# Ricardian model

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In 2015 Ireland imported

- Bananas from Belize (7.89M USD)
- Soybean oilcake from Argentina (116M USD)
- Petroleum from Saudi Arabia (17.8M USD)
- Cars from Germany (695M USD)
- Aircrafts from the USA (2.57B)

In 2015 Ireland exported

- Medicaments (24.2B USD)
- Heterocyclic compounds (17.3B USD)
- Human or animal blood (11.7B USD)
- Malt extract (2.1B USD)

Countries trade because of

1. Proximity to each other
2. Cross-country differences
   - Resource availability/factors of production
3. Economies of scale and product differentiation
   - Produce efficiently a limited amount of goods

David Ricardo thought that

1. Countries trade due to technological differences
2. Countries can always gain from trade
    - Even a country that is better at everything

Note that Ricardo lived in a time of mercantilism which has a strong focus on a positive trade balance

- Exports good, imports bad

As a result, mercantilism is in favour of high tariffs in order to reduce imports

- e.g. the corn laws in the UK at the time of Ricardo (1815-1846)

In contrast, Ricardo showed that free trade could benefit all trade partners

| Quantity produced by labour force | | |
|---|---|---|
| | Cloth (m) | Wine (l) |
| Portugal | 20 | 300 |
| England | 10 | 100 |

Although Portugal has **absolute** advantage in producing both goods, yet it can still benefit from trade

1. England should specialise in producing cloth: has a **comparative** advantage
2. Portugal should specialise in producing wine

Under specialisation Portugal could trade 300L of wine against 30m of cloth

$$300 \cdot \frac{10}{100}$$

- Would give up 20m of cloth to produce additional 300L of wine

England could trade 10m of cloth against 150L of wine

$$10 \cdot \frac{300}{20}$$

- Give up 100L of wine for 10m of cloth

- England has comparative advantage in producing cloth
- Portugal has comparative advantage in producing wine

Both countries gain by specialising and trading.

Main idea of the Ricardian model is that

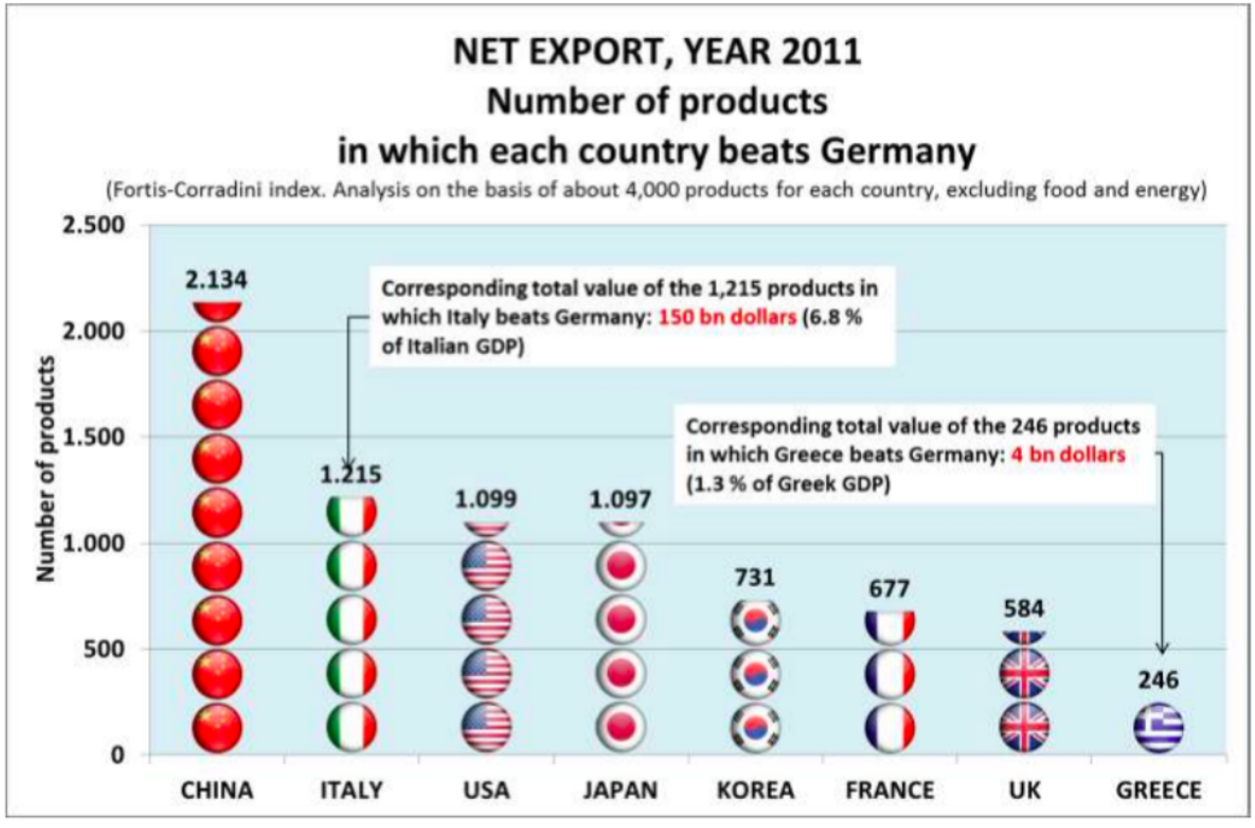
- Trade happens due to technological differences or labour productivity
- Countries will be benefit by specialising

The model therefore predicts that under free trade countries will specialise.

- Free trade will benefit all participants, relative to autarky, even if some countries are terrible at everything.

# Comparative advantage Italy

**Italy is the second country after China**
**for the highest number of non-food manufactured products**
**with a net trade value higher than of Germany's**




*Source: compiled by Fondazione Edison on data from United Nations Comtrade, Eurostat, Istat*

Let's set up the formal model, in its most basic form there are

- 2 countries: *Home*, *Foreign*
- 2 goods: $X$, $Y$
- 1 production factor: labour $L$

The supply assumption is that labour $L$ is mobile across sectors and is competitive

- Workers move to sector with higher wages

Moreover the labour supply is constant and cannot move between countries

- Production with constant returns to scale

For demand the model assumes that consumers consume goods to maximise utility and consumption is constrained by labour income Demand assumptions include

- Price increase in one good leads to substitution with other good

Importantly under free trade the consumed goods can be produced anywhere.

*Home* has $L$ hours of labour

- One unit of $x$ takes $a_x$ hours
- One unit of $y$ takes $a_y$ hours

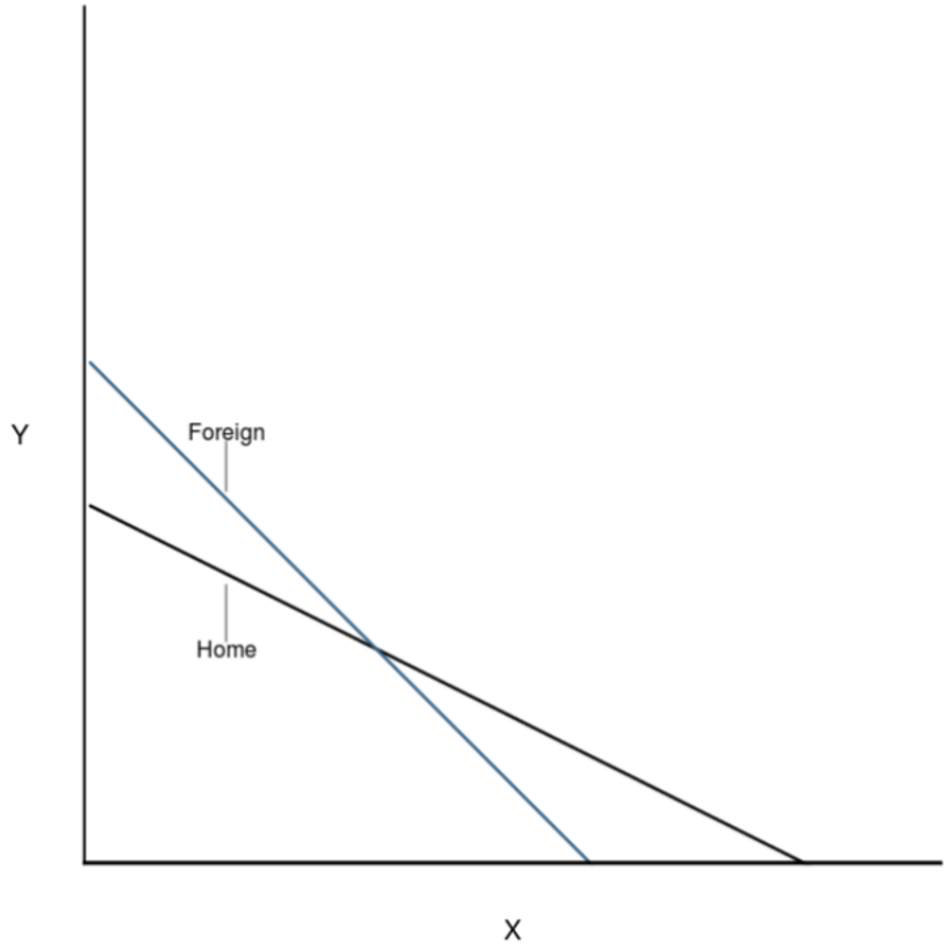
*Foreign* has $L^*$ hours of labour

- One unit of $x$ takes $a_x^*$ hours
- One unit of $y$ takes $a_y^*$ hours

Production is constrained by labour supply $L$ and the production possibilities frontier (PPF) is given by

$$L = a_x X + a_y Y$$
$$L^* = a_x^* X + a_y^* Y$$

# Example of PPF



In autarky the PPF acts as a budget constraint for the country.

- In perfectly competitive market the country will produce at highest level of utility within PPF limits

Under autarky relative prices under perfect competition are

$$p_x = a_x w; p_y = a_y w \Rightarrow p^a = \frac{p_x}{p_y} = \frac{a_x}{a_y}$$

$$p_x^* = a_x^* w^*; p_y^* = a_y^* w^* \Rightarrow p^{a*} = \frac{p_x^*}{p_y^*} = \frac{a_x^*}{a_y^*}$$

Wages are therefore given by

$$w = \frac{p_x}{a_x} = \frac{p_y}{a_y}$$

$$w^* = \frac{p_x^*}{a_x^*} = \frac{p_y^*}{a_y^*}$$

**NB** - Wages are equal across sectors.

In autarky the relative price of good $X$ will be higher in *Home* than *Foreign*

$$\frac{p_x}{p_y} > \frac{p_x^*}{p_y^*}$$

This means that in *Home* the opportunity costs of $X$ in terms of $Y$ is higher than in *Foreign*.

$$\frac{a_x}{a_y} > \frac{a_x^*}{a_y^*}$$

Given

$$\frac{a_x}{a_y} > \frac{a_x^*}{a_y^*}$$
$$\frac{p_x}{p_y} > \frac{p_x^*}{p_y^*}$$

suggests that since *Home* is better at producing $Y$ it should import $X$ from *Foreign*. The model therefore predicts two things concerning production and trade patterns;

1. *Home* specialises in $Y$ and imports $X$
2. *Foreign* specialises in $X$, imports $Y$

Concerning trade patterns each country will export its comparative advantage good

- $Y$ for *Home*
- $X$ for *Foreign*

And due to a mutual beneficial exchange, moving from autarky to free trade will imply a price convergence of the two goods

$$\frac{p_x}{p_y} = \frac{p_x^*}{p_y^*}$$

The question that remains is what would be the level of this free trade relative price?
Under free trade three possible equilibria could occur

1. Free trade relative price equals *Home* autarky relative price
2. Free trade relative price equals *Foreign* autarky relative price
3. Free trade relative price is strictly in between autarky relative prices

Scenario 1: Free trade relative price equals *Home* autarky relative price.

$$p^e = p^a = \frac{a_x}{a_y}$$

1. *Home* keeps producing both goods
2. *Foreign* will only produce $X$

Only *Foreign* specialises and will gain, for *Home* there is no difference between free trade and autarky prices; will not specialise and not gain.

Scenario 2: Free trade relative price equals *Foreign* autarky relative price.

$$p^e = p^{a*} = \frac{a_x^*}{a_y^*}$$

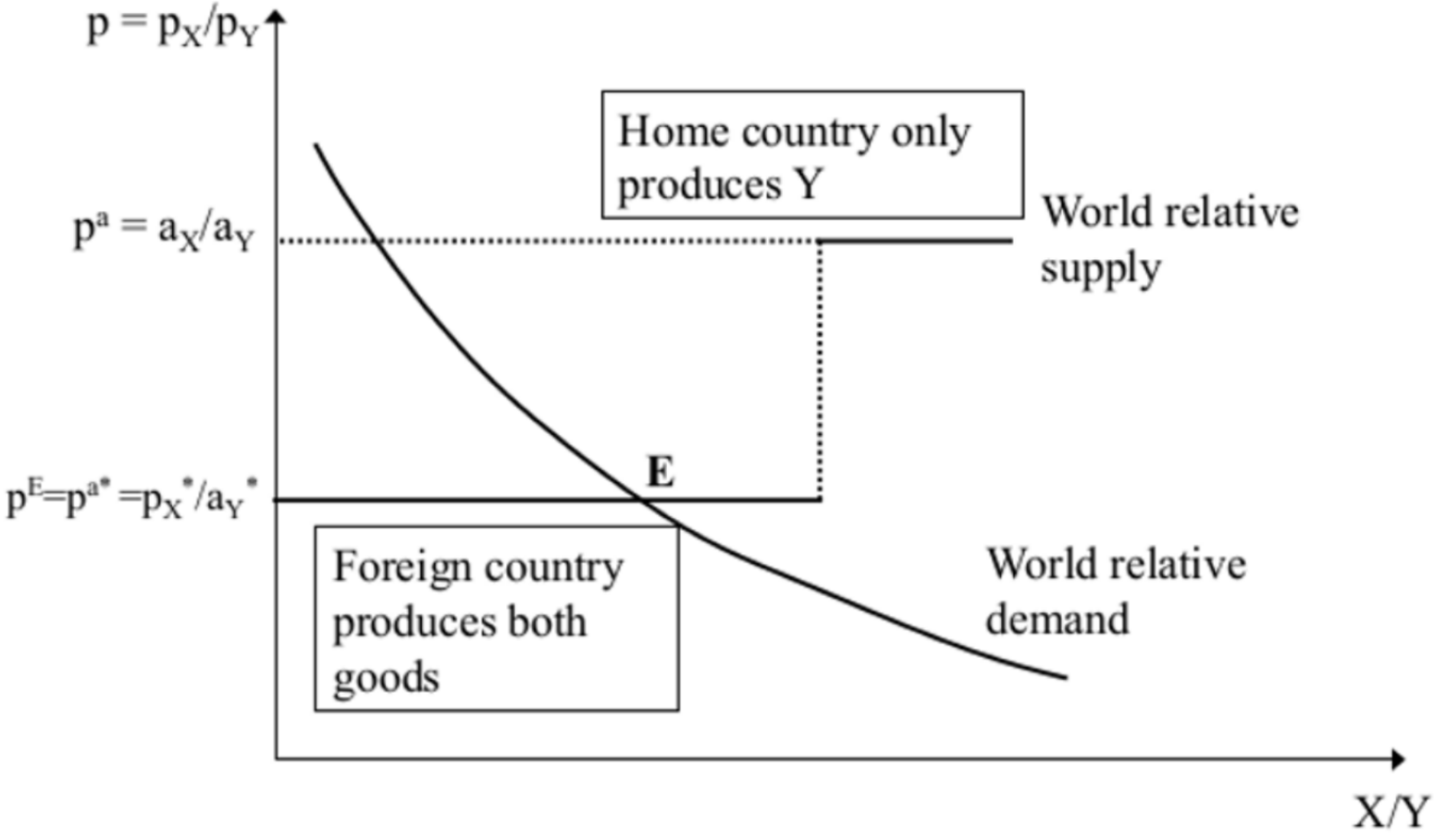
This will be similar to the other scenario, in this case

1. *Foreign* produces both goods
2. *Home* produces only $Y$

Here *Home* will gain and *Foreign* won't.

$\Rightarrow$ Scenarios 1 and 2 will lead to a world equilibrium with incomplete specialisation.

# World equilibrium with incomplete specialisation

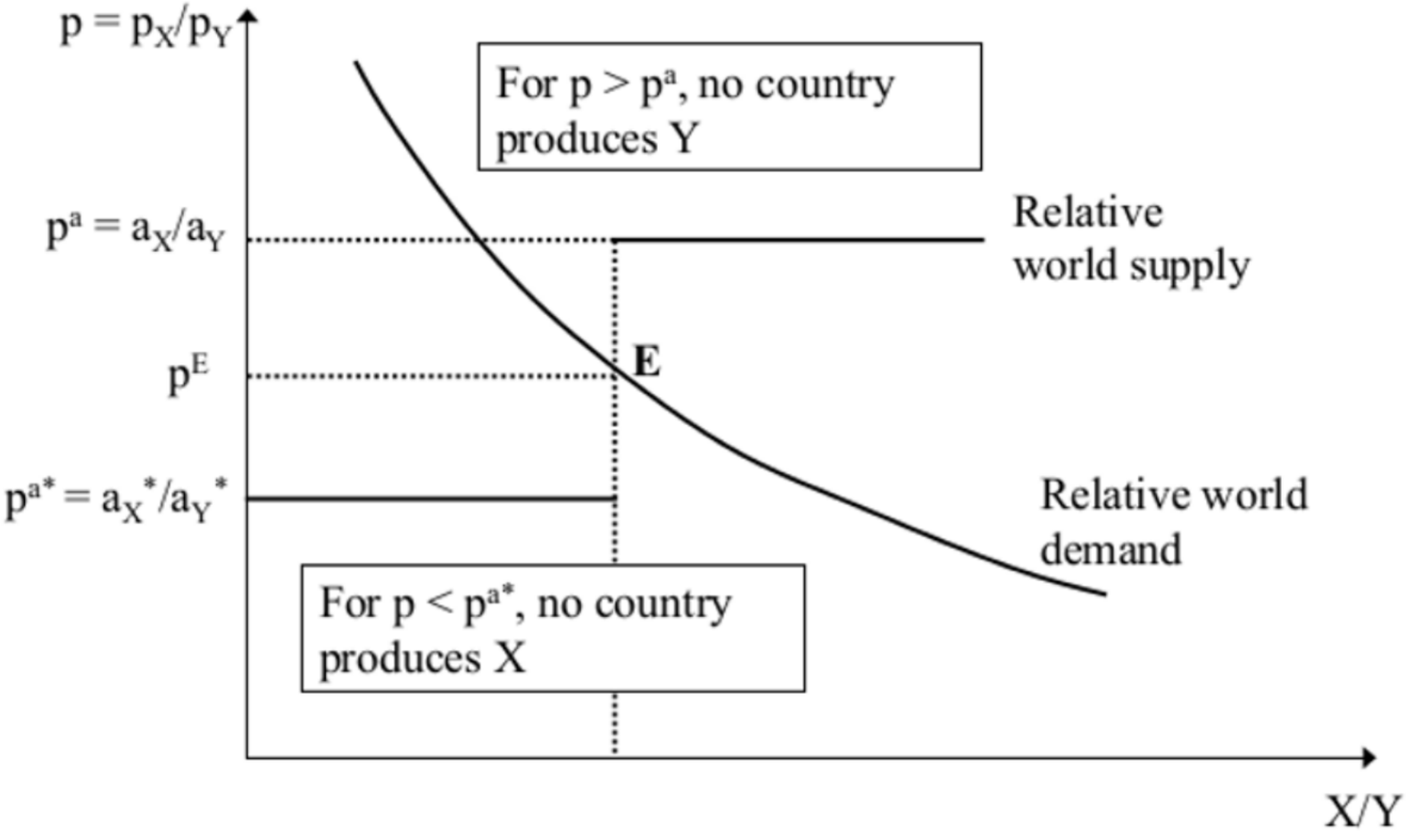


Scenario 3: Free trade relative price strictly between autarky relative prices.
This is the equilibrium where we will see full specialisation so

1. *Home* only produces $Y$
2. *Foreign* only produces $X$

In this case both countries will gain.

# World equilibrium with complete specialisation



To reiterate, full specialisation will occur if

$$\frac{a_x^*}{a_y^*} < p < \frac{a_x}{a_y}$$

Which means that the relative supply of goods will be given by

$$\frac{X}{Y} = \frac{L^*/a_x^*}{L/a_y}$$

The gains from trade stem from specialisation in the most resource efficient industry and using the generated income to buy desired goods and services

- Again think about Norway using their oil revenue to buy oranges

Workers can benefit from trade as well since opening up the economy will increase the price of their exported good(s).

**NB** - In this model we only have one production factor.

Trade can be considered as an indirect method of production or acquiring a new technology.

- In absence of trade, country has to allocate resources to produce all the goods it wants to consume
- With trade, country can specialise production and trade products for goods it wants to consume

This means that trade can expand the consumption possibilities beyond the production possibilities.

Summarising; opening up to trade *Home* stops producing $X$

- This will save $a_x$ labour units

These $a_x$ "additional" labour units are used to produce

$$\frac{a_x}{a_y}$$

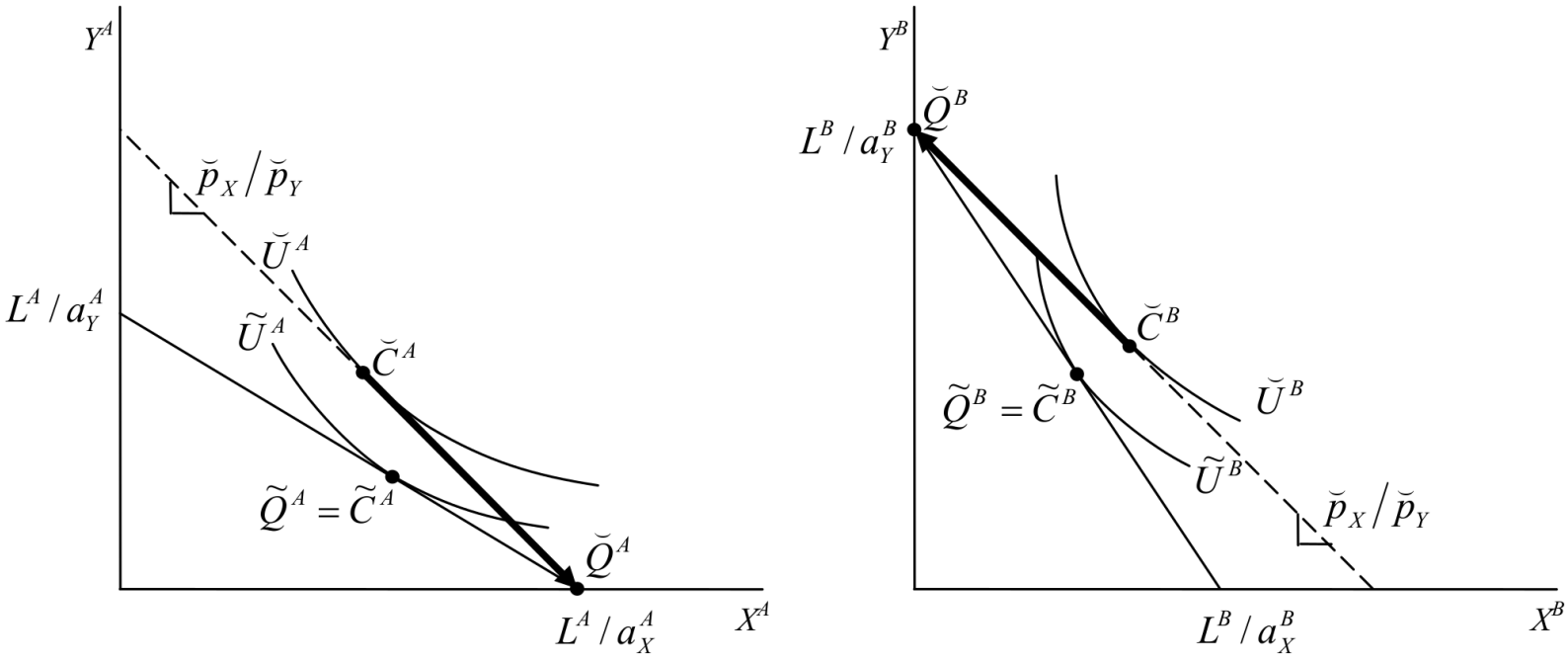
more units of $Y$ which are sold to *Foreign* and the income is used to buy

$$\left(\frac{p_y}{p_x}\frac{a_x}{a_y}\right)$$

more units of $X$.

The next diagrams illustrate how production possibilities change as a result of trade. Note that in this case the comparative advantage good of country $A$ will be $X$.

# Complete specialisation

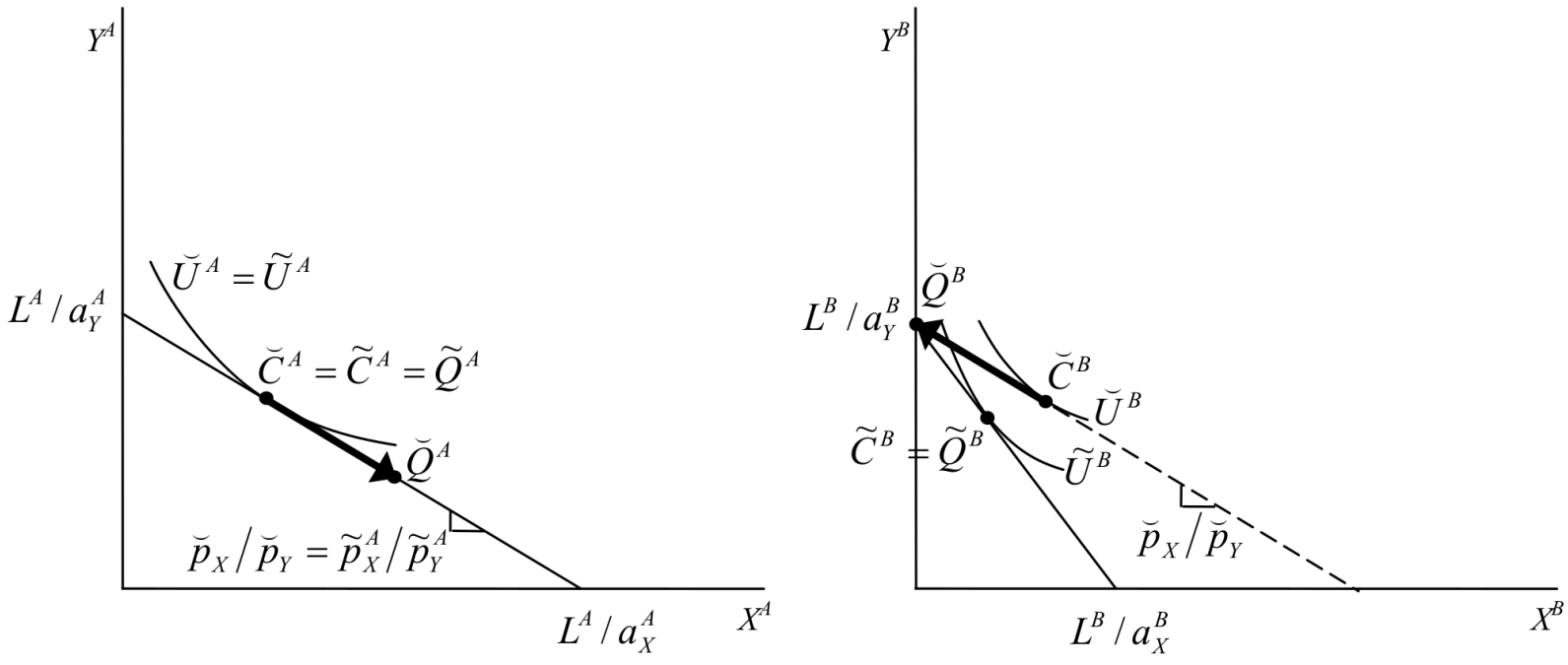


Next we consider the case of incomplete specialisation were

- Country $B$'s labour endowment is smaller
- Preferences for good $Y$ is larger in both $A$ and $B$

As a result, the production of country $B$ is too small to meet $A$'s demands, even under $A$'s autarky prices.

# Incomplete specialisation



Concerning the economic size of trading partners the implications of the model are such that

- The relative price of an export good in a large country will not increase as the partner country is too small to meet demand
- Consumption and welfare will be unchanged

In constrast, for a small country relative prices will change as well as consumption and welfare which will increase.

If both countries are specialised the relative prices of the preferred good will increase and improve the ToT of the exporting country.

Workers can benefit from free trade. Let's have another look at how their wages are determined. Recall that an industry will hire workers until wages equal production value or

$$w = p \cdot MPL$$

This applies to each industry, and since $L$ can move freely between industries, it will move to the highest paying industry until wage equalisation occurs.

$$p_x MPL_x = p_y MPL_y$$

$$\frac{p_x}{p_y} = \frac{MPL_y}{MPL_x}$$

Price ratio $\frac{p_x}{p_y}$ denotes relative price of the numerator good in terms of foregone denominator goods

From earlier we know that under autarky prices are given by

$$p_x^a = wa_x; p_y^a = wa_y$$
$$p_x^{a*} = w^* a_x^*; p_y^{a*} = w^* a_y^*$$

Under full specialisation wages will be determined by the comparative advantage good, i.e. the good that is exported[1]

$$w = \frac{p_y}{a_y}$$
$$w^* = \frac{p_x}{a_x^*}$$

The relative wages are given by

$$\frac{w}{w^*} = \frac{p_y}{p_x}\frac{a_x^*}{a_y}$$

[1] Superscripts on prices are dropped here.

Although trade is determined by comparative advantage, wages are determined by absolute advantage

- In the Ricardian model productivity differences determine wage differences

Meaning that a country with an absolute advantage in producing a good will enjoy higher wages in that industry after trade.

The link between wages and productivity has some interesting implications given that it provides countries with an cost advantage in production, specifically

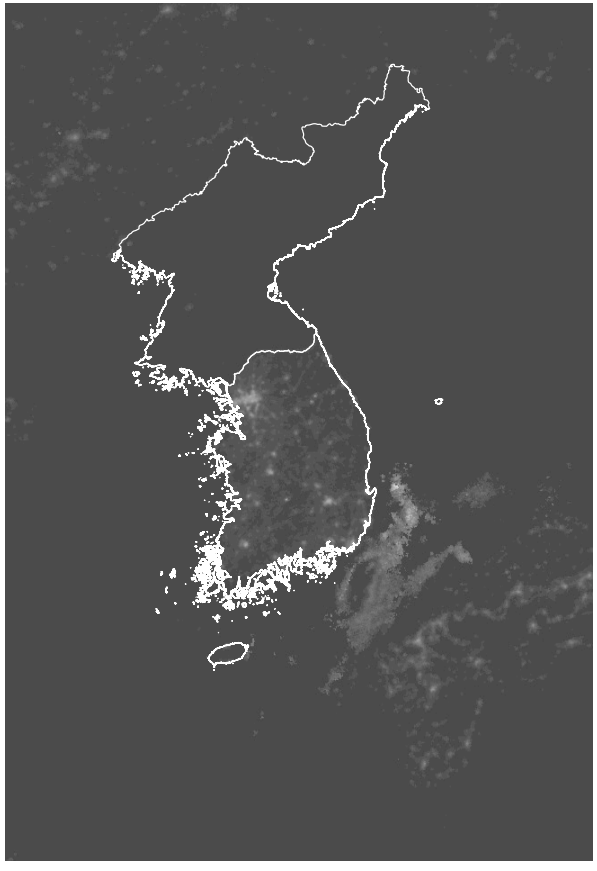
1. High wages cost can be offset by high productivity
2. Low productivity costs can be offset by low wages

This means that technological poor countries can export at competitive prices by having low wages.

- Wages will increase when technology improves

Therefore, an important prediction of the Ricardian model is that real wages will increase when countries engage in trade.[2]

[2] Note that this is an implication of the fact that all income accrues to labour.



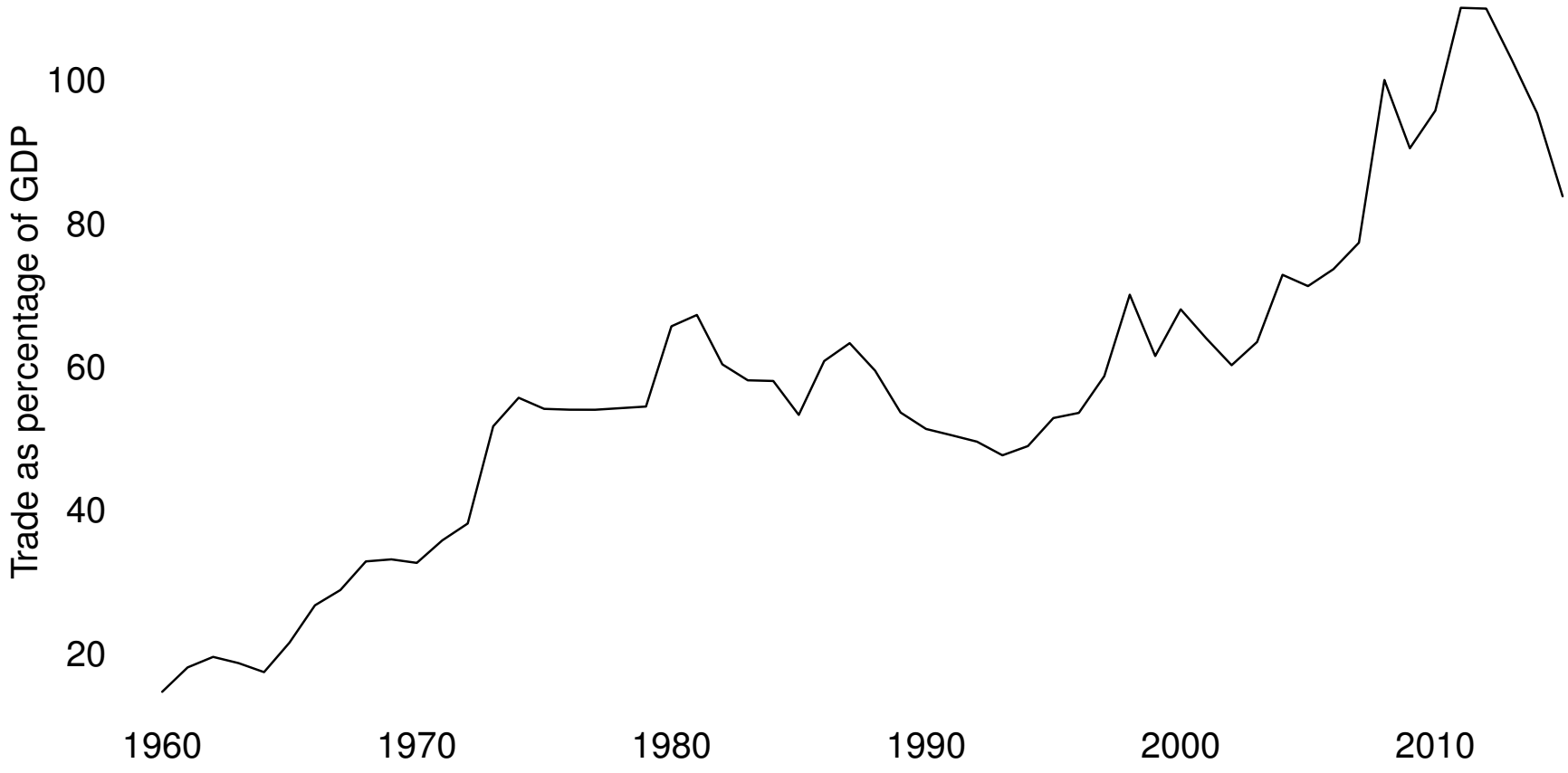
South Korea, or Republic of Korea

- 11th economy in the world (1.4T USD)
- 5th largest exported, 7th largest importer
- Highly diversified economy
- Reached semi-final of 2002 FIFA World Cop

In 1960 South Korea's GDP per capita was about 900 USD, lower than most countries in Sub-Sahara Africa.

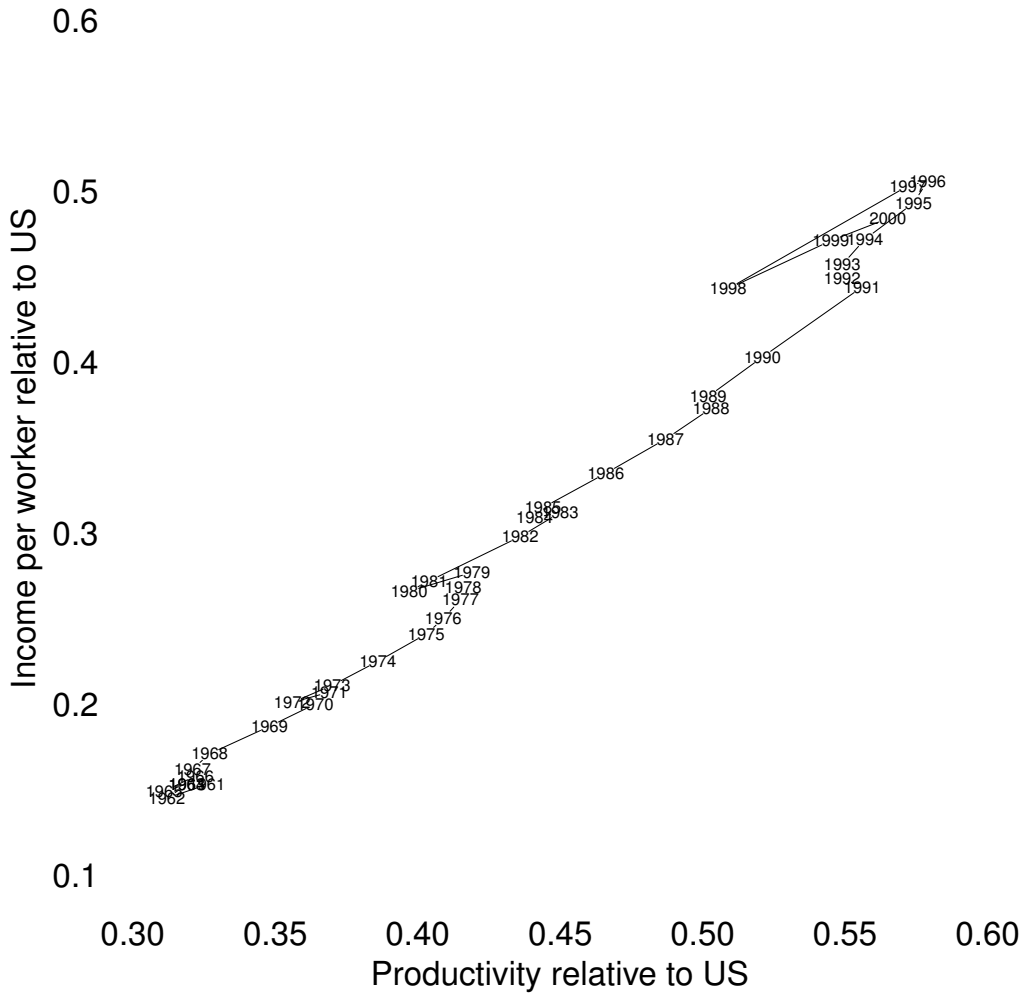
# Trade relative to GDP in South Korea 1961-2015

source: WDI



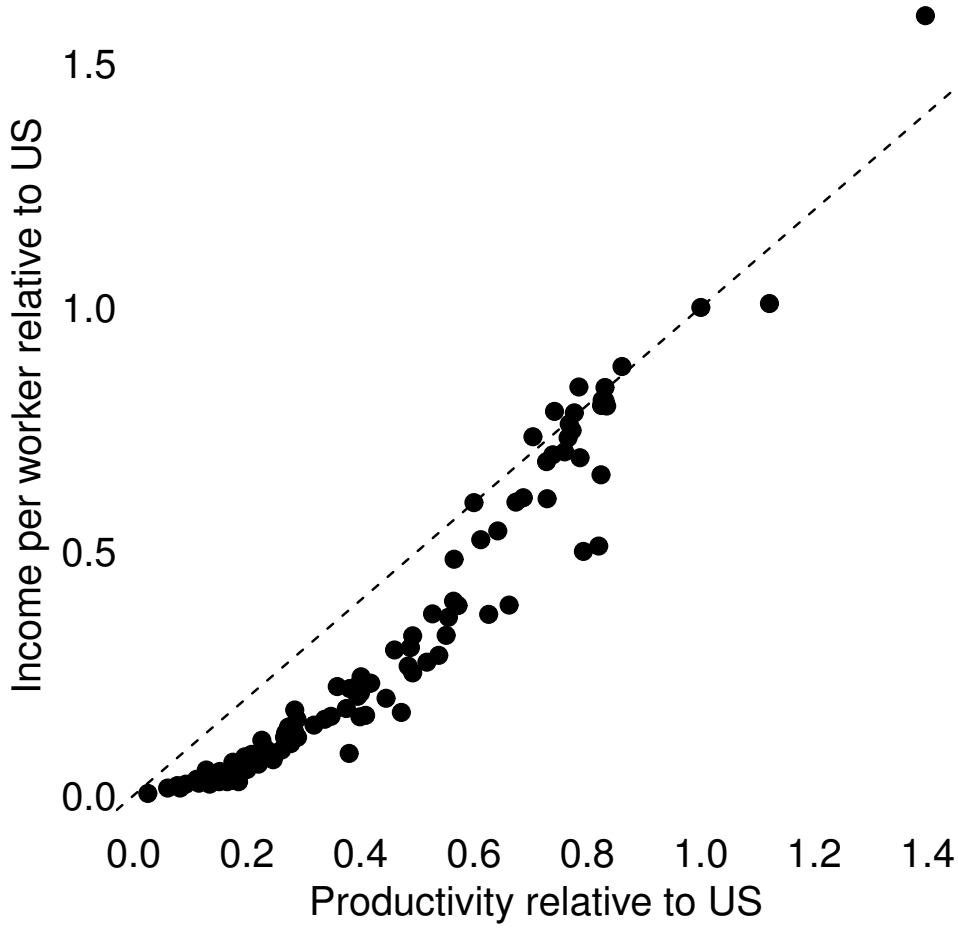
# Productivity and wages in South Korea 1961-2000

source: UNIDO



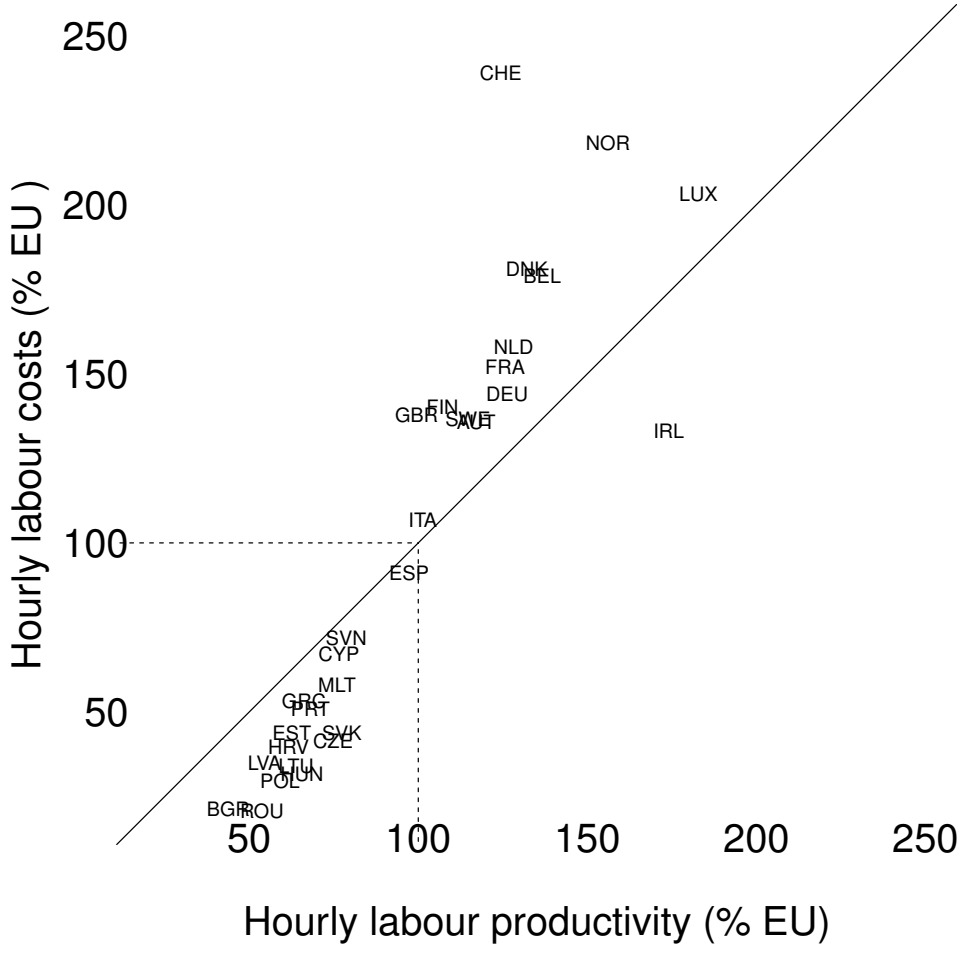
# World productivity and wages in 2000

source: UNIDO



# Hourly productivity and labour costs in the EU

source: Eurostat

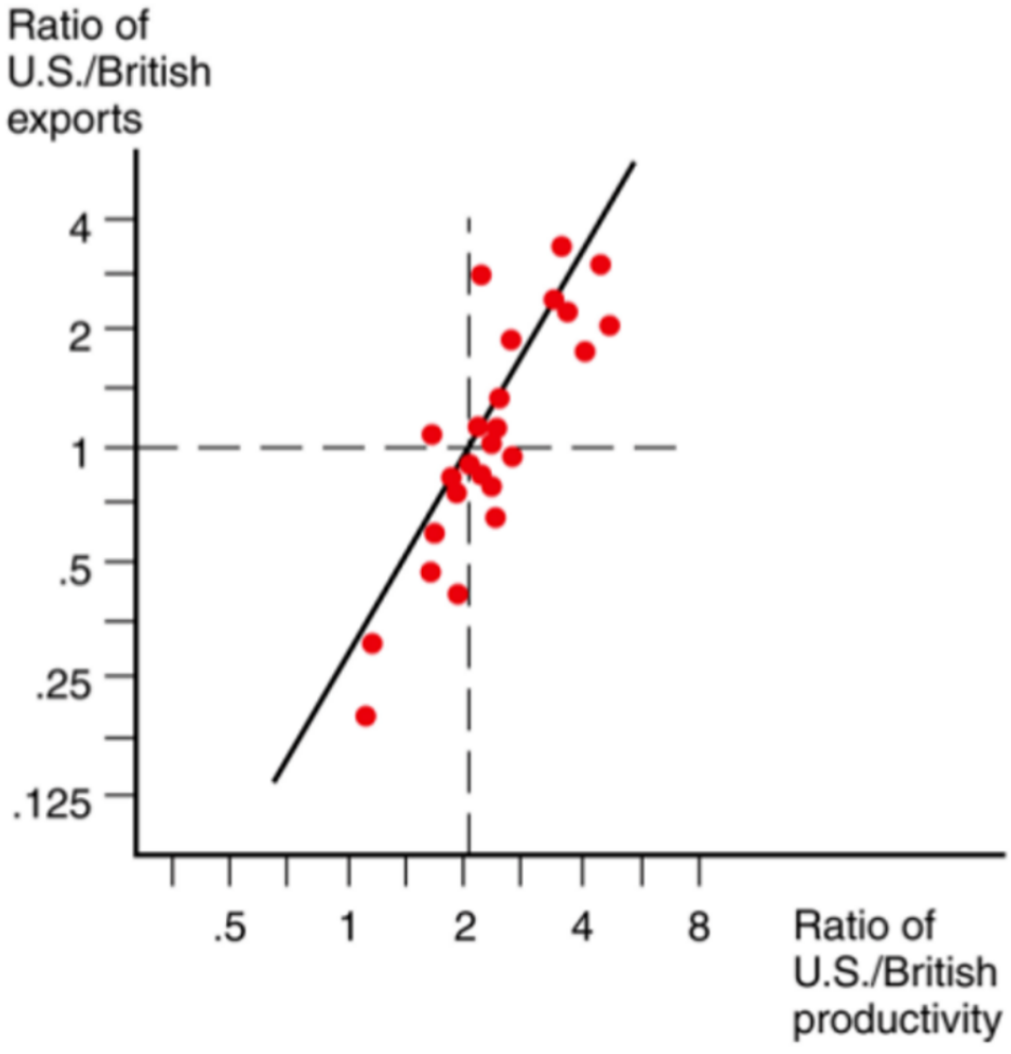


# Bangladesh relative productivity in textiles

| | Bangladeshi Output per Worker as % of China | Bangladeshi exports as % of China |
|---|---|---|
| All industries | 28.5 | 1.0 |
| Apparel | 77 | 15.5 |

**Source:** McKinsey and Company, "Bangladesh's ready-made garments industry: The challenge of growth," 2012; UN Monthly Bulletin of Statistics.

# US ratio of exports is lowest in least productive sectors in 1951



The Ricardian equilibrium attempt to identify the country that can supply a good at minimum cost. However, the standard model only contains two countries and two goods. In order to apply it to actual world trade we need to add

- More goods
- More countries

Let's run through Ricardo's original example from the beginning, applying what we discussed so far.

How many workers to make one unit of a good

| | Cloth (m) | Wine (l) |
|---|---|---|
| Portugal | 90 | 80 |
| England | 100 | 120 |

Let's look at relative wages, Portugal's wage is set equal to 1.

| | Cloth (m) | Wine (l) |
|---|---|---|
| Portugal | 90 | 80 |
| England | $100w$ | $120w$ |

With free trade and perfect competition, prices will be equal in England and Portugal

- It will also be the lowest-cost way of producing each good

Let's assume that $w$ is larger than the ratio of Portuguese to English workers required for producing cloth ($\frac{90}{100}$).

What will happen to production?

Since

$$\frac{90}{100} > \frac{80}{120}$$

both goods will be produced in Portugal, actually leaving English labour unemployed.

- i.e. $w$ must be lower than 90% of the Portuguese wage

Similarly, if

$$w < \frac{80}{120}$$

both goods will be produced in England, by undercutting the Portuguese wages, leaving the latter unemployed.

- So $w$ should be somewhere between $\frac{2}{3}$ and $\frac{9}{10}$

Let's start with adding an additional good: linen. In this case both Portugal and England require a 100 workers for one unit of linen. We get the following inequality

$$\frac{100}{100} > \frac{90}{100} > \frac{80}{120}$$

- England has a stronger comparative advantage in producing linen, compared to cloth, over Portugal.

The ordering of goods in terms of England's relative productivity is called a chain of comparative advantage. Under free trade, relative wage $w$ will break the chain between goods for which England's relative productivity is above or below it's relative wage.

- For example $w = 0.95$ will break it between linen and cloth and wine

We can use this chain of comparative advantage to construct a demand curve for English labour as a function of $w$.

- We assume that both countries spend their money the same way

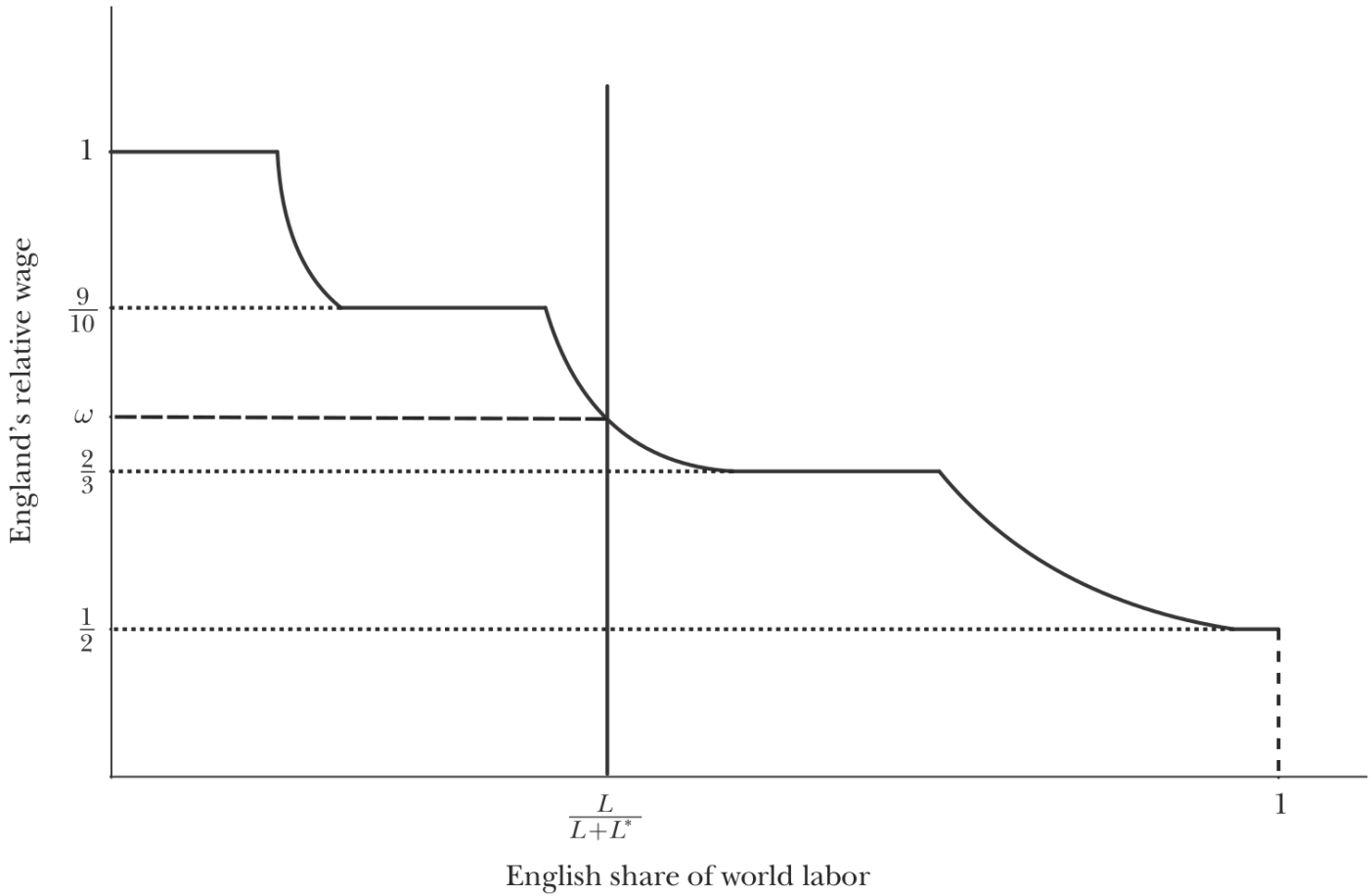
Note that for $w > 1$ England will price itself out of all goods; for $w = 1$ England will be competitive for linen.

- Buyers will be indifferent from the source

Any decline $w$ will make England the sole producer of linen, and it will become more competitive at lower wages.

*Figure 1*

**Wage Determination in the Many Good Model**



This diagram illustrates the intensive and extensive margins of trade

- Intensive margin: exporting more of a given set of goods
- Extensive margin: exporting a larger variety of goods

Decline in $w$ increases England's export demand at the intensive margin until it reaches a threshold where it expands at the extensive margin.

More general, the Ricardian model can be extended by ranking all the goods based on productivity

$$\frac{a_1^*}{a_1} < \frac{a_2^*}{a_2} < ... < \frac{a_n^*}{a_n}$$

For this series locate $\frac{w}{w^*}$ and home will export goods

$$\frac{a_i^*}{a_i} > \frac{w}{w^*}$$

Wage disadvantage is compensated by advantage in productivity

It is straightforward to expand the model to include more countries

- Although not more countries and more goods at the same time

Let's add France with the following labour requirements

- 60 in wine
- 120 in cloth

We can use the chain to produce

$$\frac{120}{100} > \frac{80}{90} > \frac{60}{120}$$

Here England will produce cloth and France will produce wine.

Although the economic ideas of Ricardo are 200 years old, they provide some powerful arguments in favour of free trade. Nonetheless, there are still some popular misconceptions concerning trade, for instance

1. Trade only helps the more productive countries
   - Specialisation allows unproductive countries by using resources more efficiently

2. Industrialised countries are hurt by low wage countries
   - Consumers in industrialised countries benefit from cheaper products
   - Although trade can bring disadvantages for certain groups

3. Trade hurts developing countries as exports require low wages
   - Consider alternative in absence of trade

Although the Ricardian model can help understand trade patterns, the predicted specialisation rarely happens

1. Transportation costs reduce/hamper trade
2. Multiple production factors which reduce specialisation tendency
3. Protectionism

Concerning transportation costs, and briefly going back to the gravity model; the Ricardian model can be adjusted to account for transport costs.
Let $\tau$ be proportional transport cost, then good $i$ is not traded when

$$wa_i < w^* a_i^* < wa_i(1+\tau)$$