

PRINCIPLES IN ECONOMICS

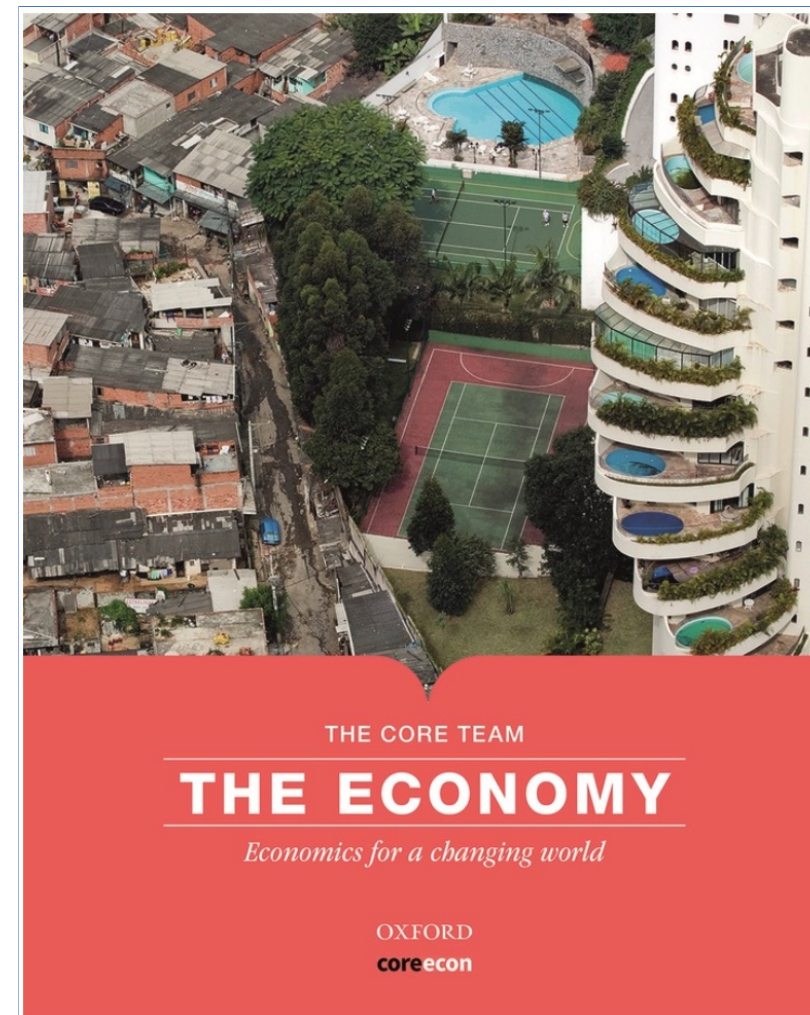
FALL 2025

SLIDES ADAPTED FROM THE CORE ECON TEXTBOOK

(THANKS TO BRUNO PESSOA CARVALHO FOR AN EARLIER VERSION OF THIS COURSE'S SLIDES, AND TO ANGEL HERNANDO VECIANA AND SONIA CECILIA PEREIRA FOR SUBSEQUENT ADAPTATIONS)

COURSE MATERIALS

- Main Resource: [The Economy 1.0](https://www.core-econ.org) by CORE
 - A fully online textbook written by a team of economists from around the world.
 - Free to read online.
 - And through google play, iBooks, and a Windows app.
 - Covers topics not typically addressed in introductory economics courses.
 - Lots of additional questions and exercises in the book.
 - You can order a print copy from Amazon.
- **Main reference:** The Economy 1.0, <https://www.core-econ.org>



CLASS 1: INTRODUCTION, CAPITALIST REVOLUTION, TECHNOLOGY, POPULATION AND GROWTH

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INTRODUCTION

global poverty inequality development socialism warming sustainable economic resources globalisation resource conflicts ponzi sustainable crisis debt brexit income memes fighting pressure housing wealth government failure scheme growth education war wars trade rural gap national communist environmental allocation inequality

- From a more recent survey:



PRACTICAL INFO

COURSE CONTENTS — PART 1 (WEEK 1 TO 7)

Question	Tools	Unit	Week
<i>Which questions are posed by the capitalist revolution?</i> Wealth creation, environmental impact, inequality	Measuring output and inequality	1	1
<i>Why did the capitalist revolution happen when & where it did?</i> Profit seeking & competition → innovation and increased productivity	Innovation rents, production function	2	
<i>How do we make decisions in nonstrategic environments?</i> Economic models: doing the best you can	Optimization subject to a constraint	3	2
<i>How do we make decisions when interacting with others who optimize?</i> Strategic interactions: self-interest, altruism & cooperation	Game theory, Nash equilibrium, experiments	4	3
<i>Why do firms exist and how are mutual gains and conflicts of interest within firms resolved?</i> Wage-setting by firms	Best response functions – the principal-agent model	6	4
<i>How do firms interact with their customers?</i> Price-setting by firms	Elasticity, producer & consumer surplus	7	5
<i>How does a market with many buyers and sellers work?</i> Price-taking by firms	Supply and demand, market equilibrium	8	6
<i>When are markets inefficient and what can the government do about it?</i> Externalities and public goods.	Private and social costs, pigouvian taxation	12	7

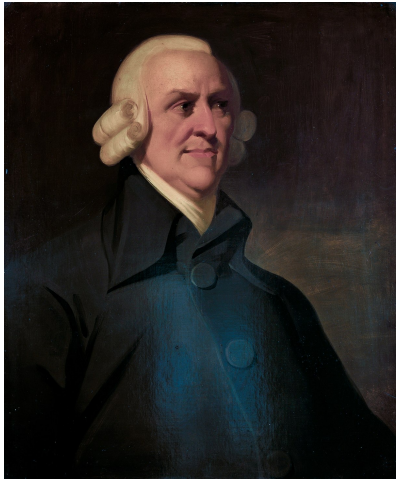
PRACTICAL INFO

COURSE CONTENTS — PART 2 (WEEK 8 TO 14)

Question	Tools	Unit	Week
<i>How does the economy-wide labour market work? Wage-setting, price-setting and unemployment</i>	The labour market model	9	8
<i>How do credit, money and banks work to expand (and sometime limit) opportunity?</i>	Borrowing, lending and investing	10	9
<i>Why does the economic go through cycles of boom and bust and how does that affect employment?</i>	Business cycles	13	10
<i>How does the government use its revenue generation and spending power to improve the economy?</i>	Fiscal policy, unemployment	14	11
<i>How do central banks use their power to create money to stabilize the economy?</i>	Monetary policy, inflation	15	12
<i>What drives technological progress, employment and living standards in the long run?</i>	Economic growth	16	13
<i>How do we measure the disparity of income, wealth and power in the economy and what do we do to change that?</i>	Inequality measures, redistribution policy	19	14
<i>How are we destroying the environment and what can we do about it?</i>	Climate change, pollution	20	

WHAT IS ECONOMICS?

A BIT OF HISTORY

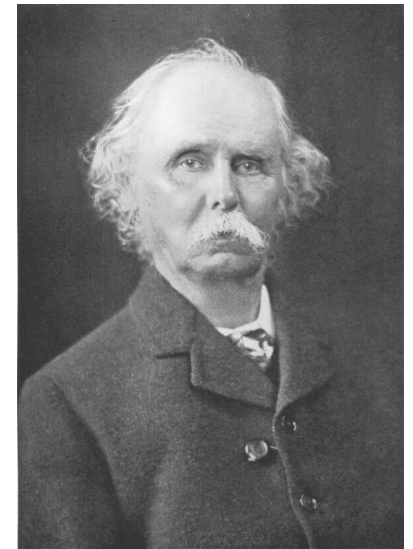


Economics is “an inquiry into the nature and causes of the **wealth of nations**”, studying the process of **production, consumption** and **accumulation of wealth (goods and services that can be exchanged)**, and how **free markets** (as opposed to protectionist policies) lead to the highest possible outcome in most cases.

Adam Smith (1723-1790)

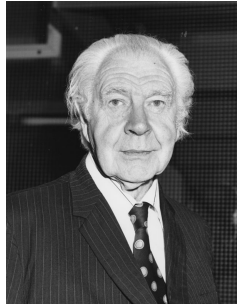
“Economics is the **study of mankind** in the ordinary business of life. It examines that part of individual and social action which is most closely connected with the attainment and with the use of the **material requisites of well-being**”, wealth as a mean to human welfare

Alfred Marshall (1842-1924)



WHAT IS ECONOMICS?

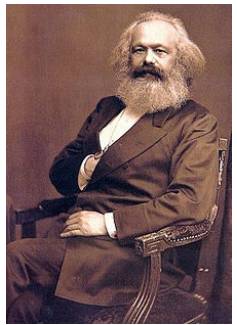
A BIT OF HISTORY



Economics is the “science which studies human behaviour as a **relationship between ends and scarce means which have alternative uses**” Lionel Robbins (1898-1984)

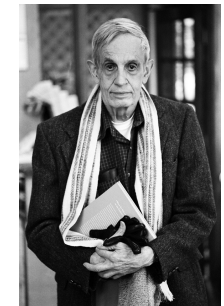
Economics as *Decision Theory* with **No Free Lunch**, where incentives and freedom of choice lead to efficiency.

Milton Friedman (1912-2006)



“The economy is a **relationship between men** disguised as a relationship between things”, where oppression from capitalists eventually leads to a communist revolution. Karl Marx (1818-1883)

Economics as *Interactive Decision theory* – Game theory,
John Nash (1928-2015) [L] and John Von Neumann (1903-1957) [R]



“Assuming equilibrium, we may even go so far as to **abstract from entrepreneurs** and simply **consider the productive services** as being, in a certain sense, exchanged directly for one another.” Léon Walras (1834-1910)

Economics as relationship with **Nature and how to preserve**. Solving the **problem of the Commons** through **cooperation, bottom-up solutions** and **self-governing local institutions**.

Elinor Ostrom (1933-2012).



WHAT IS ECONOMICS?

A MORE CURRENT DEFINITION

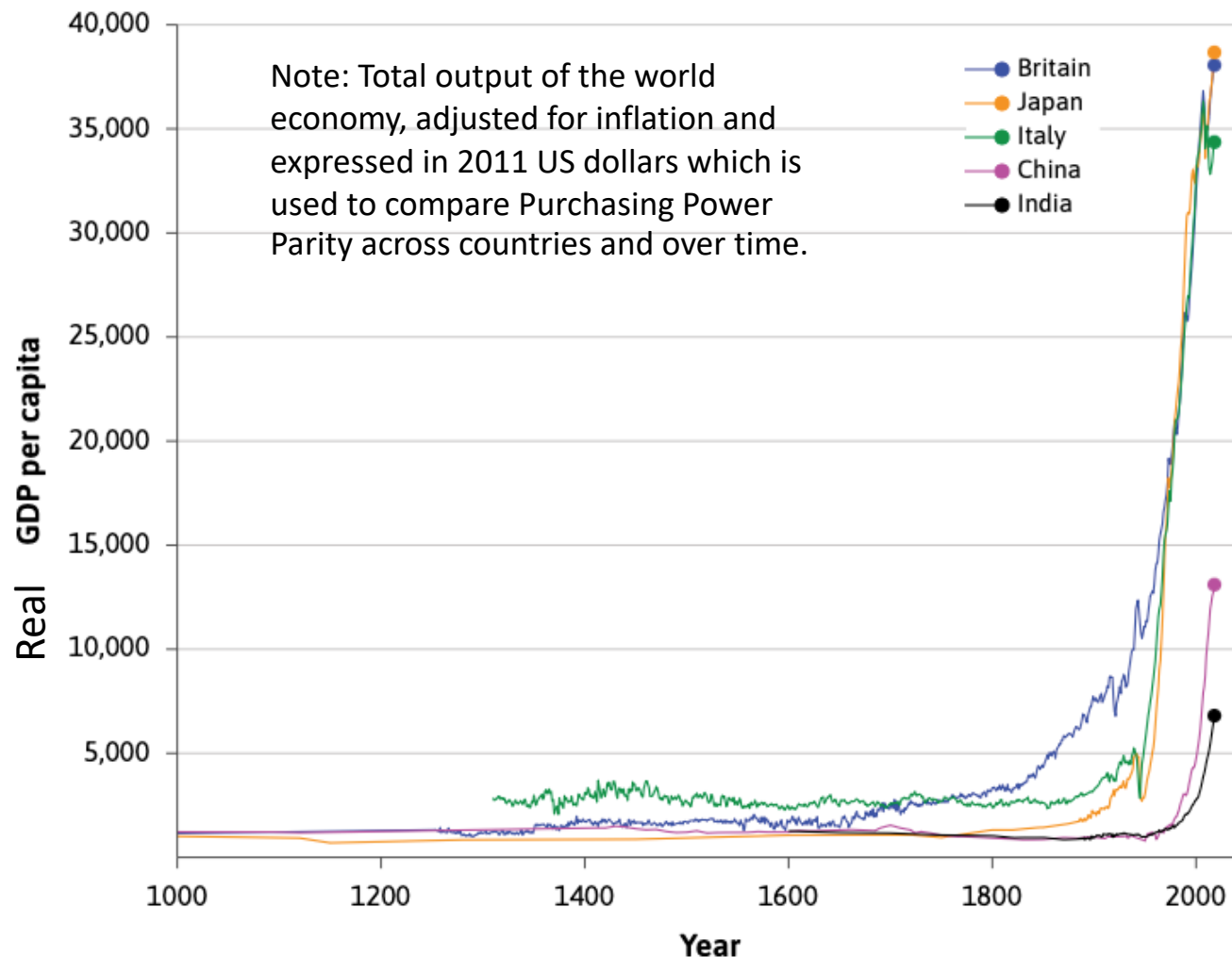
- According to core-econ, The economy, Economics can be defined as:

The study of how people **interact** with each other and with their natural surroundings in providing their livelihoods, and how this **changes over time**.

- So, economics is about:
 - *How we come to **acquire the things** that make up our **livelihood***: Things like food, clothing, shelter, or free time.
 - *How we **interact with each other***: Either as buyers and sellers, employees or employers, citizens and public officials, parents, children and other family members, spouses - economic agents.
 - *How we interact with our **natural environment***: From breathing, to extracting raw materials from the earth.
 - *How each of these **changes over time***.

THE STARTING QUESTION

RAPID GROWTH IN AVERAGE LIVING STANDARDS SINCE 1700



Explore other time periods and countries at Our World in Data: <https://tinyco.re/3290463>

- Almost **flat lines until 1700's** and very fast, sustained growth (acceleration) since:
 - UK ≈1700;
 - Japan/Italy ≈1870
 - China/India ≈1960
- This is known as **“Hockey-Stick” growth**



- **What happened in the last 200 years?**
- **Why is this period so special in history?**

TECHNICAL NOTE

WHAT IS GDP?

Gross Domestic Product (GDP): value of the output of *final* goods and services produced in the economy in a given period.

Domestic means it is produced in the country (regardless of who owns the production factors)

How do we find it?

We need all *final* goods and services produced (**quantities**) and what is their relative value (**prices** – e.g. bread vs car)

Nominal GDP measures output at *current* prices. So, if the economy produces n different goods and services in period t :

$$GDP_t = p_{1,t}q_{1,t} + p_{2,t}q_{2,t} + \dots + p_{n,t}q_{n,t}$$

Real GDP is calculated using *constant prices* (for a particular year - base year).

$$GDP \text{ per capita} = GDP / Population$$

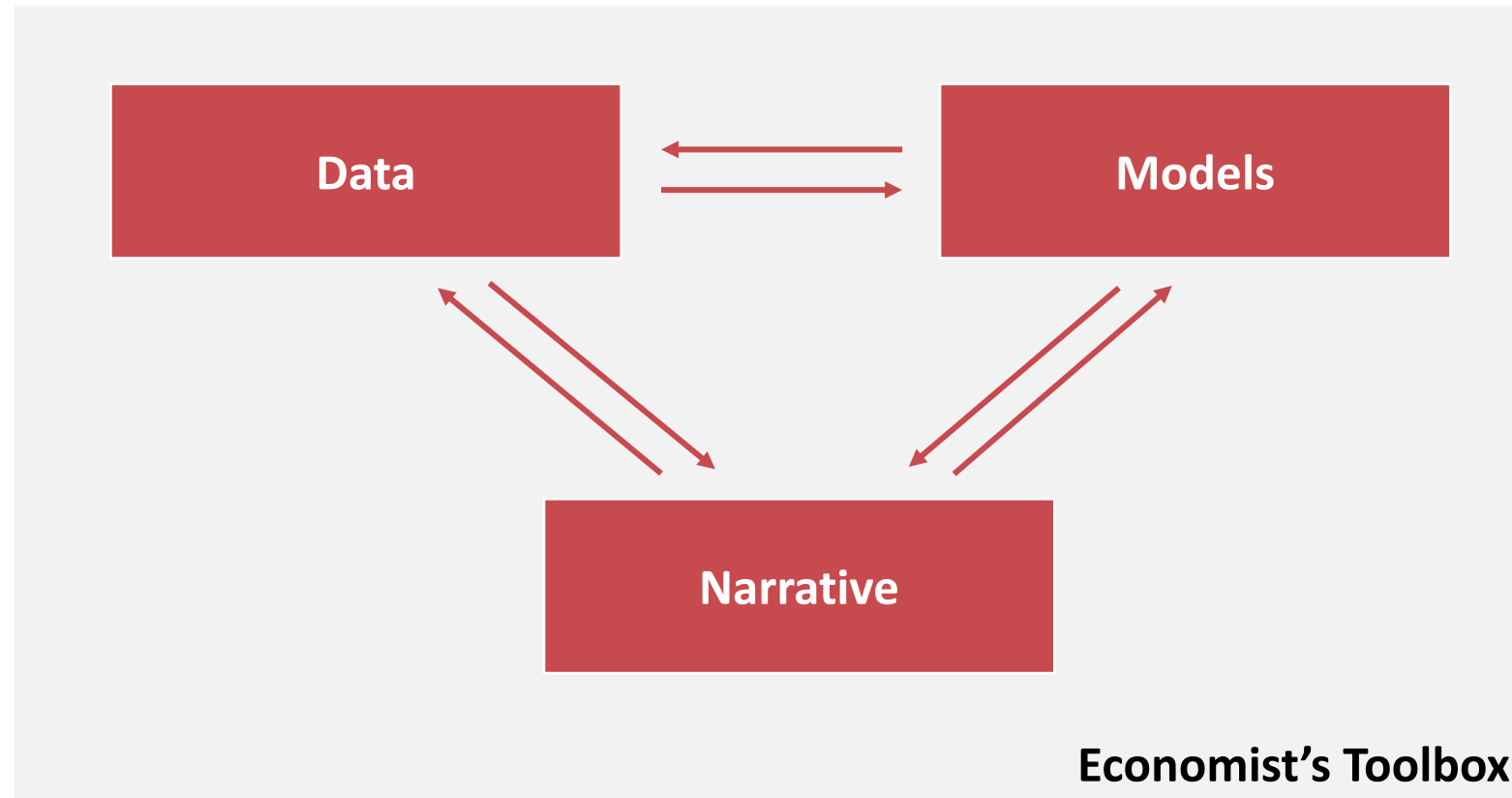
- 1) There are **other approaches** to measure GDP in a country, we will return to this later (week 10).
- 2) We will also discuss comparisons across time (Nominal vs Real GDP) and across space (Purchasing Power Parity GDP). And limitations: Measurement of informal economy; GDP and distribution of resources, etc.



THE ECONOMIST'S TOOLBOX

UNDERSTANDING THE WORLD AS AN ECONOMIST

- Economists address questions combining **three components**:



Economists use several **types of data** to study their questions:

Common examples: GDP, GDP per capita, inflation, sovereign debt, tax revenue, public spending, socio-demographic information, asset market prices, etc.

Some **fields of economics** use perhaps less expected data:

Economics of education (grades of students), Political Economy (election outcomes), Health Economics (number of patients admitted to hospitals), Labour Economics (wages, job satisfaction), Environmental Economics (gas emissions, willingness to pay for whale preservation).

Data can be obtained from **different sources** (administrative, observational, from surveys), with different **frequencies** (daily, monthly, quarterly, yearly), in different **dimensions** (across municipalities, regions, countries);

Recent technological advances allowed for **new types of data**. E.g.: Data from twitter, or news content.

THE ECONOMIST'S TOOLBOX

WHAT IS A MODEL?

- What happens in the economy (or in society in general) depends on the actions and **interactions of millions of people**;
 - Economic models incorporate essential features and ignore (on purpose) unimportant details – **parsimony**;
 - They are used to **describe how agents act**, and how they interact with each other and the elements of the model;
 - They **allow us to find “outcomes”**, given the context and the agent's interactions:
 - An **equilibrium** of a model is a situation from which no agent has an incentive to move away from;
 - They are often challenged by external forces (**shocks**) that change the conditions and possibly lead to different outcomes.
- 
 - Important concept: ***ceteris paribus***, meaning “everything else remains constant”.
 - **Models typically include** several explanatory variables (independent) to explain one variable of interest (dependent);
 - **Economic analysis** typically focuses on the impact of **one variable** on another, leaving **all the other variables constant**.

MODEL

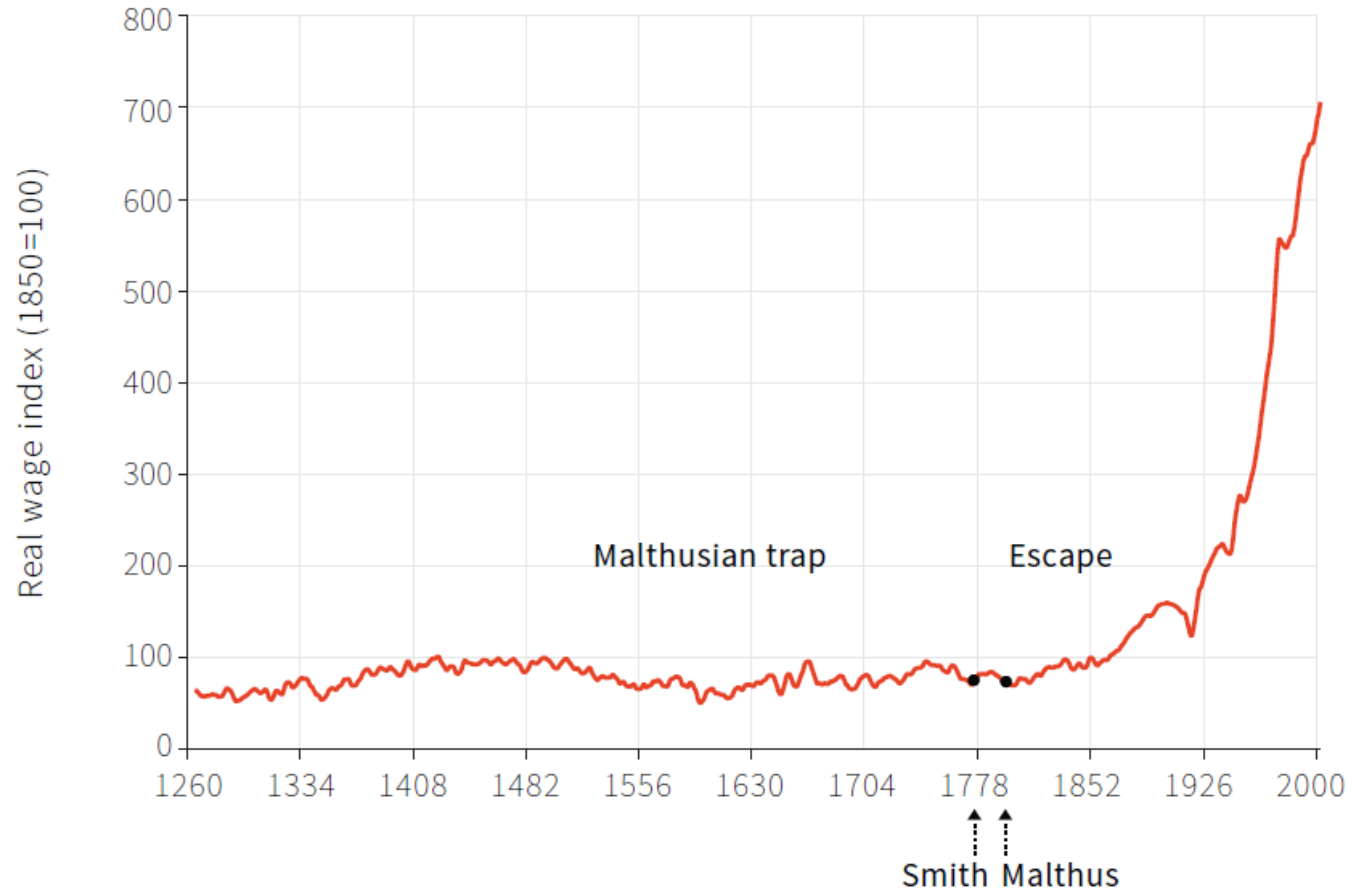
What makes a good *model*?

- 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

MAKING THE ECONOMIST'S TOOLBOX WORK

EXPLOIT THE DATA

- The **first step** is to find an interesting question using empirical regularities or patterns:



- **Wages** are a big **component of GDP-per-capita**.
- Real **wages were relatively stable** between 1260 and 1850s;
 - We call this period the **Malthusian Trap**
- Then, **real wages start increasing fast** and by 2000, they were 7x larger than in 1850.
 - This is known as the **Escape period**.
- What **explains** this evolution?

MAKING THE ECONOMIST'S TOOLBOX WORK

MALTHUSIAN MODEL

- Let us start by the **600-year stagnation, between 1260 and 1850**:
 - To understand why this happened, it may be useful to **exploit an economic model**.
 - The “**Malthusian trap**” is one such model, **intuitively** this model poses:

Technological advances lead to gains in average living conditions, which lead to increased population that in turn *dilute the average improvement in living conditions*.



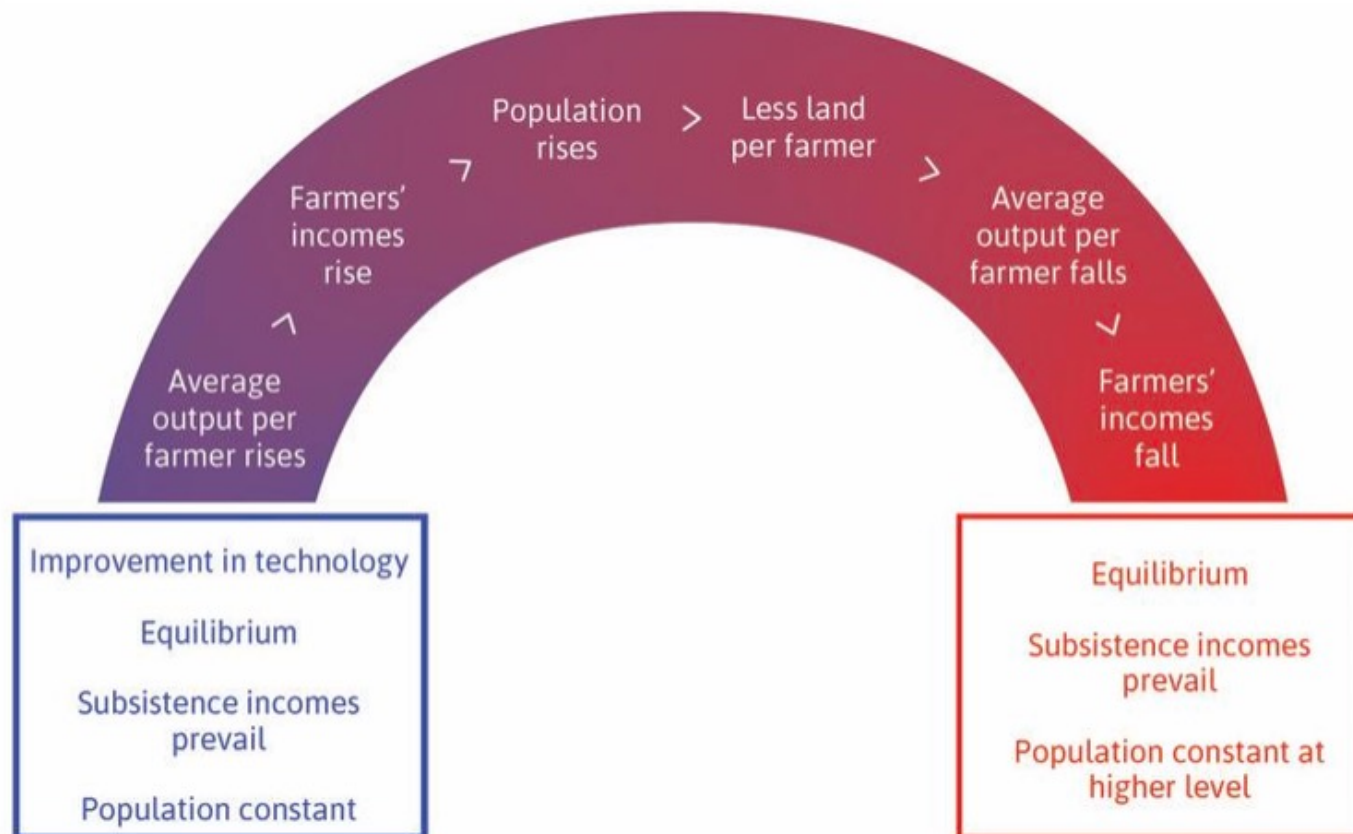
Thomas Robert Malthus
1766-1834

- We can understand this further analysing how **production and demography** interact to produce this outcome.

MAKING THE ECONOMIST'S TOOLBOX WORK

MALTHUSIAN MODEL: DIAGRAM

- We can also explain this process with a **diagram**:

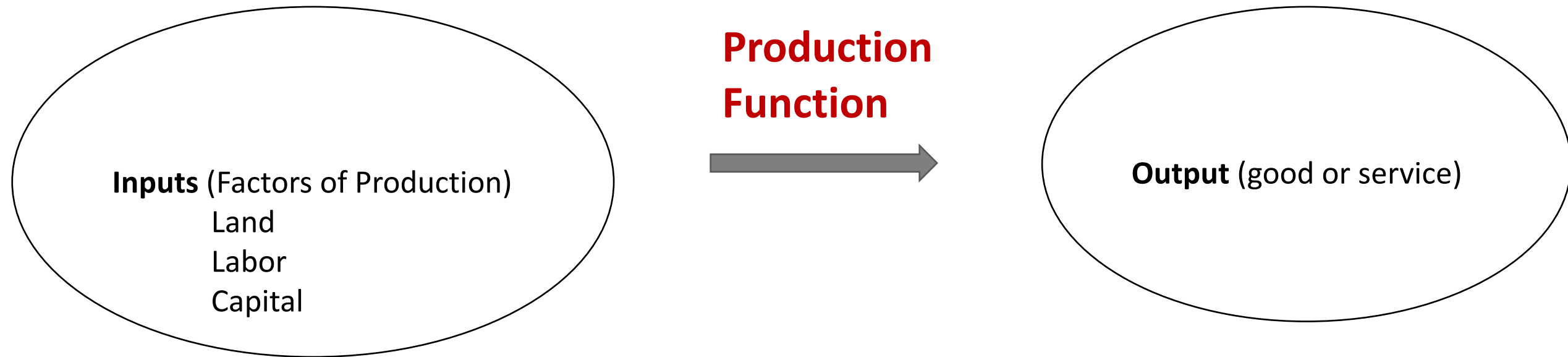


Source: core-econ, Unit 1

- **Key result from Malthus Model:**
 - Improvement of technology leads to prevalence of subsistence incomes, because of the **population mechanism**
- **Key assumption from Malthus Model:**
 - **Land is a fixed factor** which results in **decreasing returns to scale** and declining average output when population grows.

MAKING THE ECONOMIST'S TOOLBOX WORK

MALTHUSIAN MODEL: PRODUCTION FUNCTION – INTRODUCING THE CONCEPT



Definition of Capital as a factor of production: capital goods, or man-made resources, such as tools, machines, buildings and other infrastructure, used in the production of a good or service.

Other inputs: Materials, Energy (fuel), Human capital, Entrepreneurship, etc.

Inputs in Malthus Model:
Labor
Capital (and energy – coal)
Land

MAKING THE ECONOMIST'S TOOLBOX WORK

MALTHUSIAN MODEL: PRODUCTION FUNCTION

- First let us define the **function** that determines the **production of food**:
 - If Y is the amount of food produced (output) and X the amount of labour and land (inputs) needed for production;
 - Then, the **production function**, f , which relates inputs and outputs is:

$$Y = f(X)$$

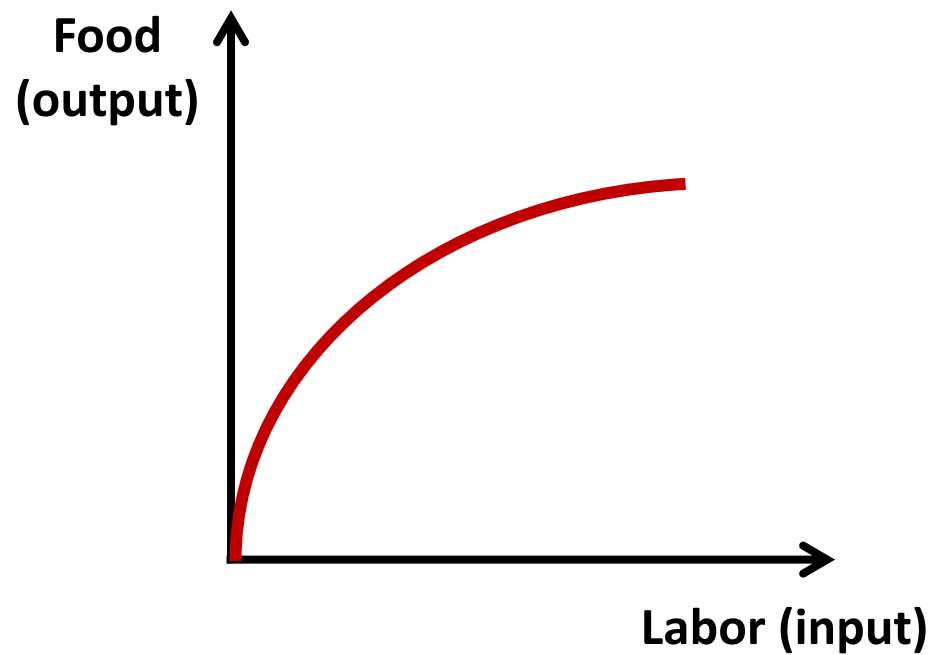
- We **assume** that:

Mathematical notation	Mathematical meaning	Economic meaning
$f(0) = 0$	Function crosses the point (0,0).	With no inputs there is no production.
$f(X) > 0$, if $X > 0$	Function is positive when $X > 0$.	Positive amount of inputs leads to positive output levels.
$\frac{dY}{dX} > 0$	Function is increasing.	Production increases with inputs.
$\frac{d^2Y}{dX^2} < 0$	Function is concave.	Increasing inputs has a diminishing impact on output. (increases by less and less/decreasing returns to scale)

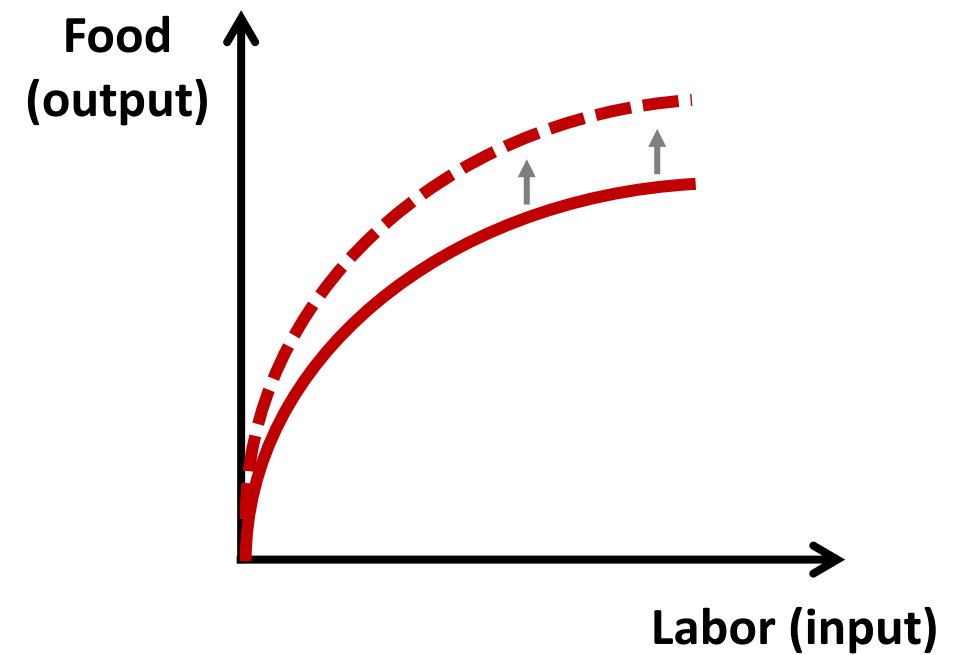
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MALTHUSIAN MODEL: PRODUCTION

- For simplicity, we **further assume**:
 - **Land cannot be changed**, so we focus on the impact of changing labour on food production. [ceteris paribus];
 - Labour= **Number of workers** $\approx$ **Population**.
- One **production function** that is consistent with all these assumptions is:



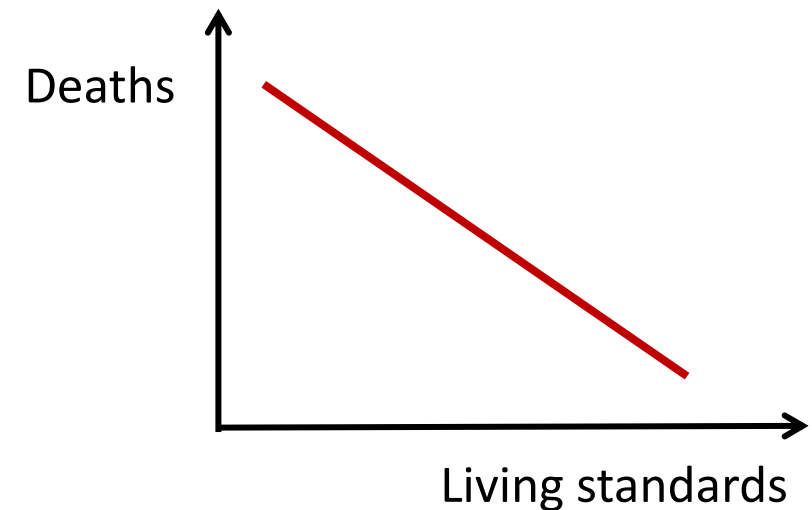
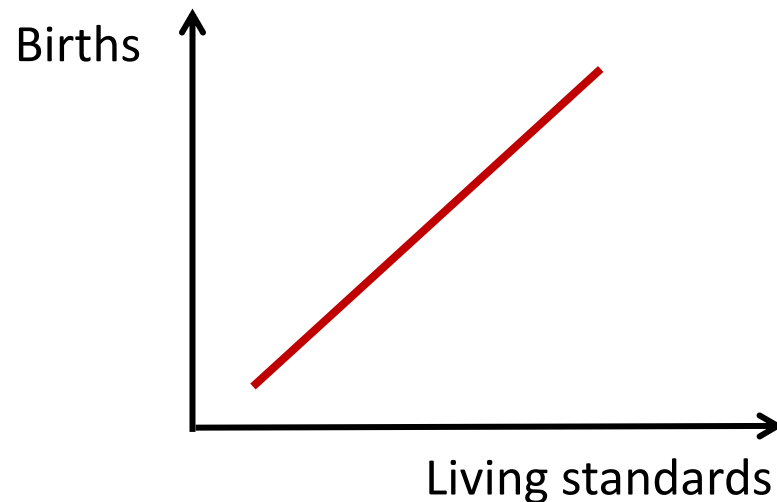
What if technology improves a bit?



MAKING THE ECONOMIST'S TOOLBOX WORK

MALTHUSIAN MODEL: POPULATION

- What happens when we **produce more food**?
 - Living standards increase** (for simplicity, say food consumption = living standards)
 - More food per person: $\uparrow$ average living standards
 - As a result, **population starts increasing**, due to two combined effects:

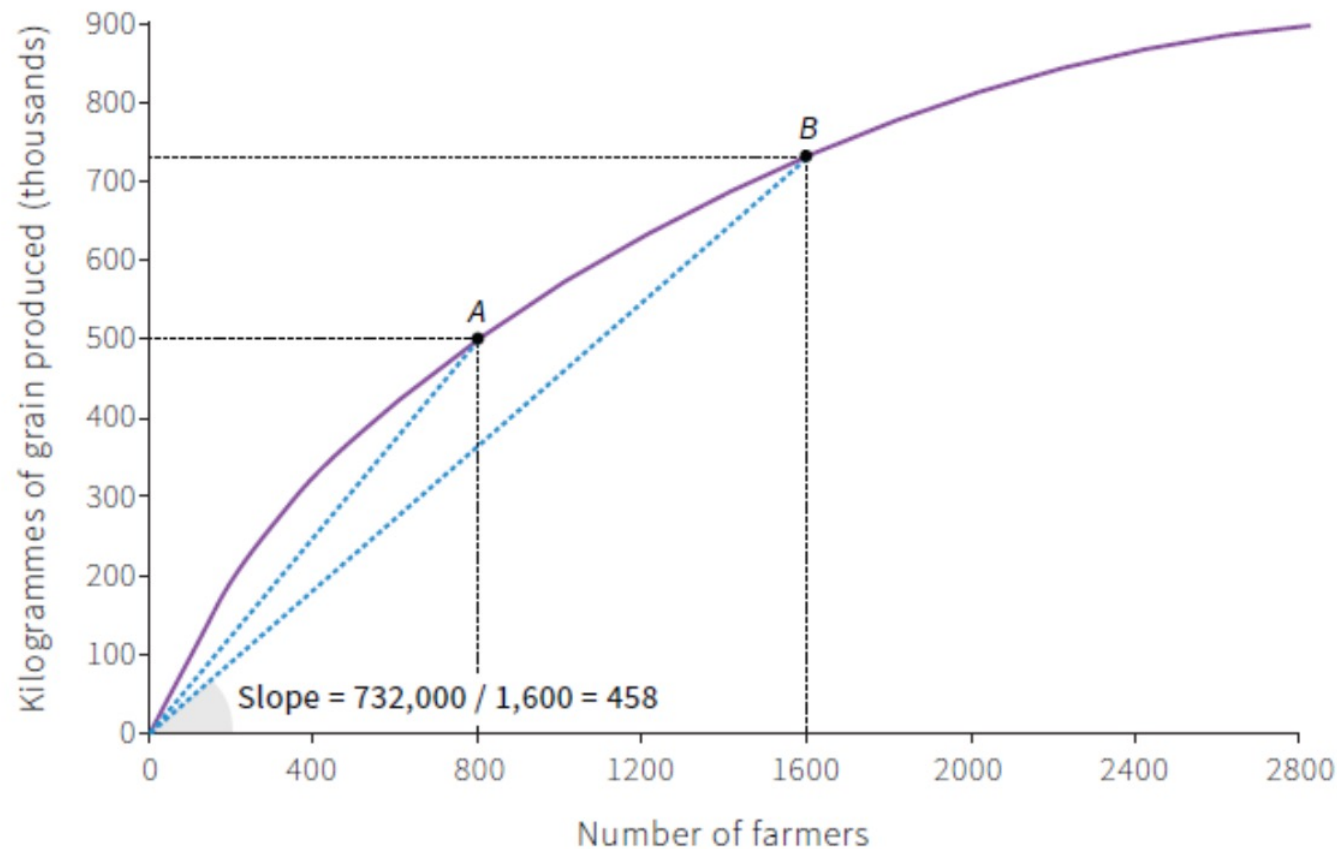


- But if the population increases **what happens to the average living standards?**

MAKING THE ECONOMIST'S TOOLBOX WORK

MALTHUSIAN MODEL: GRAPHICAL INTUITION

- Say production of grains (output) using farmers (labour), is represented by the **production function** below:



$$\text{Average output} = \frac{\text{Total output}}{\text{Number of workers}}$$

- At **point A**:

$$\text{Average output}_A = \frac{500\,000}{800} = 625$$

- At **point B**:

$$\text{Average output}_B = \frac{732\,000}{1600} = 458$$

- **From A to B:**

- Labour productivity declined.
- Evidence of **diminishing marginal returns to labour**.

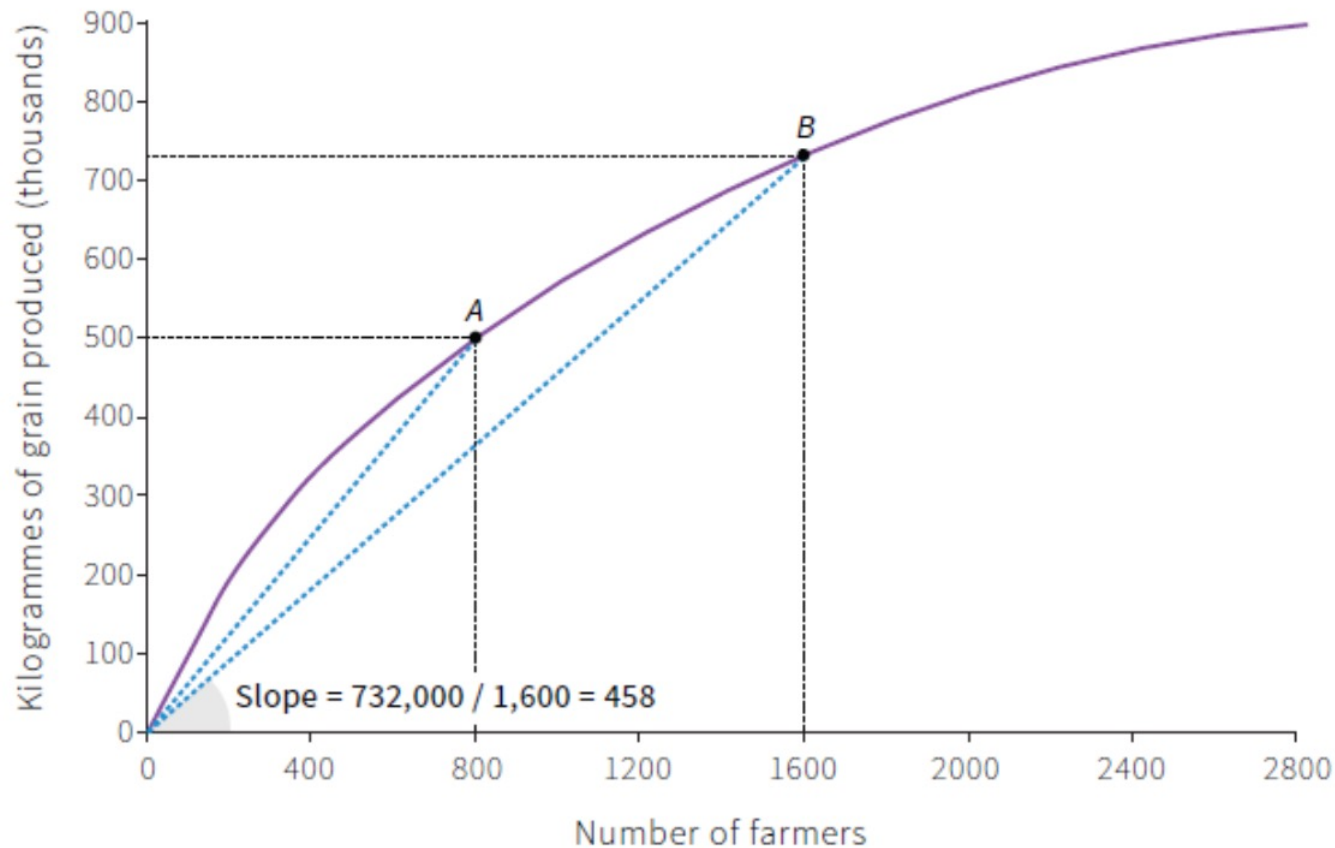
The **Average Output** of a given point is the **slope** of the line from the origin

MAKING THE ECONOMIST'S TOOLBOX WORK

MALTHUSIAN MODEL: GRAPHICAL INTUITION

- Say production of grains (output) using farmers (labour), is represented by the **production function** below:

$$\text{Average output} = \frac{\text{Total output}}{\text{Number of workers}}$$

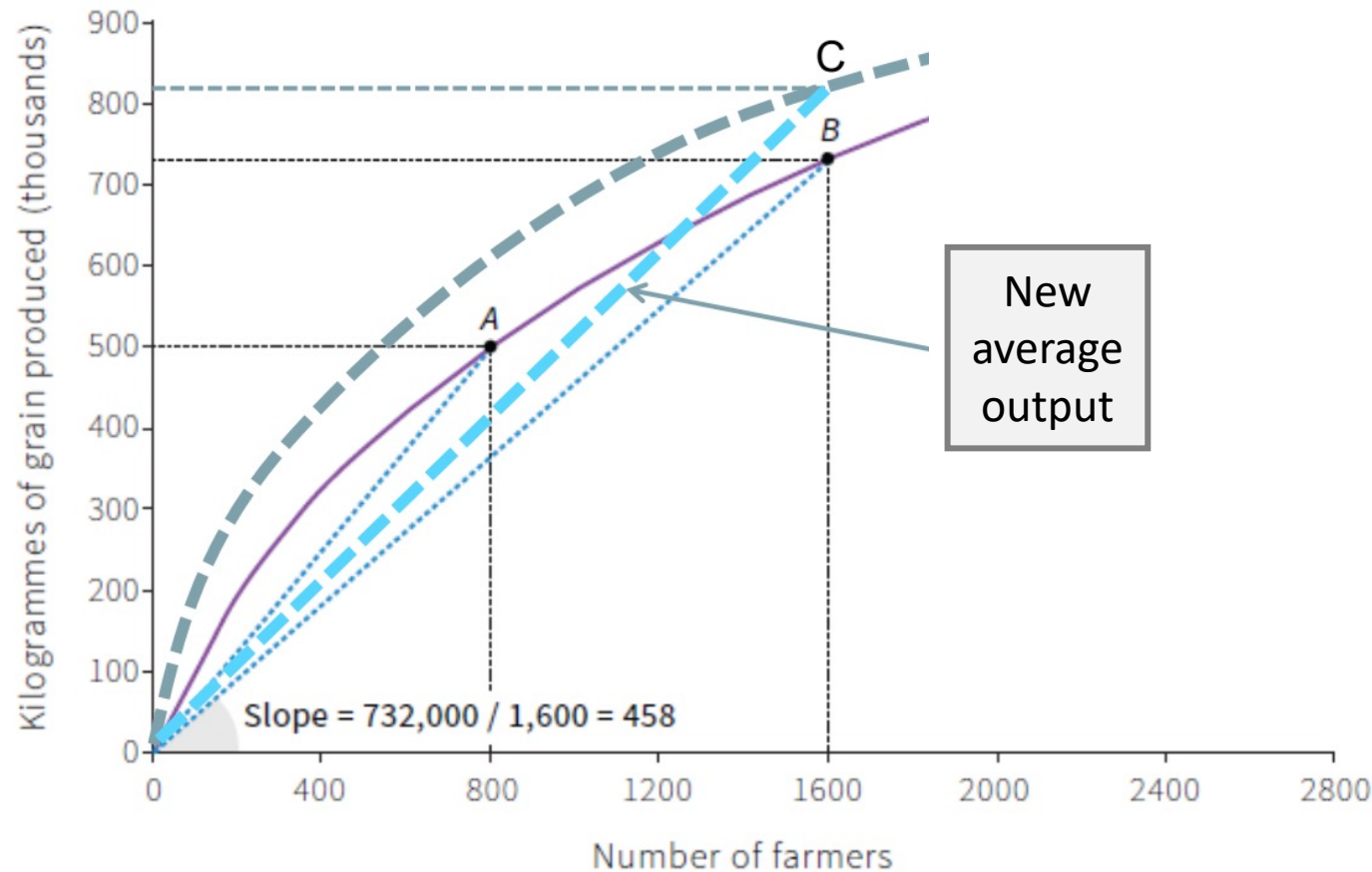


- Suppose we are at point B (an *equilibrium*)
- And **technology improves** (*shock*).
- What happens to:
 - **Output?**
 - And to **average output?**

MAKING THE ECONOMIST'S TOOLBOX WORK

MALTHUSIAN MODEL: GRAPHICAL INTUITION

- The **impact of the increase in technology** is shown in the new production function below (before any changes in population):



Short term effect of technological shock

- At **point C**:

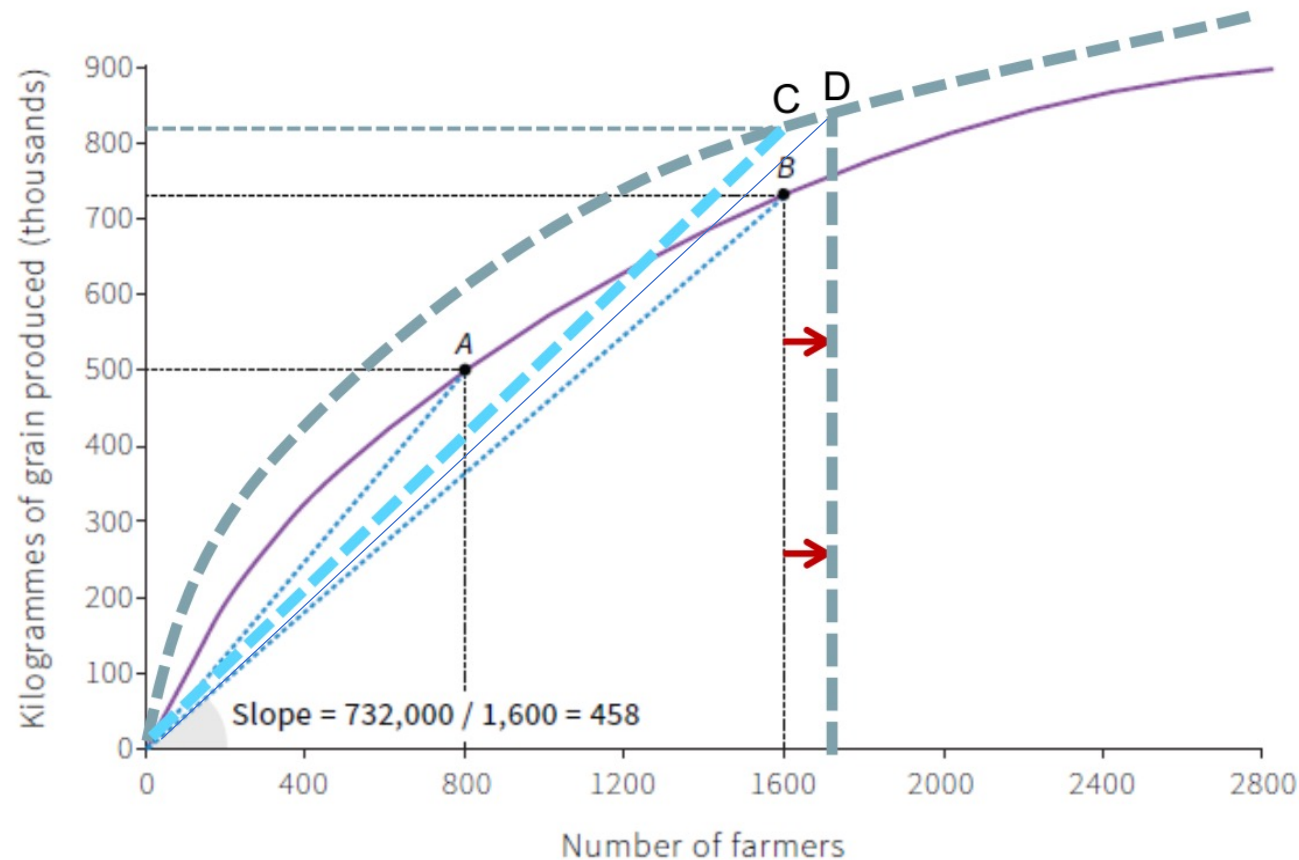
$$\text{Average output}_C = \frac{820\,000}{1600} = 513$$

- **Average output increased** from B to C, intuitively:
 - The same number or workers can produce more, because of improved technology.
- But then **what happens to population?**

MAKING THE ECONOMIST'S TOOLBOX WORK

MALTHUSIAN MODEL: GRAPHICAL INTUITION

- According to Malthus, **population increases**, and the number of farmers also increases:



- As **number of farmers increases** total output increases - D;
- But **what about average output?**
 - It declines between C and D!
 - With the same technology, **more workers increase production by less and less.**
- At at point D, are we **better or worse than in B?**
 - We have more total output for sure.
 - Average output_D = $\frac{850\,000}{1700} = 513 > 458$.

MAKING THE ECONOMIST'S TOOLBOX WORK

MALTHUSIAN MODEL: GRAPHICAL INTUITION

With no further changes in technology, **when does the population increase stop?**

Population increases **while there are gains to be explored from the technology increase;**

At **point E**:

$$\text{Average output}_E = \frac{870\,000}{1900} = 458$$

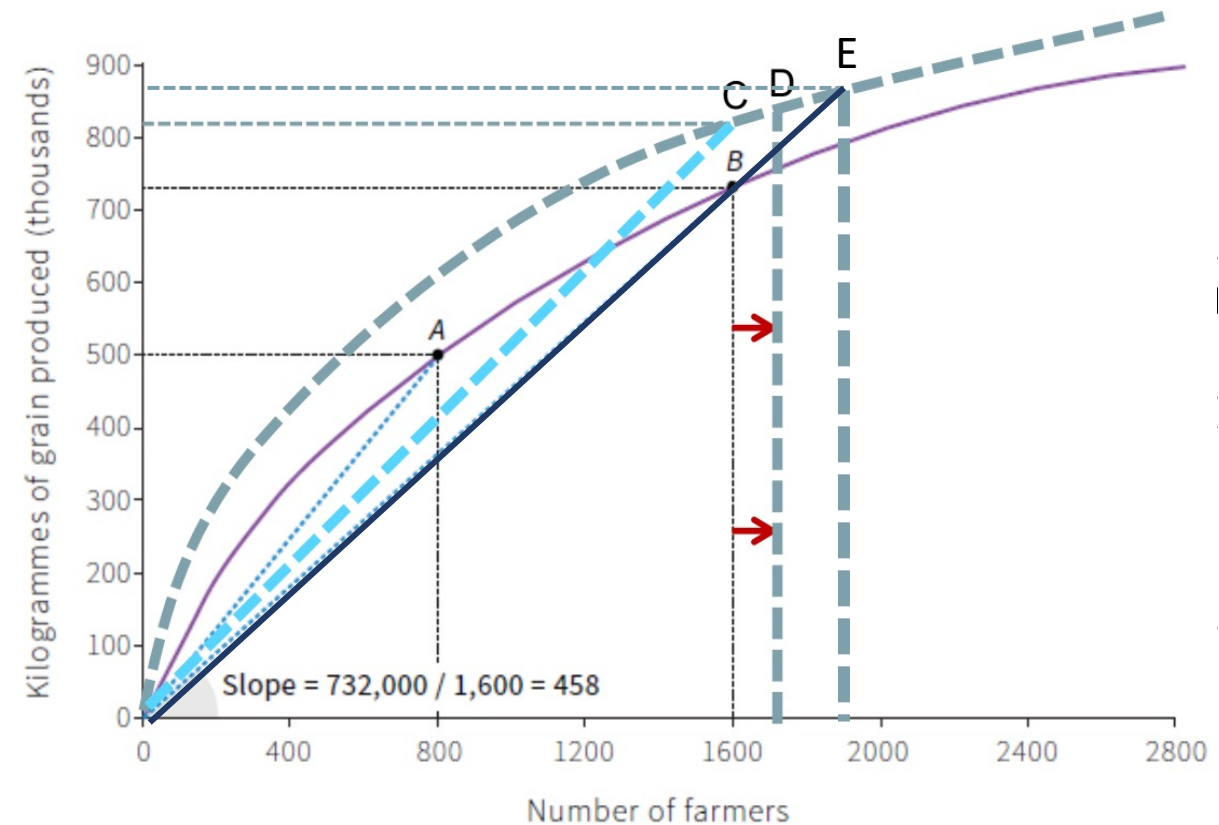
$$\text{Average output}_E = \text{Average output}_B = 458$$

No incentive to increase population further!

So, the **technology shock increased output**:

But population growth absorbed gains from technology shock.

Average living standards remain.

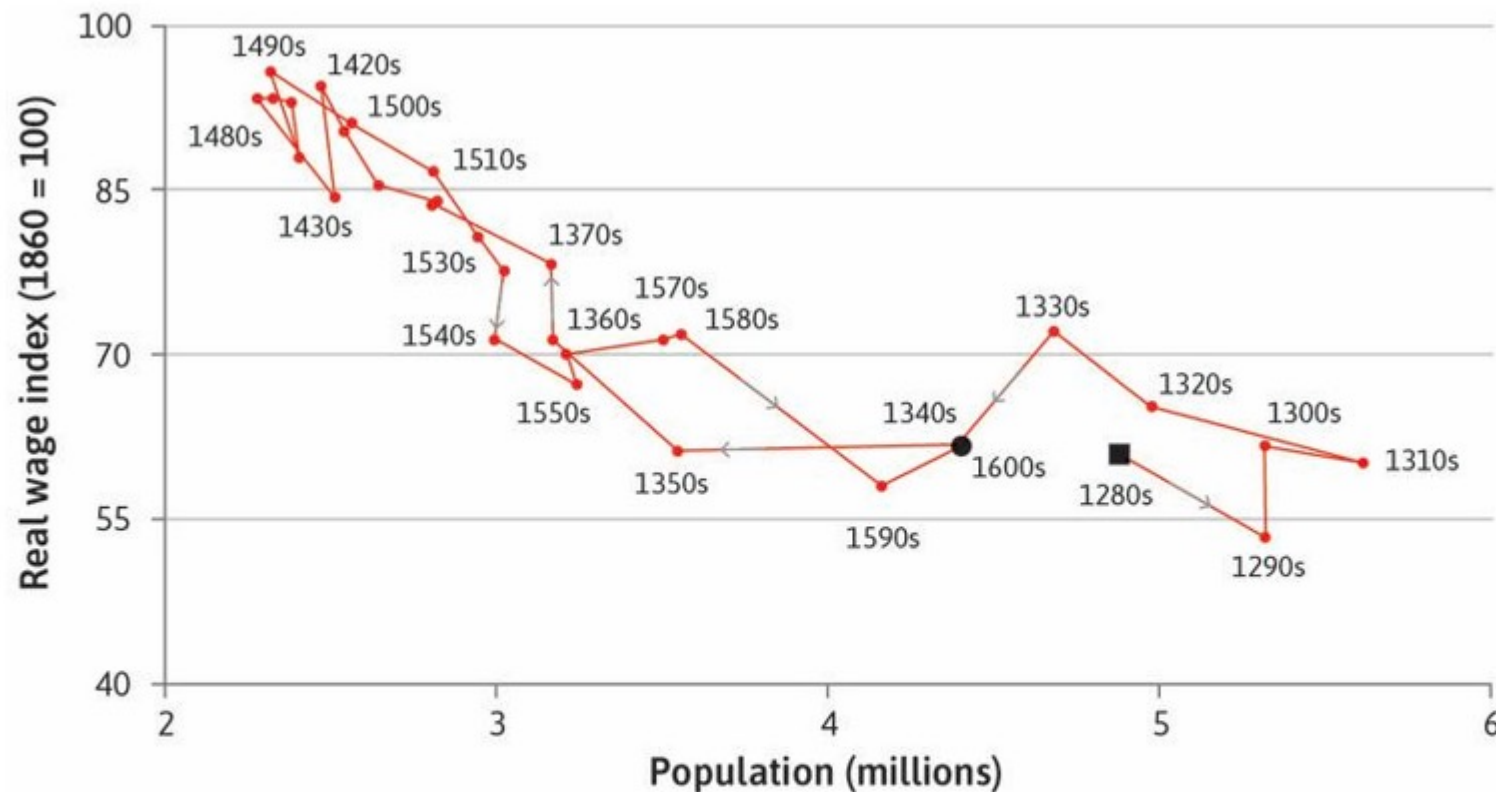


We are stuck at Average output = 458, which we call the **subsistence level living standard**.

MAKING THE ECONOMIST'S TOOLBOX WORK

MALTHUSIAN MODEL: RESULTS AND DATA?

- If we plot the **wage index** and the **population level**:



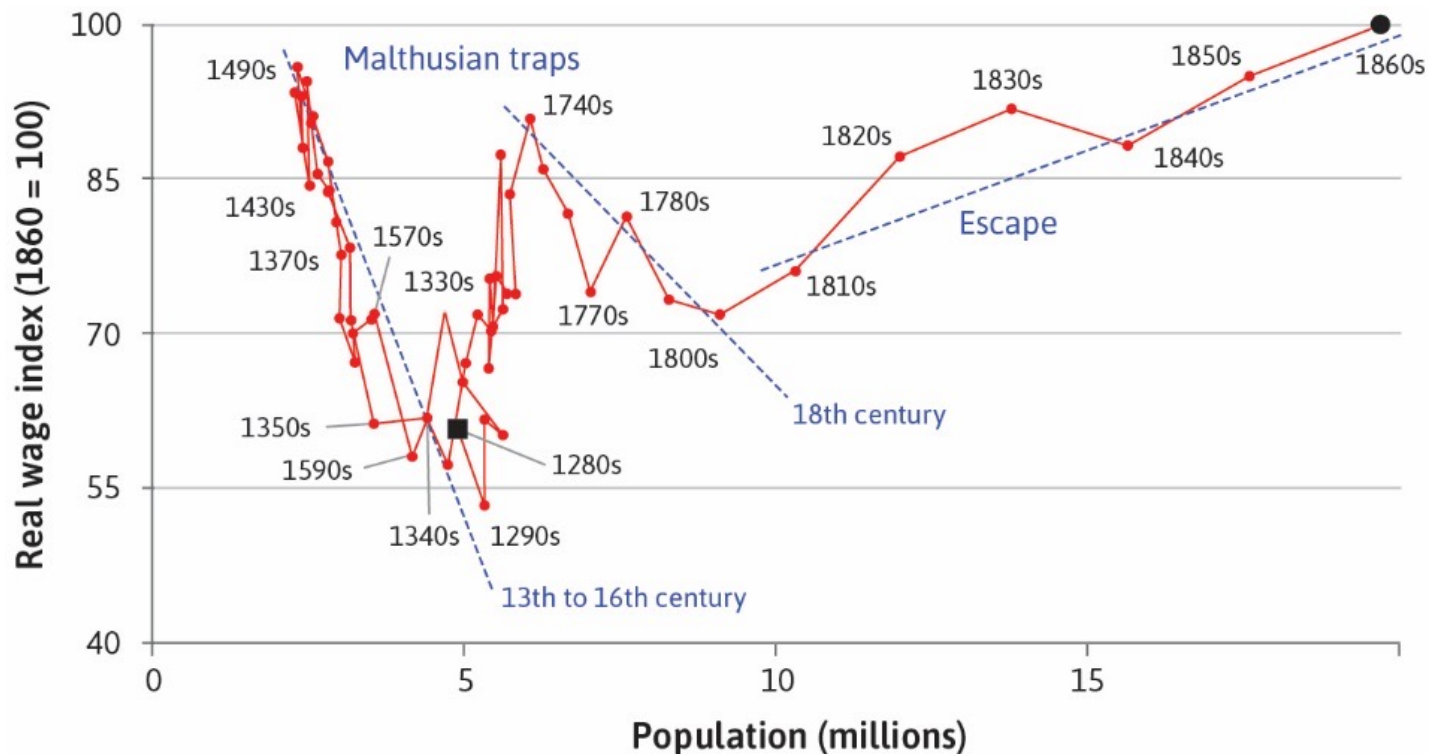
Source: core-econ, Unit 2

- The **negative relation** between the variables is clear.
- So, between 1280-1600, **model matches reality** reasonably well!

MAKING THE ECONOMIST'S TOOLBOX WORK

ESCAPE: MALTHUSIAN MODEL?

- We have a good model to explain the stagnation between 1280-1600;
- The natural question that arises is: **can we use it to understand the escape period?**
 - If we expand the graph to include the 19th century:

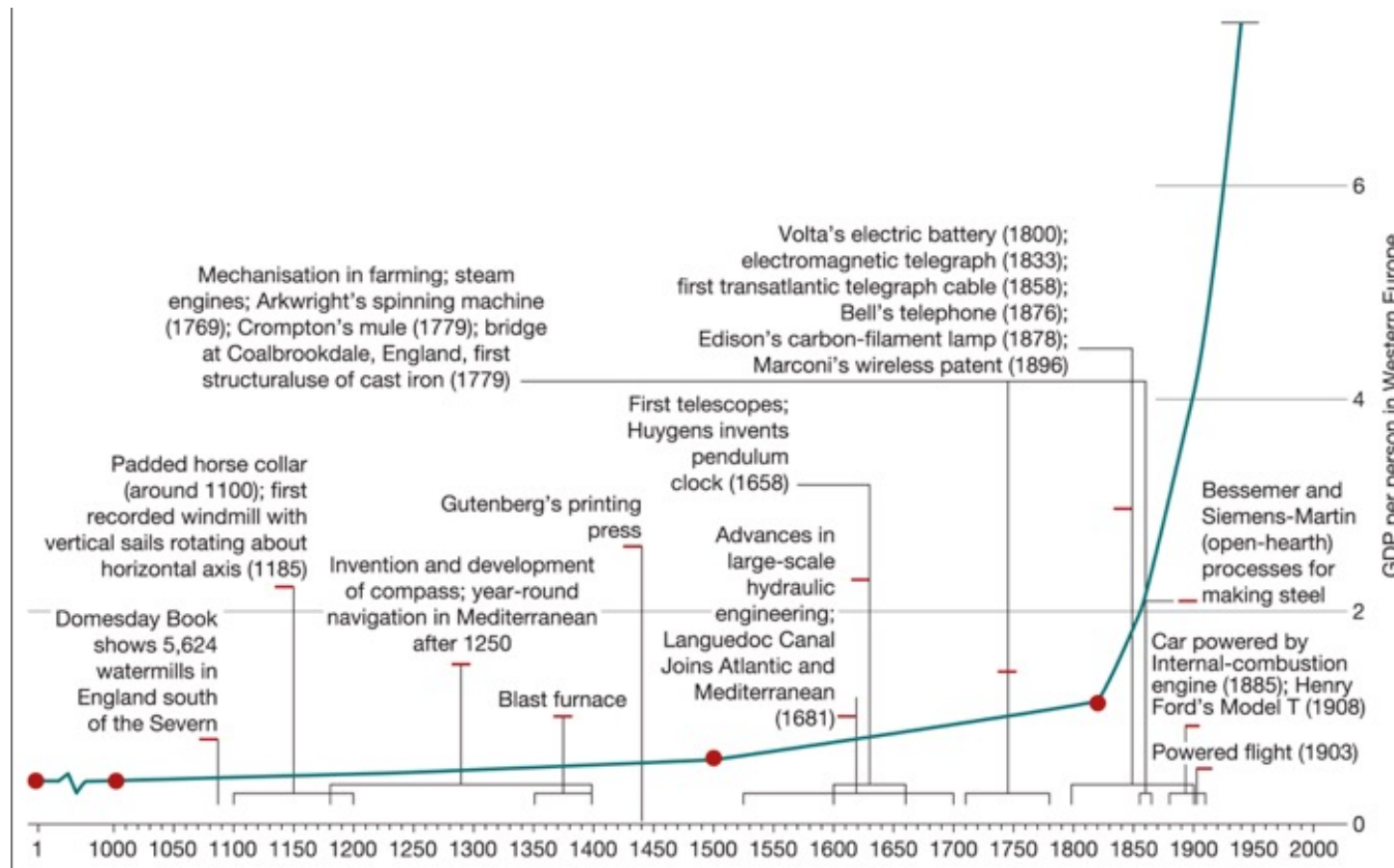


- The negative relation is not there for this period!
- The Malthusian model **cannot be used** to explain what happened in the 19th century.

MAKING THE ECONOMIST'S TOOLBOX WORK

ESCAPE: MALTHUSIAN MODEL?

- This does not mean the model is bad, just that **something** important **changed**.
 - What started in Britain in the early 19th century?



- The **industrial revolution** brought lots of inventions;
 - Particularly from mid-18th century onward;
- And the use of non-renewable resources: coal
- As a result, **workers became more productive** and
- GDP per person in Western Europe exploded from the 1800s.

MAKING THE ECONOMIST'S TOOLBOX WORK

ESCAPE: MALTHUSIAN MODEL?

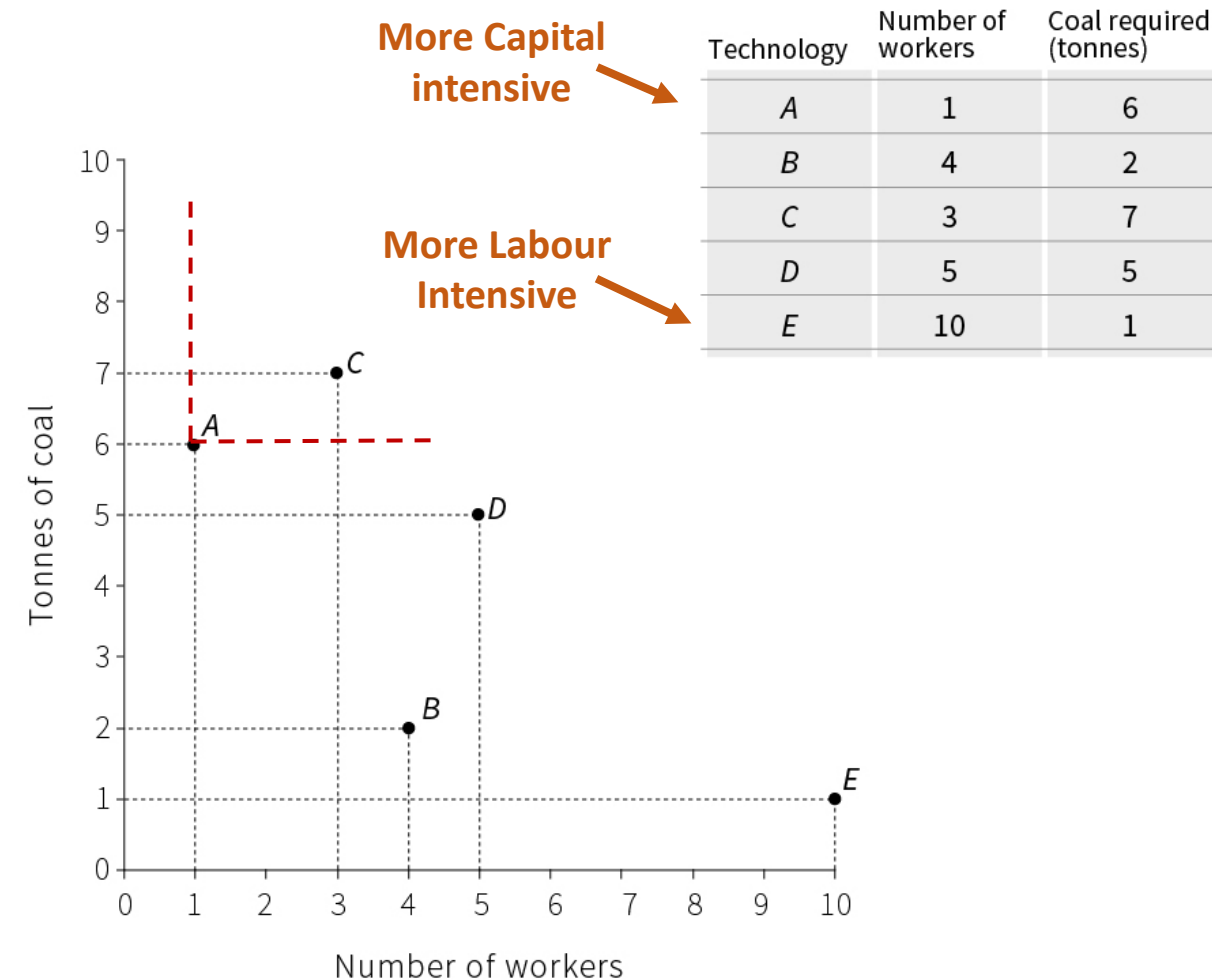
- The first **Industrial Revolution** began in Great Britain around the 1760s.
- Around this time, many technological innovations were introduced, particularly in the British textile industry.
- But important innovations have occurred throughout history: pyramid architecture in Egypt, the numeral system in South Asia, the magnetic compass in China for example.
- So why did innovation give rise to an industrial revolution in Britain, not elsewhere?
- Economists disagree about which factors were critical (you can read more about these theories in [Section 2.1](#) of your readings)
- In class today, we'll explore a theory put forward by economist Robert Allen who points to the **relatively high cost of labor** and the **relatively low cost of coal** as a key to explaining the **early success of the British economy**.
- Important resource: Watch [Robert Allen](#) video on Section 2.1

MAKING THE ECONOMIST'S TOOLBOX WORK

ESCAPE: EXPLAINING THE INDUSTRIAL REVOLUTION

- To understand why this happened, we need to dig further **into the way production of output works**.

- Suppose there are **5 possible technologies** (combination of inputs) to produce the **same output**, they differ:
 - In **Labour** (E) or **capital** (C) intensity.
- Some **technologies dominate** others.
 - C is dominated by A, why?
 - Are there other dominated technologies?
- The firm will likely prefer the **less expensive combination**
 - C is more expensive than A (and D than B);
 - But what about between A and E?



MAKING THE ECONOMIST'S TOOLBOX WORK

ESCAPE: EXPLAINING THE INDUSTRIAL REVOLUTION

- Given the input prices, the **total cost** is given by:

- $C = wL + rK$

- Suppose the **unitary costs of inputs** are:

- 1 unit of labour: 10 E = w
- 1 tonne of coal: 20 E = r

- Calculate the total costs of B , $B1$ and $B2$.



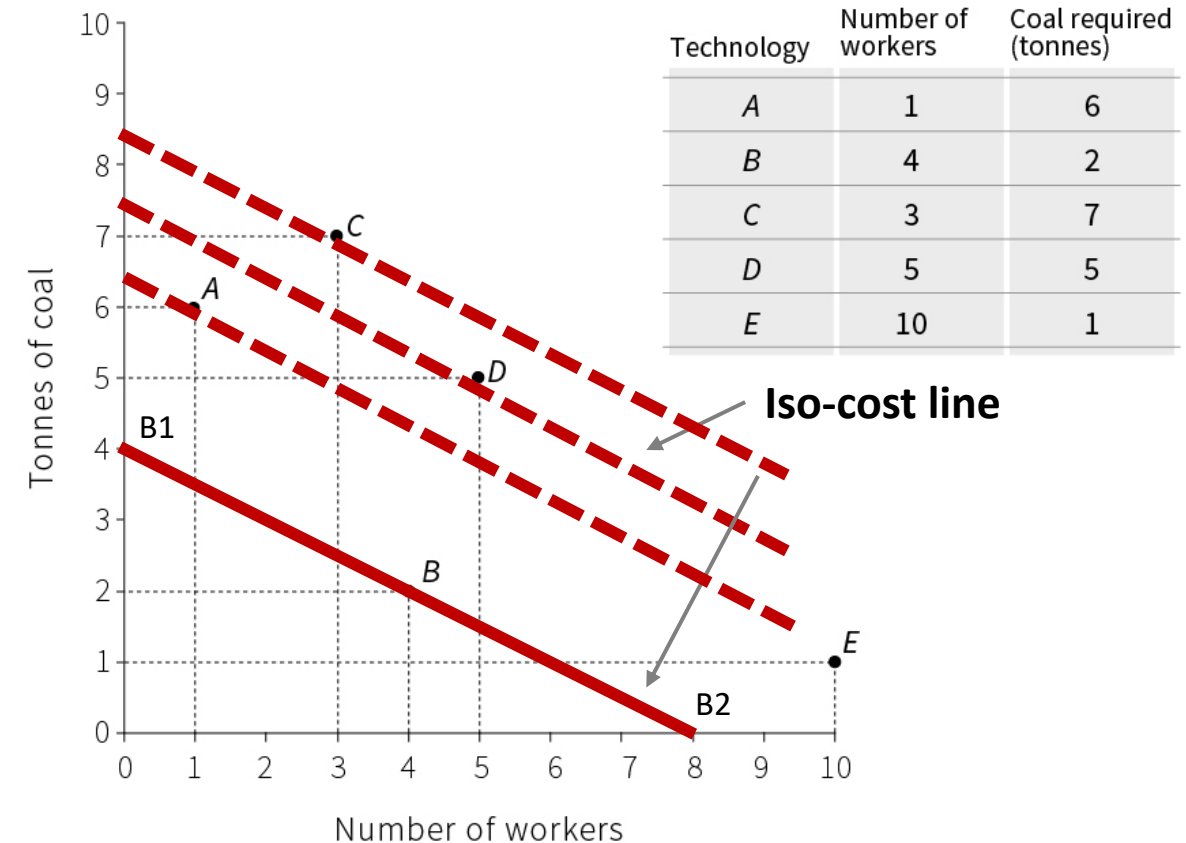
An **iso-cost line** represents all possible combinations of inputs with the same total cost.

- What is the slope of the isocost?

$$C = wL + rK \quad \Leftrightarrow \quad K = -\frac{w}{r}L + \frac{C}{r}$$

slope/wage-capital ratio

For a given pair of relative prices, all
iso-cost curves are parallel!



MAKING THE ECONOMIST'S TOOLBOX WORK

ESCAPE: EXPLAINING THE INDUSTRIAL REVOLUTION

- 1 unit of labour: $10 \text{ E} = w$
- 1 tonne of coal: $20 \text{ E} = r$

$$C = wL + rK \Leftrightarrow K = -\frac{w}{r}L + \frac{C}{r}$$

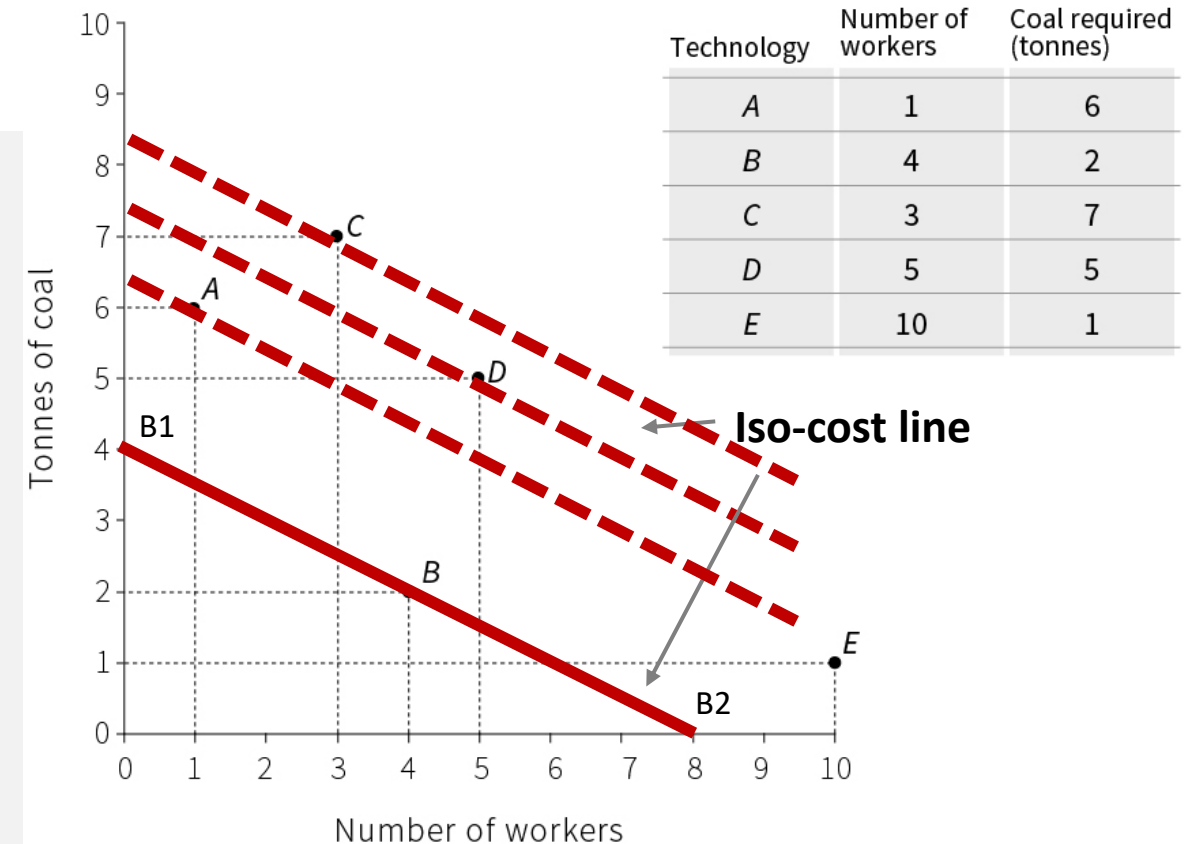
slope/wage-capital ratio

The slope of iso-cost is the Wage-capital ratio

- $-\frac{w}{r} = -\frac{10}{20} = -0.5$
- Interpretation:
 - It tells us the price of labor (w) relative to the price of capital (r) - **relative price of labor**.
 - When r is 1, w is 0.5.
 - Labour is less expensive than capital
 - So, **favour labour intensive technologies**.
 - To keep costs constant, if we want to use one unit more of labour, I need to reduce capital by 0.5.

Relative prices determine the slope of iso-costs. They are parallel.

!



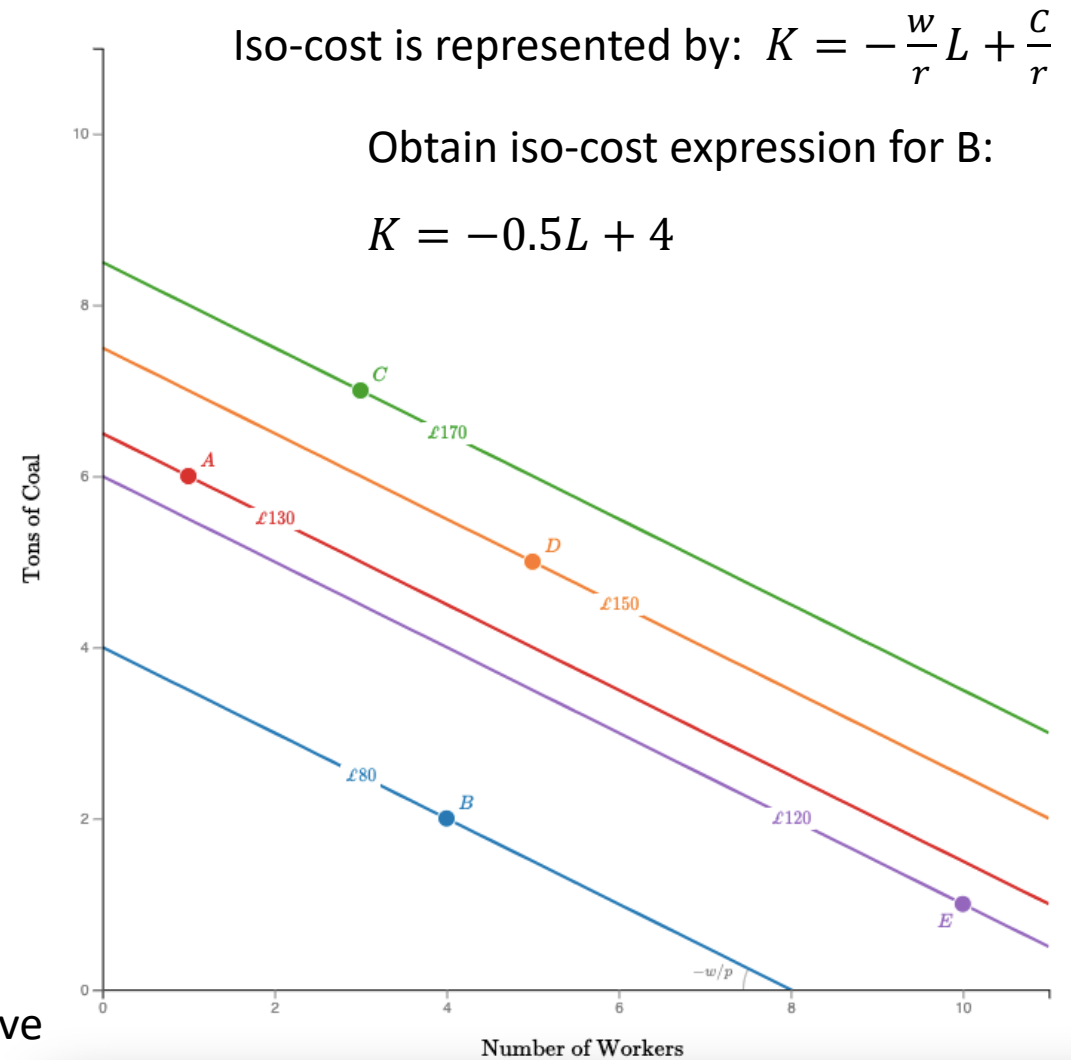
MAKING THE ECONOMIST'S TOOLBOX WORK

ESCAPE: EXPLAINING THE INDUSTRIAL REVOLUTION

- When the **unitary costs of inputs** are:
 - 1 unit of labour: $10\text{€} = w$
 - 1 tonne of coal: $20\text{€} = r$
- The **total cost** of the 5 technologies given by: $C = wL + rK$:

Input combination	A	B	C	D	E
Amount of labour	1	4	3	5	10
Amount of capital	6	2	7	5	1
Cost	130	80	170	150	120

- Which **technology** should the company choose?
 - B. The least expensive for the same output → **lowest iso-cost!**
 - Iso-costs further away from the origin** represent more expensive combinations of inputs.



Find this interactive graph [here](#)

MAKING THE ECONOMIST'S TOOLBOX WORK

ESCAPE: EXPLAINING THE INDUSTRIAL REVOLUTION

- Why did the Industrial revolution happen in **England** and not in **France**?

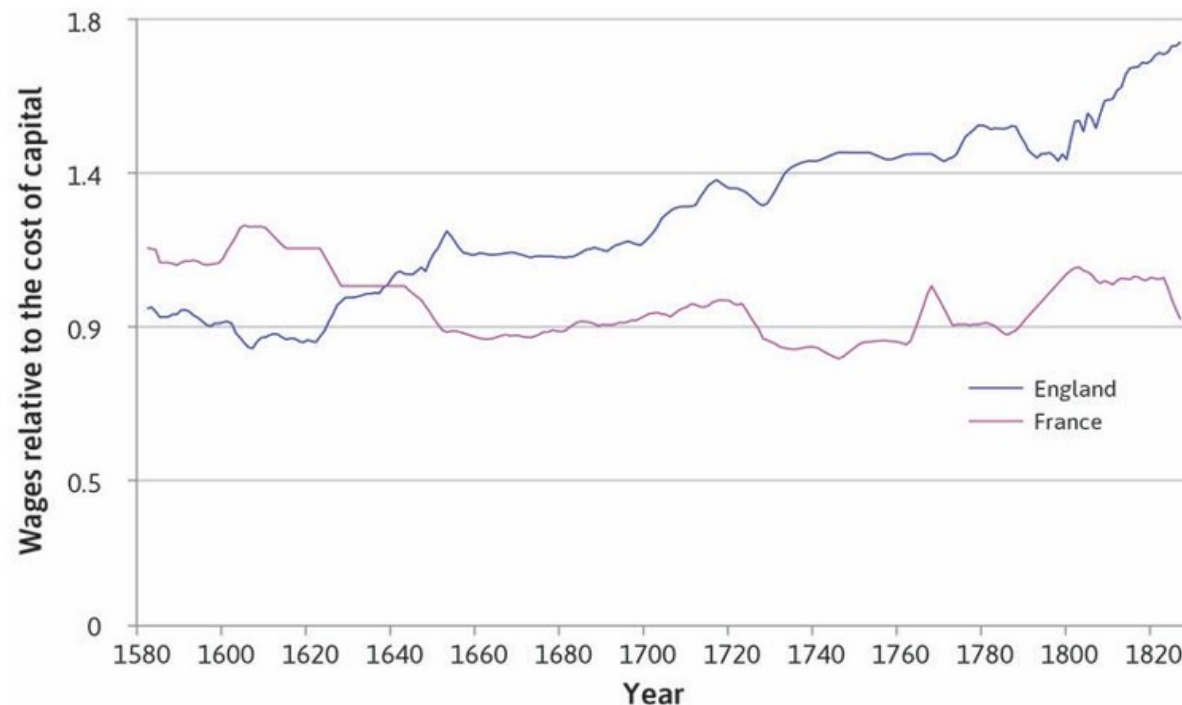


Figure 2.11 Wages relative to the cost of capital goods (late sixteenth to the early nineteenth century).

Page 138 in Robert C. Allen. 2008. *The British Industrial Revolution in Global Perspective*. Cambridge: Cambridge University Press.

- Wage to cost of capital ratio in England increased sharply since the beginning of the 17th century:
 - May be a result of: $\uparrow w$, $\downarrow r$, or both
 - According to [Bob Allen's video](#), wages rose due to **the expansion of the textile industry** due to **Britain's Commercial Empire** – **successful imperialism**.
- This motivated entrepreneurs to **seek more capital intensive production** schedules in England;
- And provided a very important **incentive for innovation**.

MAKING THE ECONOMIST'S TOOLBOX WORK

ESCAPE: EXPLAINING THE INDUSTRIAL REVOLUTION

- Let us see if we can see this numerically. Assume wages did not change, but the **cost of coal reduced to 5€/tonne**:

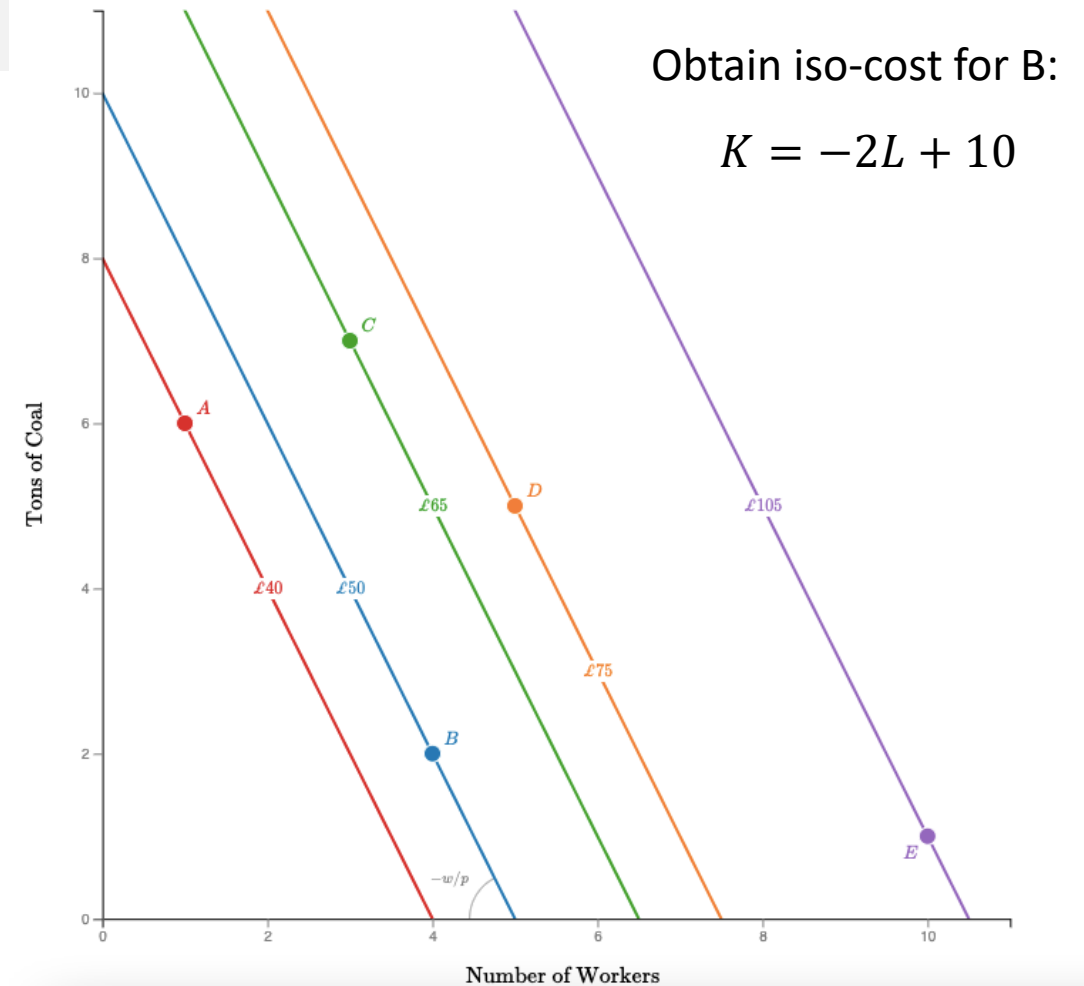
Unitary costs	Initial	Now
Capital	20	5
Labour	10	10
W-K ratio	-0.5	-2

wage-capital ratio is now larger (more negative), so we should favour more capital-intensive production.

Input combination	A	B	C	D	E
Amount of labour	1	4	3	5	10
Amount of capital	6	2	7	5	1
Initial cost	130	80	170	150	120
Current cost	40	50	65	75	105

- Which **technology** should the company choose?

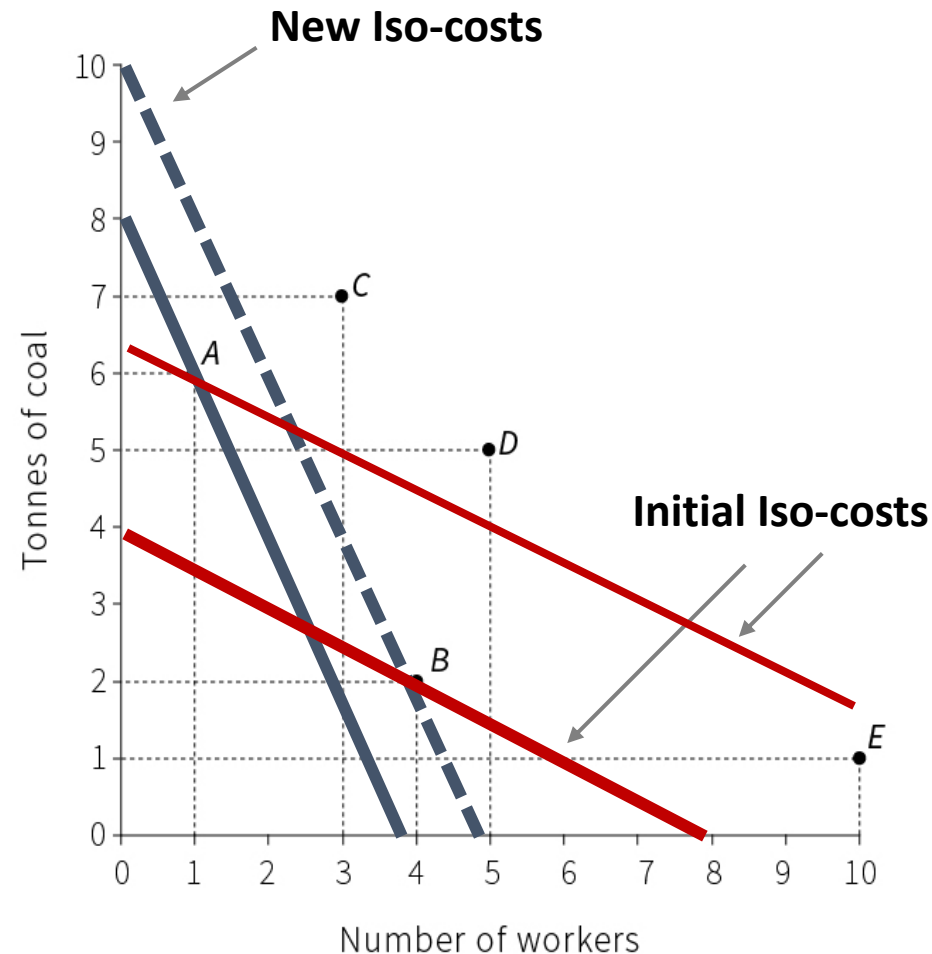
- A. It is now the least expensive, for the same output;



MAKING THE ECONOMIST'S TOOLBOX WORK

ESCAPE: EXPLAINING THE INDUSTRIAL REVOLUTION

- Back in our original iso-cost graph:



Unitary costs	Initial	Now
Capital	20	5
Labour	10	10
W-K ratio	-0.5	-2

- The lower price for coal **changes the slope of the iso-costs**:
 - They become more vertical, and **capital-intensive schedules are more desirable**.
- A is **NOW** located in an **iso-cost closer to the origin**
 - This ensures a lower cost for A, compared to B.
 - A is better cost-wise, and delivers the same output:
 - So, change input combination from B to A!**

MAKING THE ECONOMIST'S TOOLBOX WORK

ESCAPE: OTHER FACTORS

- Naturally, it would be **naïf to assume** that the incentive for innovation stemming from changes in relative prices of input factors **is the only factor** to explain a phenomenon so important as the Escape.
- Other researchers and theorists (economists or not) have argued for **other possible explanations**:
 - Europe's **scientific revolution** and the Enlightenment (17th and 18th centuries);
 - **Political and cultural characteristics** of nations as a whole;
 - **Cultural attributes** such as hard work and savings;
 - Abundance of coal and **access to colonies**.
- For instance, David Landes (1924-2013), an economic historian, emphasises the **relevance of political and cultural characteristics of nations**: “In addition, China lacked the institutions that made for a cumulative process of finding and learning: the schools, the academies, the learned societies, the challenges and competitions.”

MAKING THE ECONOMIST'S TOOLBOX WORK

ESCAPE: CREATIVE DESTRUCTION

- Is the process of **adopting new production technologies** as smooth in real life?
 - Not necessarily, **capital and labour mismatch** may make it hard;
 - There may be important **social and environmental costs**.
- **Creative destruction** is Joseph Schumpeter's name for 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.
- In his view, the failure of unprofitable firms is creative because it **releases labour and capital goods for use in new combinations**.



Joseph Schumpeter (1883–1950)

Watch a video about Schumpeter's work in your book [here](#).

SUMMARY

UNITS 1 AND 2

- In this class, we:
 1. Introduced a contemporaneous **definition of economics** (and how we came to that);
 2. Described the **Economist Toolbox** and how to use it:
 - It all starts with a good question;
 - Answers come from combining data, models and a narrative.
 3. We illustrated this with an analysis of the **evolution of the standards of living in the last centuries**.
 - We used the Malthusian model to explain the **Stagnation** period between the 13th and 17th century;
 - Then we discussed how firms may have an incentive to innovate which explains the **Escape** – creative destruction.
 4. Along the way we presented several **important concepts**: GDP, ceteris paribus, production function, equilibrium, production technology, returns to scale, iso-cost line, wage-capital ratio, etc.

REVIEW QUESTIONS

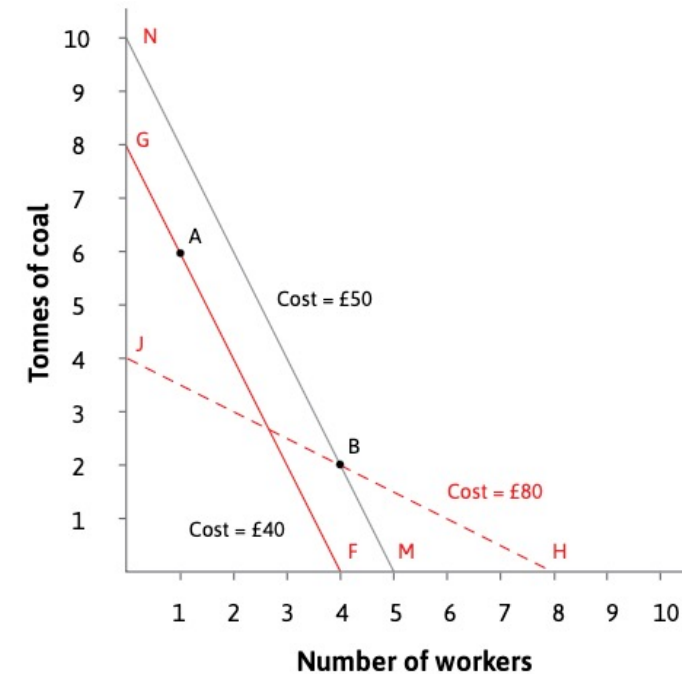
UNITS 1 AND 2

1. The GDP per capita of Greece was \$22,494 in 2012 and \$21,966 in 2013. Based on these figures, the growth rate of GDP between 2012 and 2013 (to two decimal places) was:

- A) -2.40%
- B) 2.35%
- C) -2.35%

2. Suppose a firm can produce its output using coal and workers. Considering the technologies and isocosts in the following graph, which sentence is correct?

- A) When the wage is £10 and the price of coal is £5, the combination of inputs at point N is more costly than the inputs at point B.
- B) Isocosts MN and FG represent the same price ratio (wage/price of coal) but different total costs of production.
- C) Isocost HJ represents all points that can produce 100 metres of cloth at a particular price ratio.



■ Answers: C; B

PRACTICE EXERCISE

ESCAPE: OTHER FACTORS

Use the interactive graph [here](#) to answer the following questions:

1. Which technology is chosen if $w = \$1$ and $p = \$30$?
2. What if $w = \$30$ and $p = \$1$?
3. Adjust the w and p and examine what happens to the isocost lines; are there any combinations of input prices such that technology C is chosen?
4. If $w = £4$, at what value of p do A and B cost the same? What is the value of the ratio w/p ?
5. What if $w = £8$? $£12$? $£16$? $£20$? $£24$? $£28$? What do you notice?
6. If $w = £5$, at what value of p do A and E cost the same? At these prices what is the lowest cost technology?
7. Now suppose that technology B did not exist. Would D be dominated with w and p from #6? Can you find any values of w and p at which D would be chosen?
8. True or false? Even if a technology is not dominated, there may exist no prices at which it would be optimal to choose.

https://www.econgraphs.org/core-econ/2/production_technologies_cost

PRACTICE EXERCISE

ESCAPE: OTHER FACTORS

Answers:

1. Which technology is chosen if $w = \$1$ and $p = \$30$? E
2. What if $w = \$30$ and $p = \$1$? A
3. Adjust the w and p and examine what happens to the isocost lines; are there any combinations of input prices such that technology C is chosen? No
4. If $w = £4$, at what value of p do A and B cost the same? What is the value of the ratio w/p ? £3; $4/3$
5. What if $w = £8$? £12? £16? £20? £24? £28? What do you notice? p increases proportionally: £6, etc... $w/p = 4/3$ in all cases
6. If $w = £5$, at what value of p do A and E cost the same? At these prices what is the lowest cost technology? £9; B
7. Now suppose that technology B did not exist. Would D be dominated with w and p from #6? Can you find any values of w and p at which D would be chosen? No; No
8. True or false? Even if a technology is not dominated, there may exist no prices at which it would be optimal to choose. True