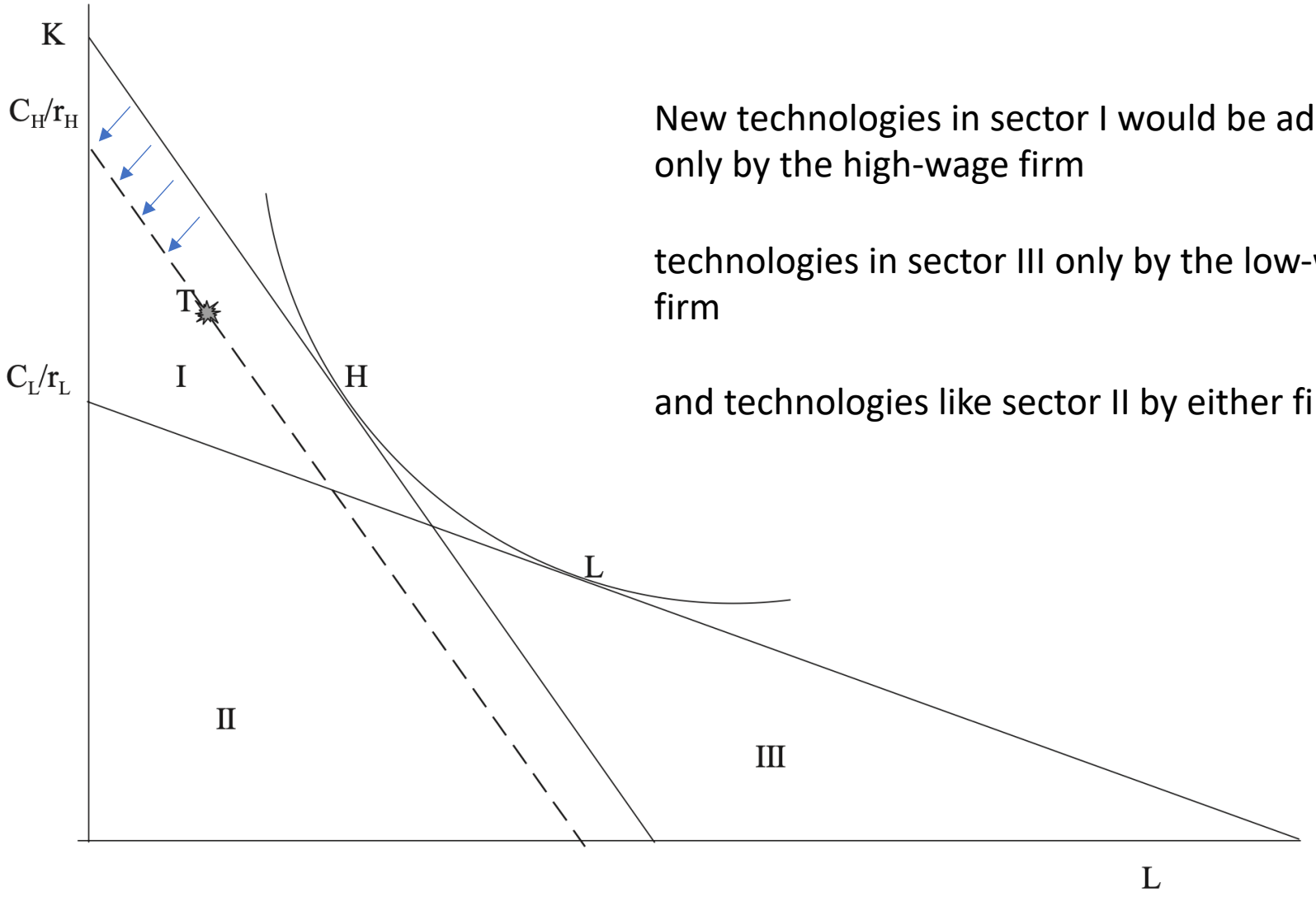

**C = rK + wN**

C is equal cost
K is capital
r is rental price of capital
N is labor
w is wage of labor

**K = C/r + (w/r)N**

. *Biased technical change*

# Adopted new technology




New technologies in sector I would be adopted only by the high-wage firm

technologies in sector III only by the low-wage firm

and technologies like sector II by either firm.

. *Biased technical change*

# Examples

**machines to spin cotton:**

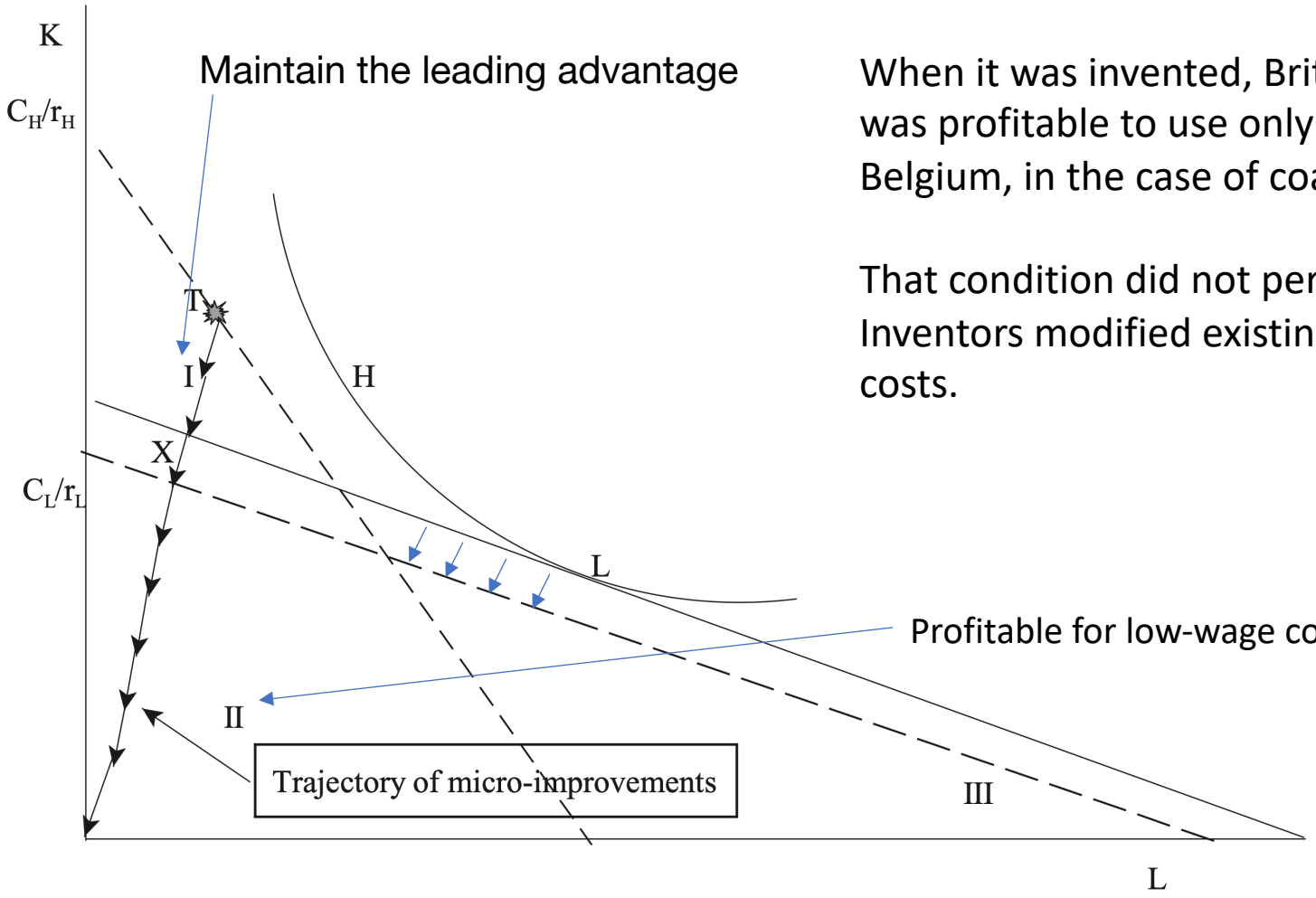
biased technical changes that raised capital–labour ratios

were profitable to use

Dropped from 35 days per pound to 8 days per pound (offset costs of capital)

the rate of return was 40% per year was higher than in France

# Adopted new technology




When it was invented, British technology was profitable to use only in Britain (or Belgium, in the case of coal).

That condition did not persist, however. Inventors modified existing practice to cut costs.

. *The trajectory of micro-improvements*

# Why was eighteenth-century Britain different?

- The scientific revolution of the seventeenth century led to a greater understanding of the natural world and allowed new technologies to be invented.
  - Conducted lots of experiments, some applied to industrial
- Active participation of first-class scientists
  - Christiaan Huygens and Robert Hooke

# Another explanations--Culture

Cultural shifts also contributed to the industrial revolution.

- On the intellectual plain:

the industrial enlightenment refers to the application of the scientific method to study of technology

- On the social plain:

the industrial enlightenment involved a small number of unusual people working in concert.

- Propensity to invent

# Why it turned into Modern Economic Growth

- Scientific knowledge increased enough to allow continuous invention.
- Britain's pre-1815 inventions were particularly transformative, much more so than Continental inventions.