Unit 2

TECHNOLOGICAL CHANGE, POPULATION, AND GROWTH

OUTLINE

A. Introduction

B. Economic models

C. Explaining growth

D. Explaining stagnation

A. Introduction

The Context for This Unit

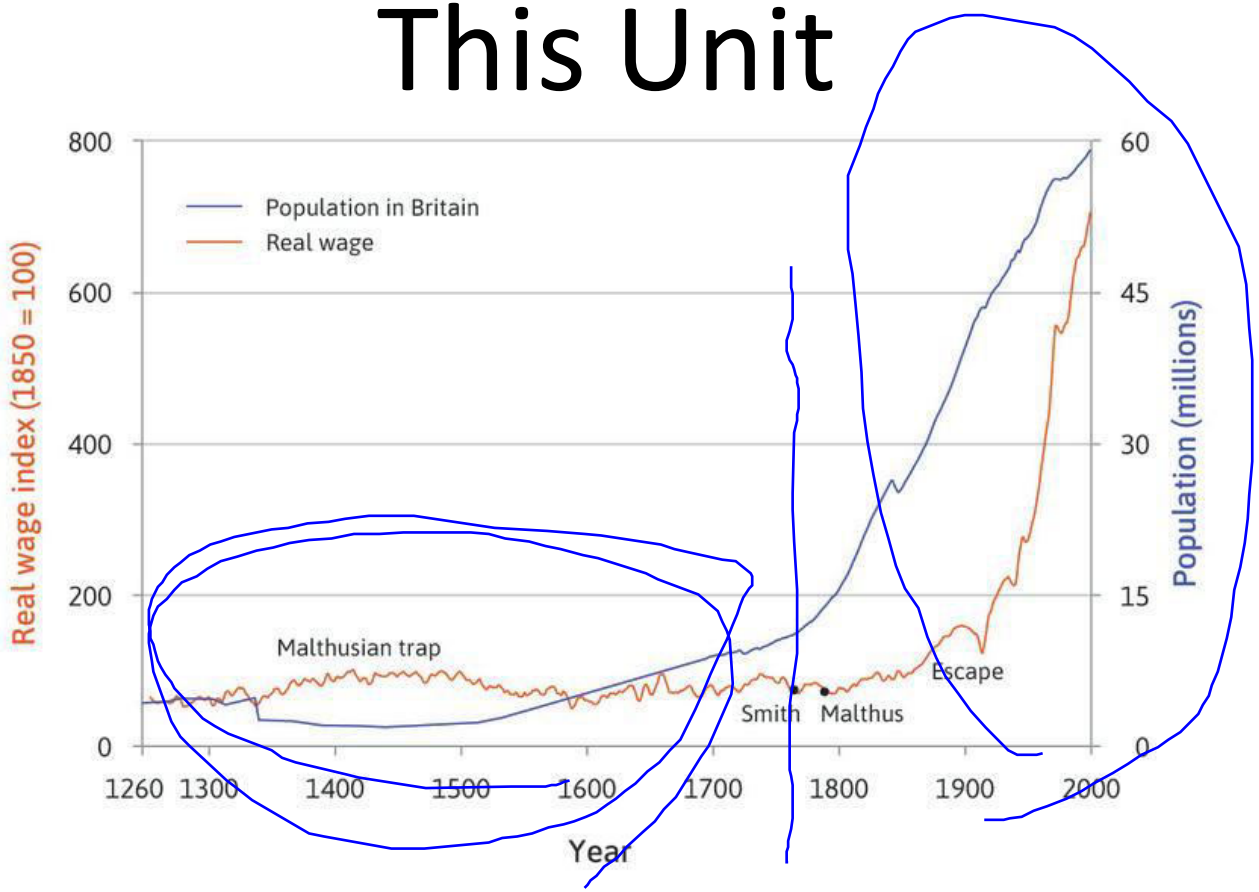
The recent rapid, sustained increase in income and living standards is largely due to technological progress.

(Unit 1)

However, these major changes started very suddenly, 200 years ago.

- How did the technological revolution start?
- Why did it not start earlier?

This Unit



Use economic models to explain the rapid growth in real wages and population in the last 2 centuries, and the stagnation in the centuries before that.

B. Economic models

Why do we need models?

What happens in an economy depends on the actions and interactions of millions of people.

We use models to see the big picture.

Building a model

To create an effective model we need to distinguish between

- the essential features of the economy that are relevant to the question we want to answer, which should be included in the model
- unimportant details that can be ignored

Models necessarily omit many details. This is their feature, not a bug.

Building a model

1. Capture the elements of the economy that we think matter for our question
2. Describe how agents act, and how they interact with each other and the elements of the model
3. Determine the outcomes of these actions (an equilibrium)
4. Study what happens when conditions change

Equilibrium of a model = situation that is self-perpetuating. Something of interest does not change unless an external force is introduced that alters the model's description of the situation.

What is a good model?

- It is clear: it helps us better understand something important
- It predicts accurately: its predictions are consistent with evidence
- It improves communication: it helps us to understand what we agree (and disagree) about
- It is useful: We can use it to find ways to improve how the economy works

Key concepts

- Less is more: **Ceteris paribus** = simplification that involves "holding other things (in/outside the model) constant".
- **Incentives** = economic rewards or punishments, which influence the benefits and costs of alternative courses of action.
- **Relative prices** help us compare alternatives.
- **Economic rent** = the benefit received from a choice, taking into account the next best alternative (**reservation option**)
  - ➢ Forms the basis of how we make choices.

C. Explaining growth

Explaining the Industrial Revolution

Why did the **Industrial Revolution** happen first in the 18th Century, on an island off the coast of Europe?

There are many alternative explanations

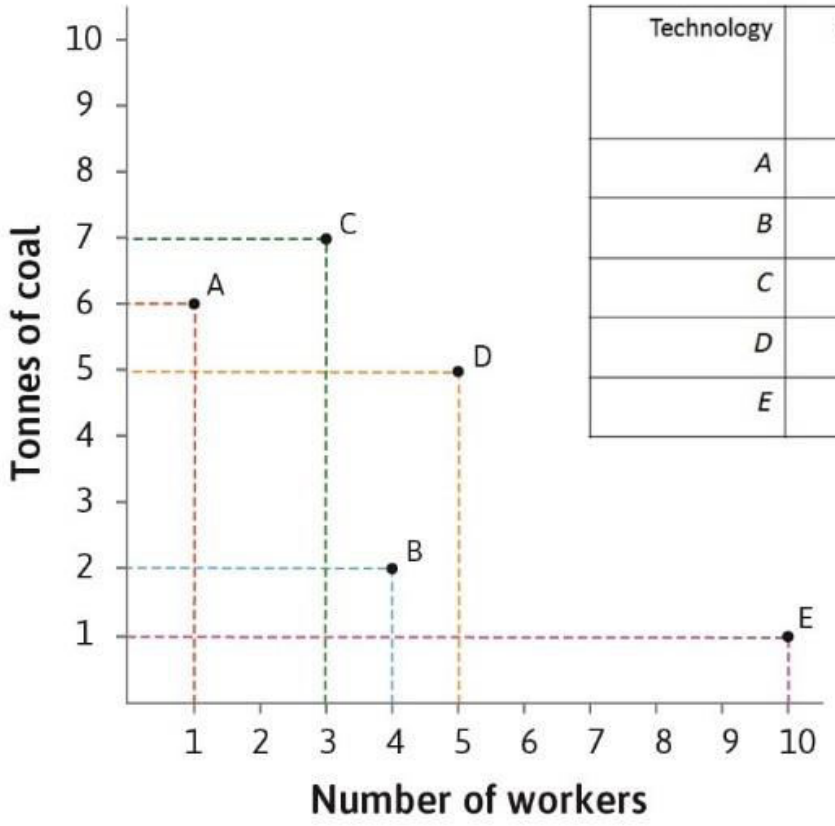
- relatively high cost of labour & cheap local sources of energy
- Europe's scientific revolution and Enlightenment
- political and cultural characteristics of nations as a whole
- cultural attributes such as hard work and savings
- abundance of coal and access to colonies

Modelling technology

Technology = A process that uses inputs to produce an output.

There are 5 different ways to produce 100 metres of cloth, using labour (number of workers) and energy (tonnes of coal) as inputs.

E-technology is relatively labour-intensive; A-technology is relatively energy-intensive.

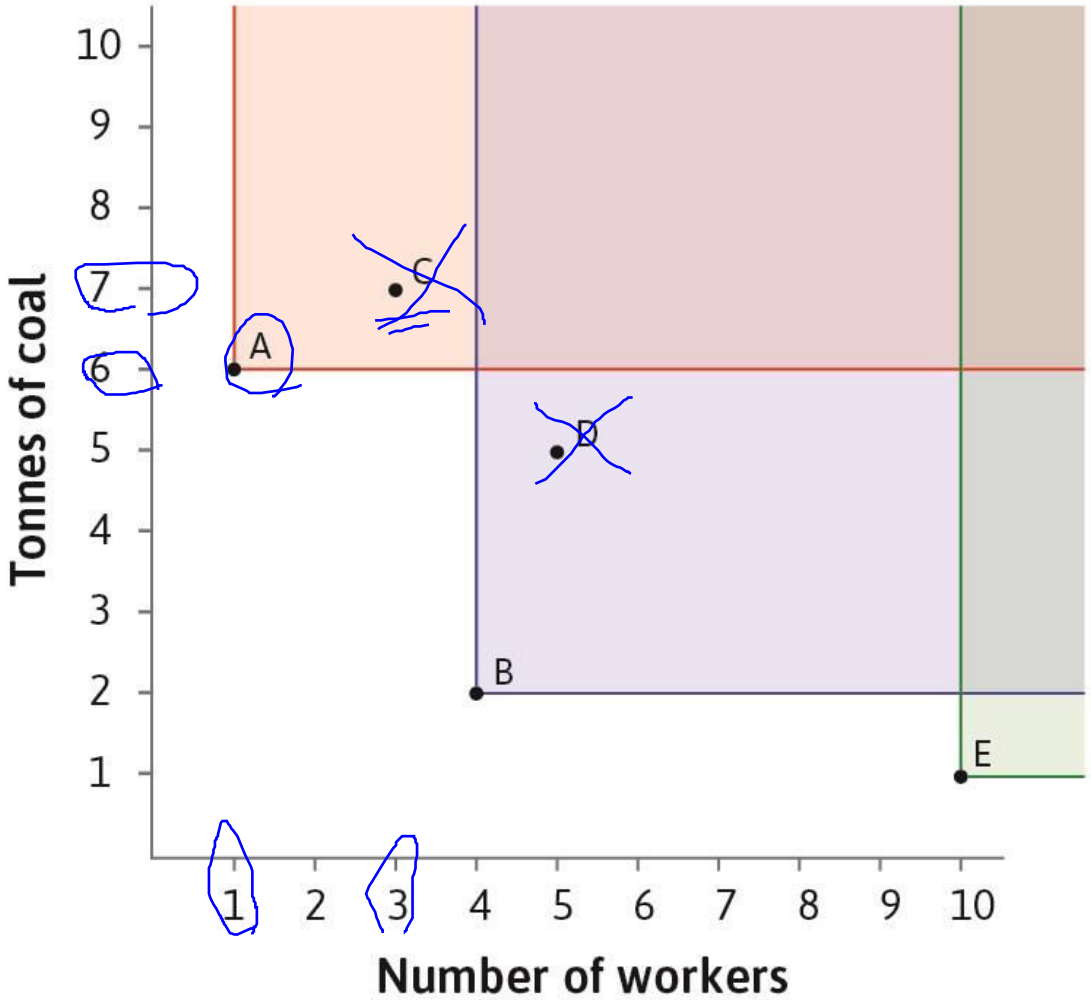


Technology	Number of workers	Coal required (tonnes)
A	1	6
B	4	2
C	3	7
D	5	5
E	10	1

Firm's choice: inferior technologies

Firms choose between technologies (specific combinations of inputs) to produce outputs.

Some technologies are **dominated** by other technologies.



Firm's choice: minimising cost

Firms aim to maximise their profit, which means producing cloth at the least possible cost.

This is why the firms' choice of technology depends on economic information about relative prices of inputs.

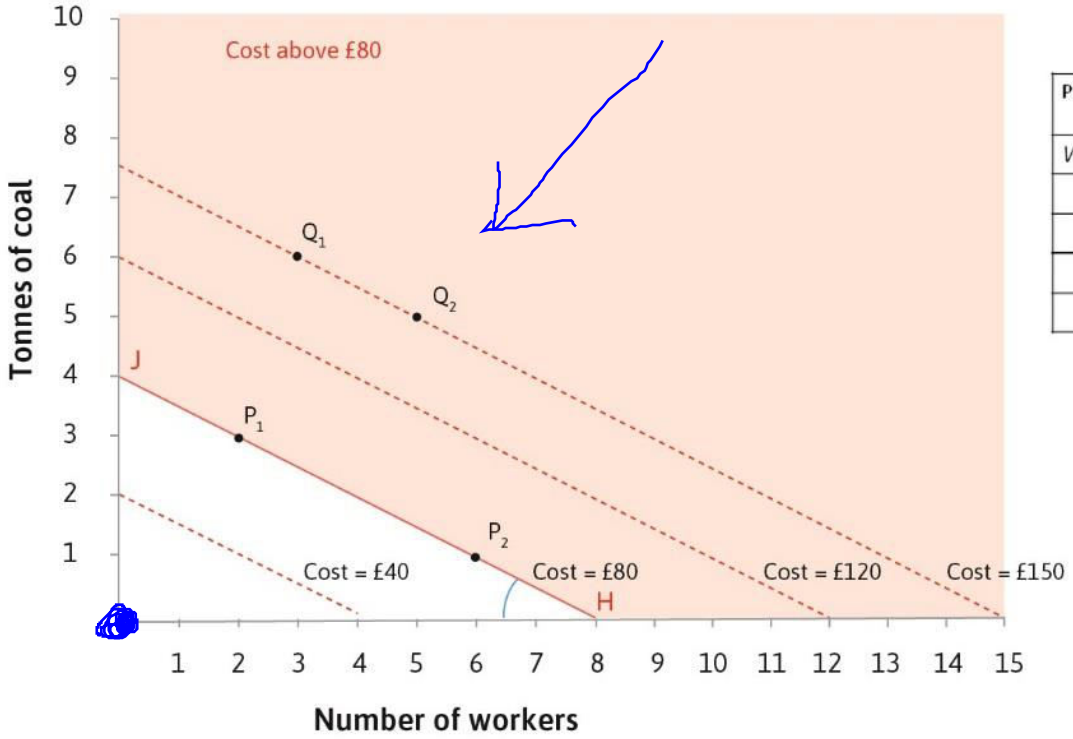
$$\begin{aligned}\text{cost} &= (\text{wage} \times \text{workers}) + (\text{price of a tonne of coal} \times \text{number of tonnes}) \\ &= (w \times L) + (p \times R)\end{aligned}$$

Isocost lines

Isocost lines = combinations of inputs that give the same cost (slope = relative price of inputs)

We can derive it from the cost equation by re-arranging it:

$$R = \frac{c}{p} - \frac{w}{p}L$$



Point	Number of workers	Coal required (tonnes)	Total cost (£)
Wage £10, cost of coal £20 per tonne			
P_1	2	3	80
P_2	6	1	80
Q_1	3	6	150
Q_2	5	5	150

Slope of isocost lines is

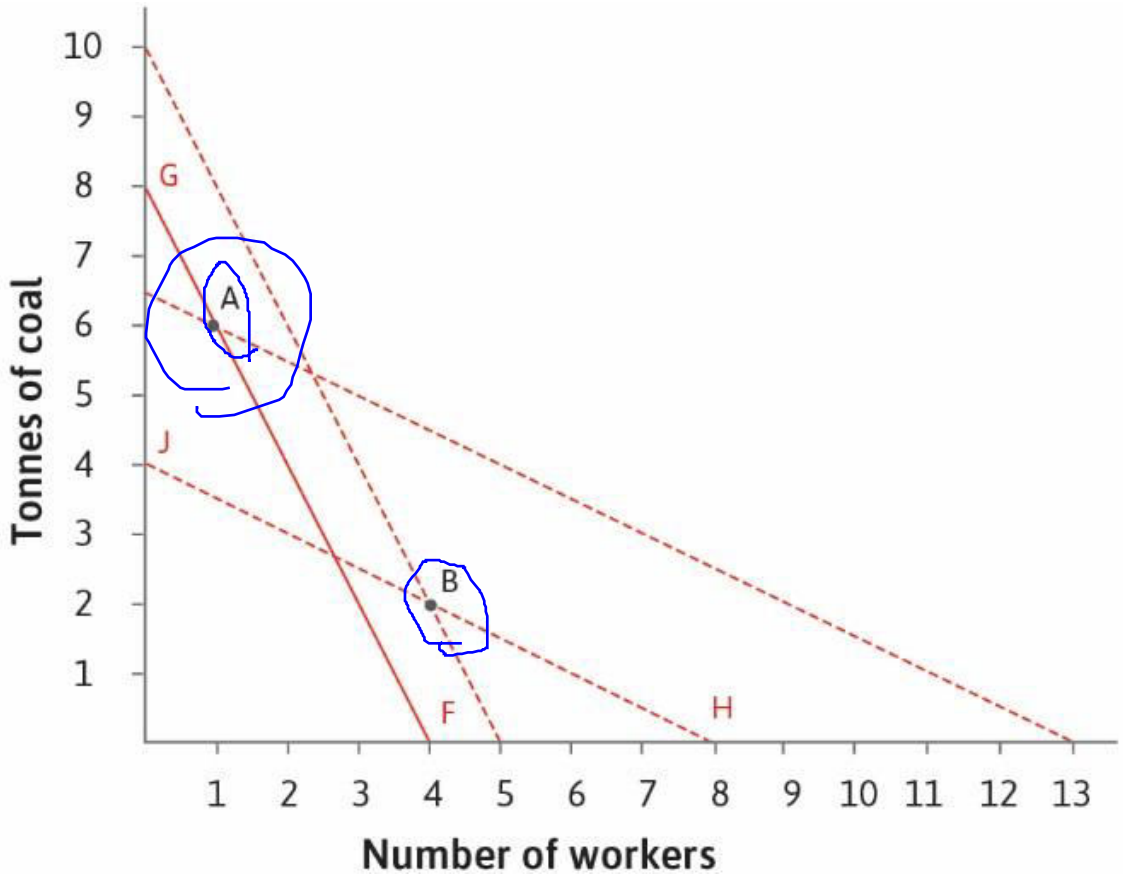
$$-\frac{w}{p} = -\frac{10}{20} = -\frac{1}{2}$$

The firm will choose the least-cost technology.

Change in relative prices in Britain

Technology was labour-intensive before the Industrial Revolution (technology B).

Increase in wages relative to price of coal in Britain create the incentive to innovate more capital-intensive technologies (technology A).



The benefits of innovation

Because relative prices of inputs changed, a firm that will switch to the new cost-minimising technology will have an advantage over its competitors.

$$\text{profit} = \text{revenue - costs}$$

The change in profit is equal to the fall in costs associated with adopting the new technology. This is the **innovation rent**.

Creative destruction

The first adopter is called an **entrepreneur**. An entrepreneurial firm is willing to try out new technologies and to start new businesses.

The first adopters will enjoy **Schumpeterian (innovation) rents**.

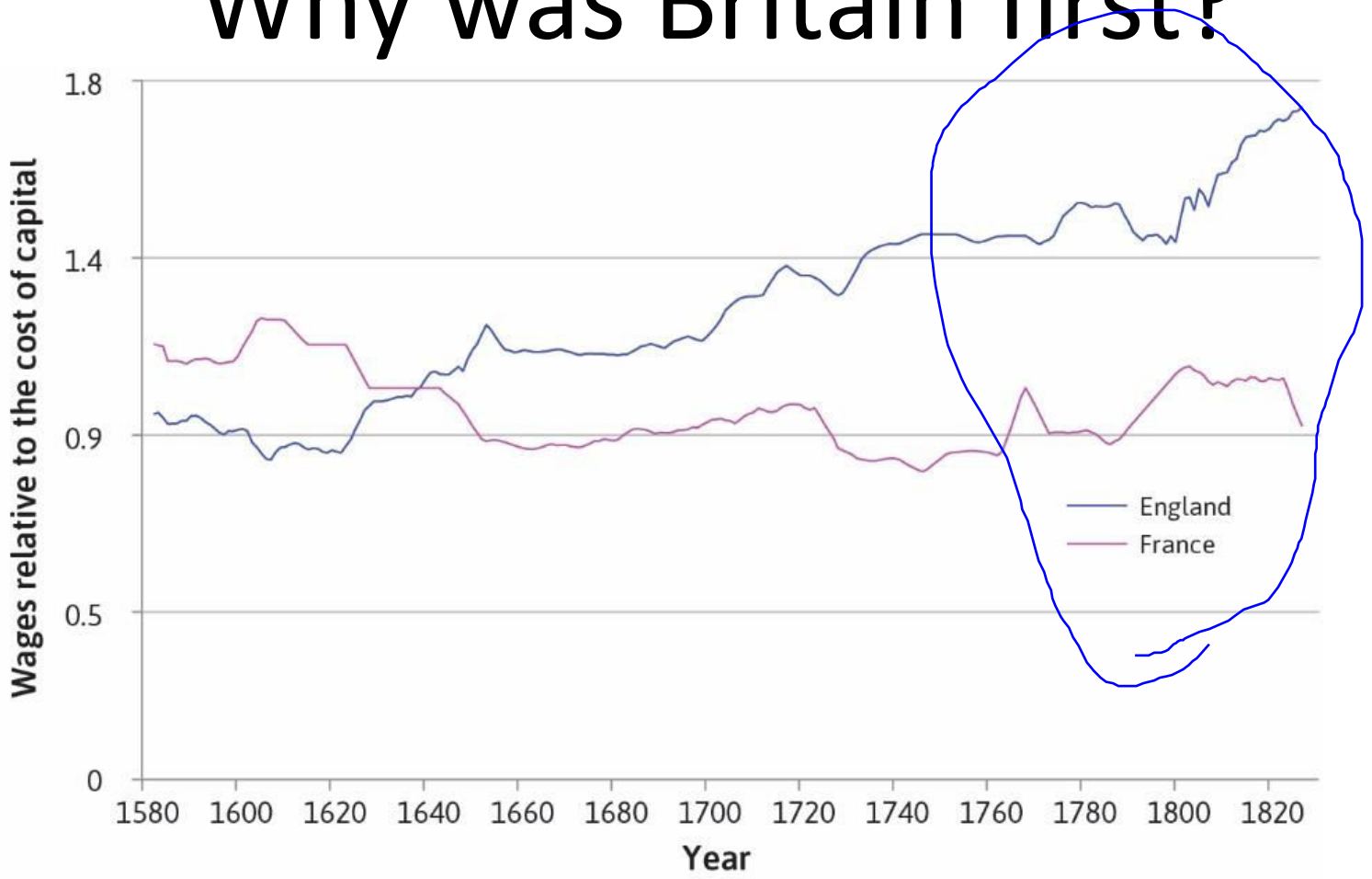
Creative destruction = the process by which old technologies and the firms that do not adapt are swept away by the new, because they cannot compete in the market.

Technological change in Industrial Revolution

One of the first sectors to undergo technological change was textiles

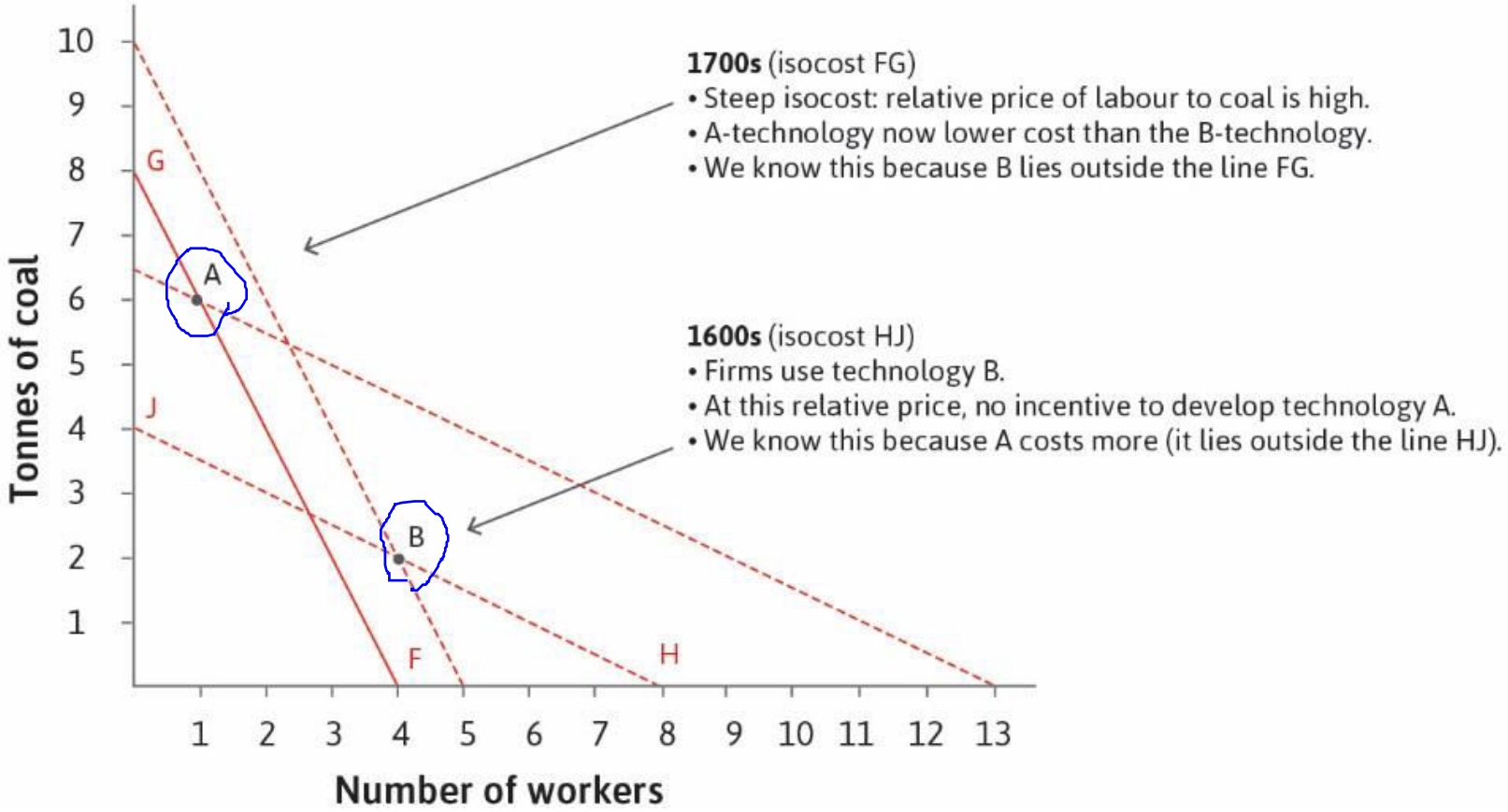
- Before the Industrial Revolution, making clothes for the household were time-consuming tasks
- By the late 19th century, a single spinning mule operated by a very small number of people could replace more than 1,000 spinsters
- These machines were powered by water wheels and later coal-powered steam engines instead of using human labour

Why was Britain first?



English wages were higher than wages elsewhere, and coal was cheaper in Britain than in the other countries in the chart (Fig.2.10)

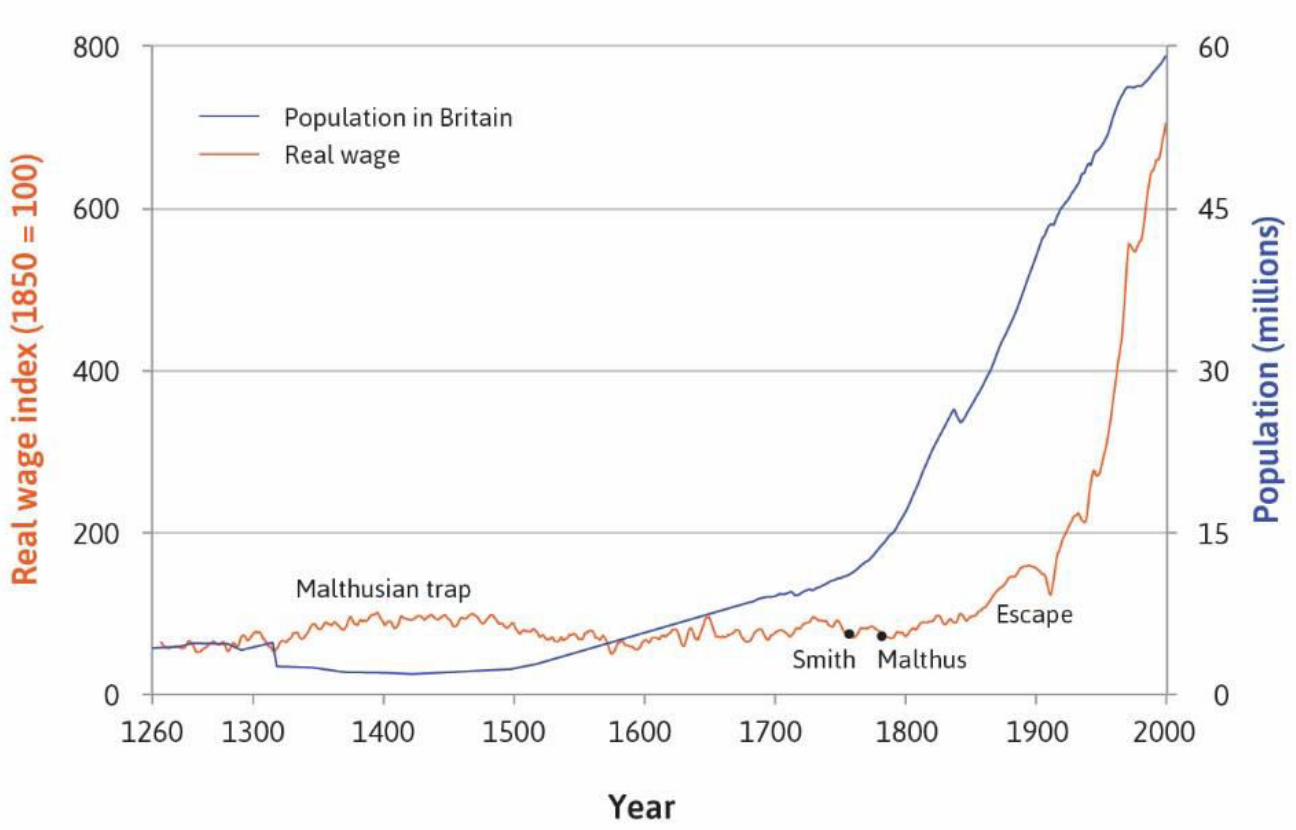
Shift to a lower-cost technology



The combination of capacity to innovate and changing relative prices of inputs led to a switch to energy-intensive technology.

D. Explaining Stagnation

Explaining economy before the Industrial Revolution

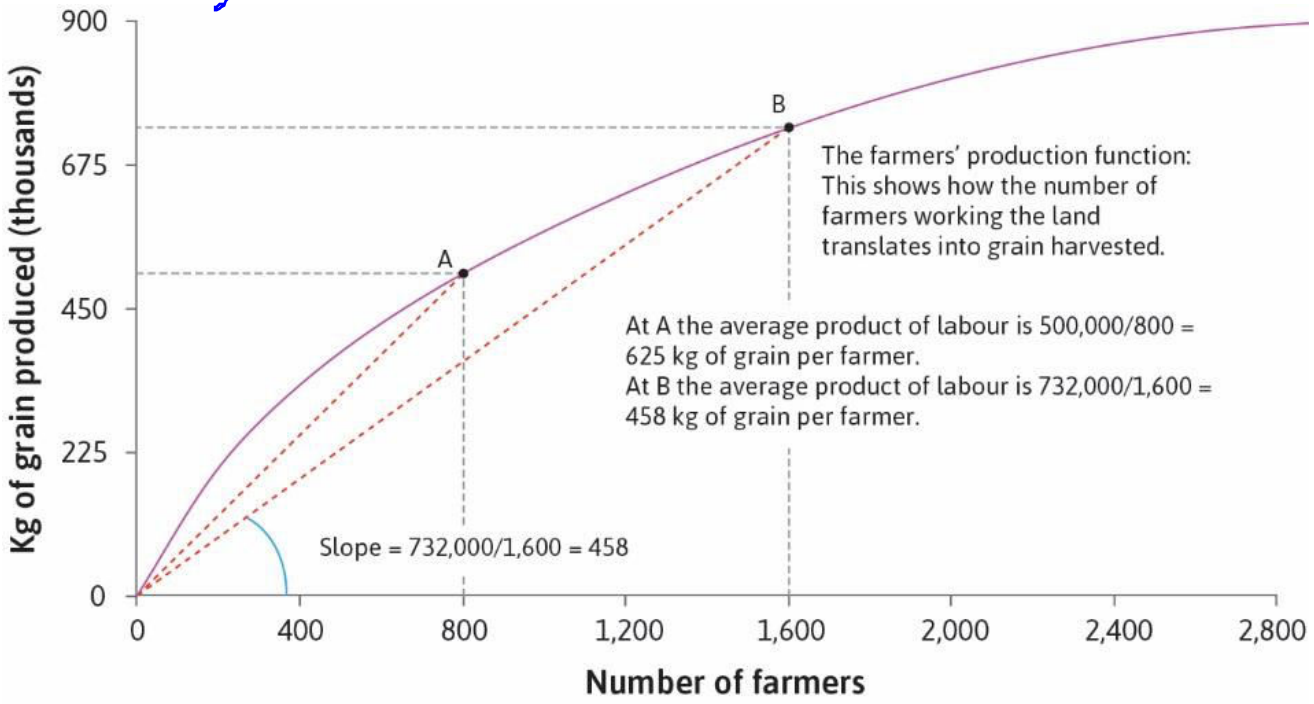


We need a different model to explain the stagnation in population and living standards before 18th century.

Diminishing average product of labour

Production function gives maximum output for a given set of inputs.

If we hold one input (land) fixed, and expand the other input (labour), the average output per worker is going to fall. This is the **law of diminishing average product of labour**.



Malthus' model

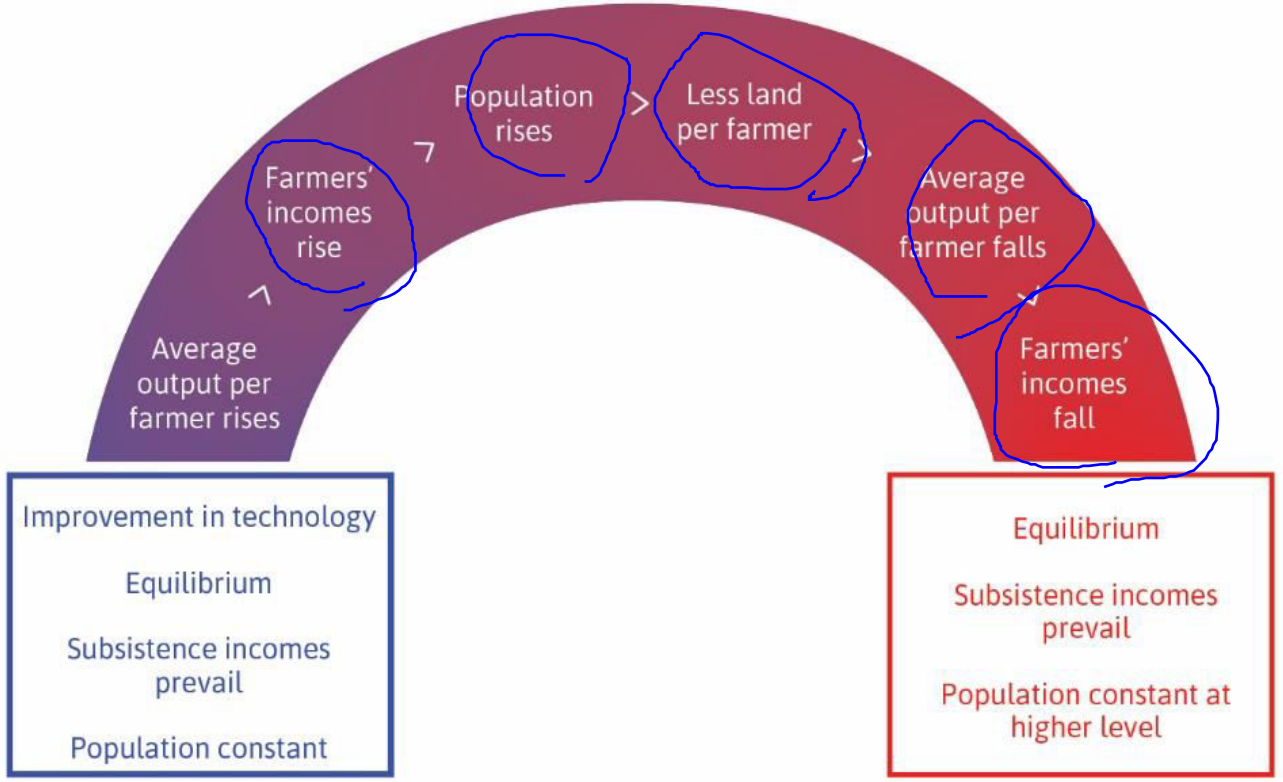
Key ideas:

1. Population expands if living standards increase
2. But the law of diminishing average product of labour implies that as more people work on the land, their income will inevitably fall

In equilibrium, living standards will be forced down to **subsistence level**.

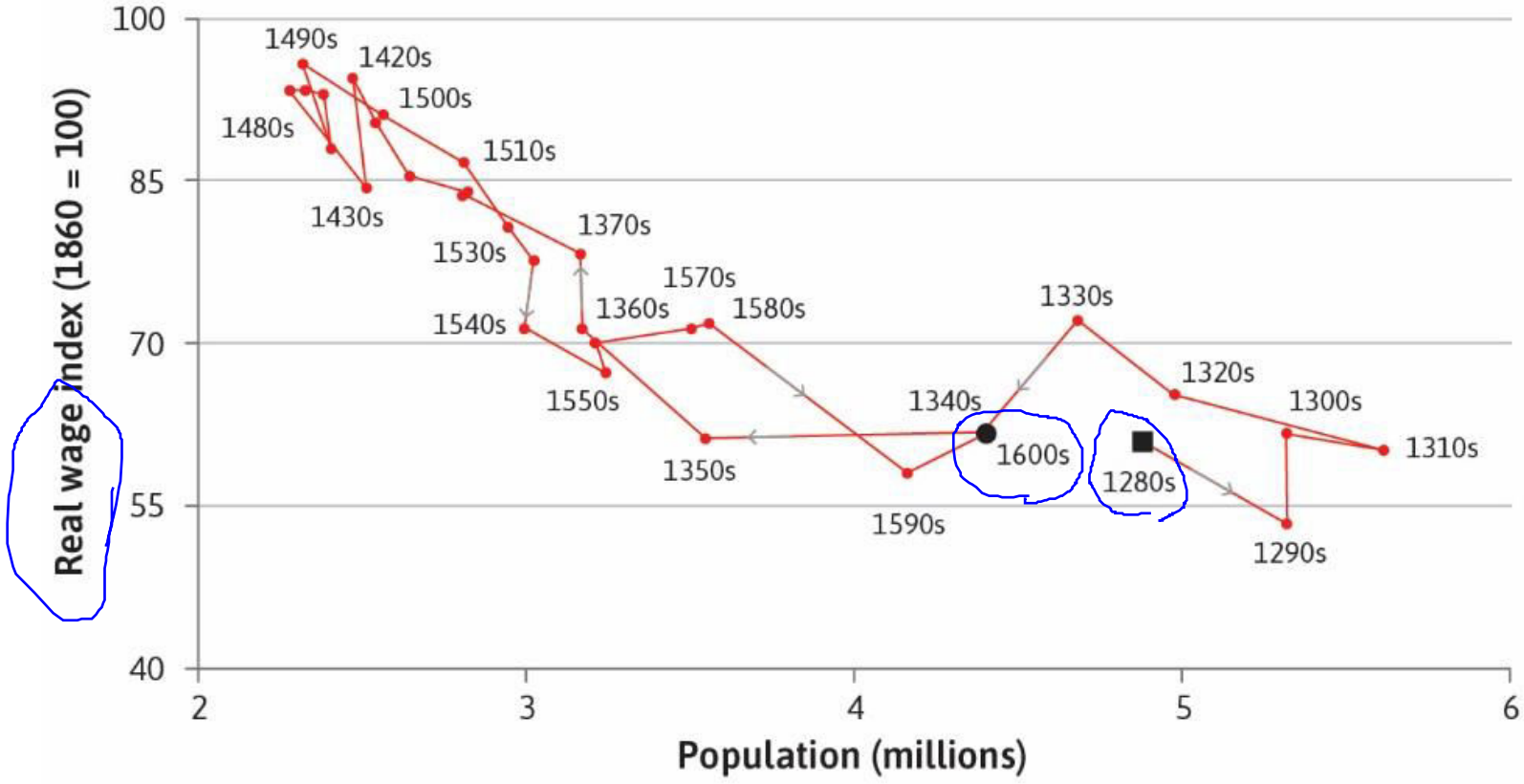
Population and income will stay constant.

The Malthus' Law



Model predicts a self-correcting response to new technology.
In the long run, an increase in productivity will result in increased population but not increased wages.

Was Malthus correct?



The relationship between real wages and population in England between 1280-1600 show evidence of this "Malthusian trap".

But what about the subsequent "hockey-stick" growth?

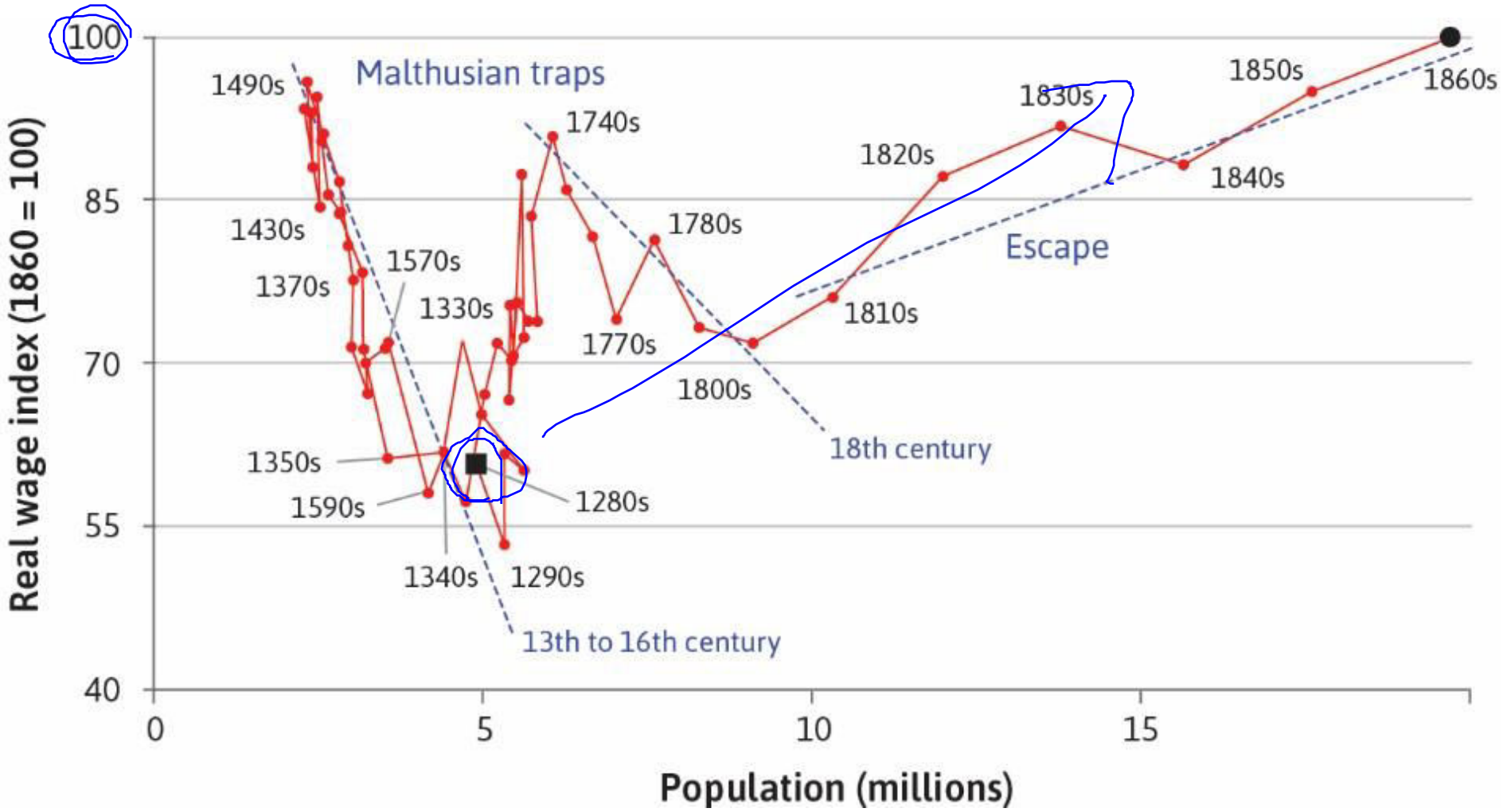
Revising Malthus' Law

3 conditions are required to stay in the Malthusian trap:

- Diminishing average product of labour
- Rising population in response to increases in wages
- **An absence of improvements in technology to offset the diminishing average product of labour**

The permanent technological revolution meant that third condition no longer holds, and explains why Britain was able to escape the Malthusian trap.

Escaping the Malthusian trap



Summary

1. Introduction to economic models
- Less is more: use simplifying assumptions e.g. ceteris paribus

2. Used models for insights on the technological revolution
- Model of a firm: high wages (relative to capital, including energy) motivated **technological innovation**
- **Malthus' model**: permanent technological change enabled economies to escape economic stagnation

In the next unit

- More about models: An economic model of decision making under constraints
- How individuals respond to technological change: Explaining trends in choices of working hours across time