EC3355: Resources and trade
Heckscher-Ohlin model

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Last week

- Specific factors model
  - Accounted for factor mobility
  - Short run model: some factors can only be used in production of one good
  - Analysed effect of trade on income distribution
  - Trade can hurts owners of certain factors
- Migration
  - Leads to increase in world output
  - Can have adverse effects as well

Today

- The Heckscher-Ohlin model
- Stolper-Samuelson theorem
- Rybczynski theorem
- Trade patterns
- Factor price equalisation
- Shortcomings of the model
- Empirical evidence
- Trade and income distribution

Drawbacks from other models

- Ricardian model
  - All agents gain from trade
  - Only one factor
  - Predicts complete specialisation
- Specific factor mode
  - Only one mobile factor, short run model

Heckscher-Ohlin model

Some background

- Builds on Ricardian model of comparative advantage
- Production and trade patterns based on factor endowments
- Trade and long-run distribution income
- Standard model for many years
    - Can be analysed graphically
    - Enough complexity to account various trade issues (tariffs, technological change)
    - Clear testable predictions

Heckscher-Ohlin model

Some background

- Fallen from grace

- As a scientific theory it generates testable predictions
- Predictions have not been backed up by empirical evidence
- Model assumptions seem out of touch

Heckscher-Ohlin model

Main ideas of the model

1. Focus on the long-term effects of trade
2. Based on idea that all factors are mobile without costs

Heckscher-Ohlin model

Four main theorems

1. Heckscher-Ohlin
   - Countries with relatively more of a resource will export goods for which that resource is more useful in production
2. Stolper-Samuelson
   - An increase in the relative price of a good will increase the relative remuneration of the factor which is intensively used in the production of this good and reduces the remuneration of the other factor
3. Rybczynski
   - For a given relative price, a higher endowment in one factor makes the production that uses this factor more intensively increase and the production that uses it less intensively decrease
4. Factor-price equalisation
   - Trade should cause resource prices to converge

Heckscher-Ohlin model

Basic model

- Two countries: Home (H) and Foreign (G)
- Two goods: Clothes (C) and Food (F)
- Two factors: Labour (L) and Capital (K)

Heckscher-Ohlin model

Model assumptions

- Goods can be produced by a combination of labour and capital
- Production technology is equal across countries
- Equilibrium of factor markets

$$L_c + L_f = L$$
$$K_c + K_f = K$$

- Production is constant returns to scale
- Budget constraint is given by

$$Y = wL + rK$$

Heckscher-Ohlin model

Model assumptions

- Productions factors are mobile across sectors, static across countries
- Each country has a different endowment of labour and capital
- Home relatively richer in labour than in capital compared to Foreign

$$\frac{L}{K} > \frac{L_*}{K_*}$$

- For each sector the technical coefficients a_{ij} ($i = \frac{C}{F}, j = \frac{K}{L}$) depend on the relative factor prices $\frac{w}{r}$
- Clothes are relatively labour intensive

Heckscher-Ohlin model

Advantages

- Can explain why some people are against trade liberalization
  - 2 factors of production
- Can explain incomplete specialisation
  - 2 factors implies decreasing returns to each factor
- Comparative advantage comes from differences in relative factor endowments
- Countries with relatively more of a resource will export goods for which that resource is more useful in production
 - e.g. China will export labour intensive manufactured goods

Heckscher-Ohlin model

Factor intensity

- 2 goods: $Clothes = CC(L_c, K_c), Food = FF(L_f, K_f)$
- Substitutability: $\frac{L_c}{K_c}$ and $\frac{L_f}{K_f}$ are decreasing in $\frac{w}{r}$
- At firm's optimum the opportunity costs equal the relative price of factors
- Since factors are mobile across sectors the opportunity costs are equalised

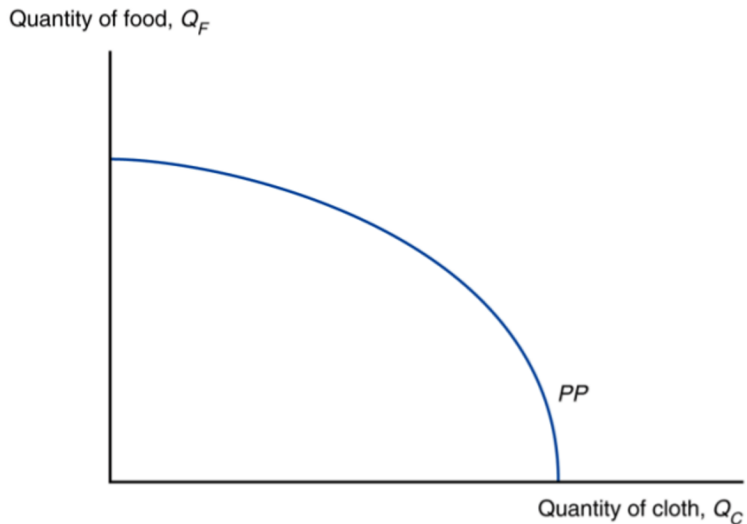# Heckscher-Ohlin model
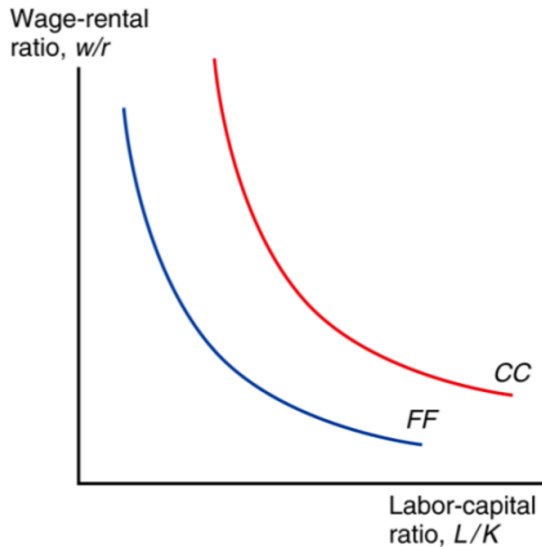
Factor intensity

Heckscher-Ohlin model

Production possibilities frontier with factor substitution

Quantity of food, Q_F

PP

Quantity of cloth, Q_C

Heckscher-Ohlin model

Production possibilities frontier with factor substitution

- ▶ Slope represents amount of labour and capital we move from clothes to food production

$$-\frac{MPL_f}{MPL_c} = -\frac{MPK_f}{MPK_c}$$
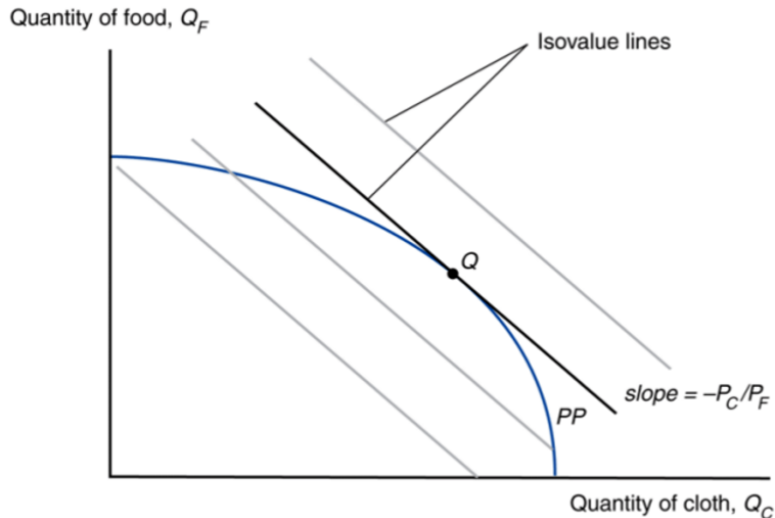
Heckscher-Ohlin model
Output price ratio

$$\frac{p_c}{p_f} = \frac{MPL_f}{MPL_c} = \frac{MPK_f}{MPK_c}$$

- ▶ Production will be given point on PPF tangent to $-\frac{p_c}{p_f}$
- ▶ Trade-off in production equals trade-off according to market prices (V is value of output)
- ▶ $V = p_c Q_c + p_f Q_f$

Heckscher-Ohlin model

Production

Heckscher-Ohlin model

Input price ratio

$$\frac{w}{r} = \frac{MPL_f}{MPL_c} = \frac{MPK_f}{MPK_c}$$

▶ Production will be given point on PPF tangent to $-\frac{w}{r}$

▶ As w increases relative to r, producers use less labour and more capital
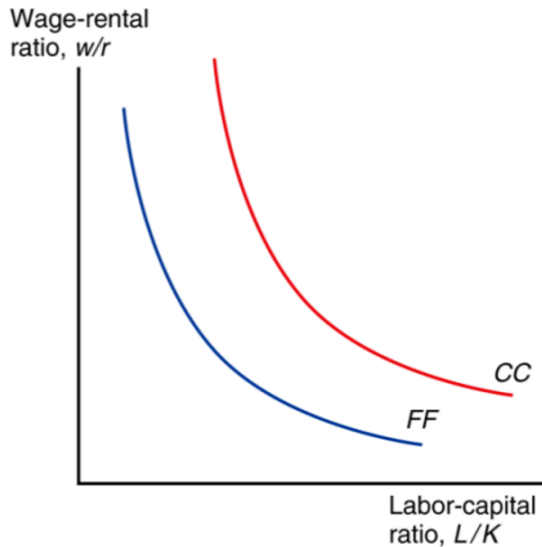
Heckscher-Ohlin model

Choosing input mix

$$\frac{a_{lc}}{a_{kc}} > \frac{a_{lf}}{a_{kf}}$$

$$\frac{L_c}{K_c} > \frac{L_f}{K_f}$$

- Production of cloth is relatively labour intensive
- Production of food is relatively capital intensive

Heckscher-Ohlin model

Recall: factor intensity

Heckscher-Ohlin model

Resources and production possibilities

- Assume the labour force of the economy grows.
- What will happen to
    1. Labour to capital ratio?
    2. Production possibilities?
   3. Ratio of labour to capital used in both sectors?

Heckscher-Ohlin model
Resources and production possibilities

1. L/K will increase
2. Expansion of production possibilities is biased towards cloth
3. At given relative price of cloth, ratio of labour to capital remains constant

- To employ the additional workers, the economy expands production of the relatively labour-intensive good cloth and contracts production of the relatively capital-intensive good food

Heckscher-Ohlin model

Resources and production possibilities
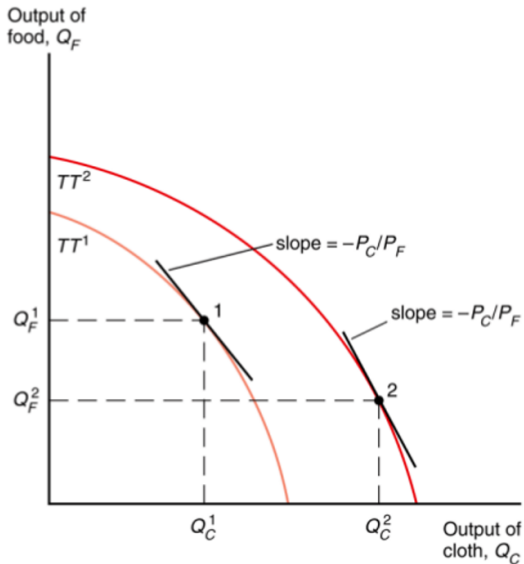
Heckscher-Ohlin model
Determination of prices

- Under competition, price of good equals the cost of production
- Production costs depend on wages paid to labour and rents paid to capital
  - As well as units of labour and capital used

$$p_c = a_{lc} * w + a_{kc} * r$$

$$p_f = a_{lf} * w + a_{kf} * r$$

Heckscher-Ohlin model
Determination of prices

- Price of a good should equal cost or production which depends on factor prices
- How changes in w and r affect production costs depends on mix of factors used
- Change in $\frac{w}{r}$ are tied to changes in $\frac{p_c}{p_f}$

Stolper-Samuelson theorem

An increase in the relative price of a good will increase the relative remuneration of the factor which is intensively used in the production of this good and reduces the remuneration of the other factor.

Stolper-Samuelson theorem

- ▶ Owners of one input are always hurt by a price change in output goods
- ▶ Trade in outputs changes output prices: some people are typically hurt by trade
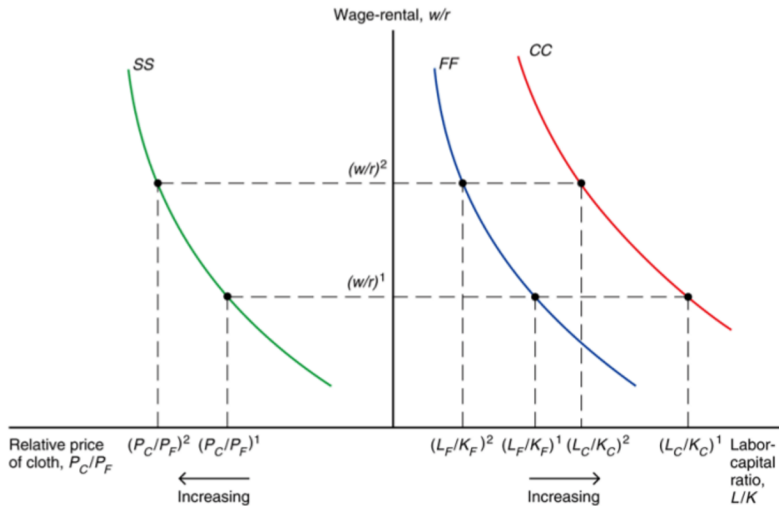- ▶ Theorem links input and output prices

Stolper-Samuelson theorem

Factor prices and goods prices

Relative price of cloth, P_C/P_F

SS

Wage-rental ratio, w/r

Stolper-Samuelson theorem

Goods prices and input choices

Stolper-Samuelson theorem

Openness to trade and income inequalities

- ▶ Opening up the economy leads to:
    - ▶ Rise in real remuneration of the relatively abundant factor
    - ▶ Fall in real remuneration of the relatively scarce factor
- ▶ Trade creates winners and losers:
    - ▶ In Home winners are the owners of capital
    - ▶ In Foreign winners are the labourers
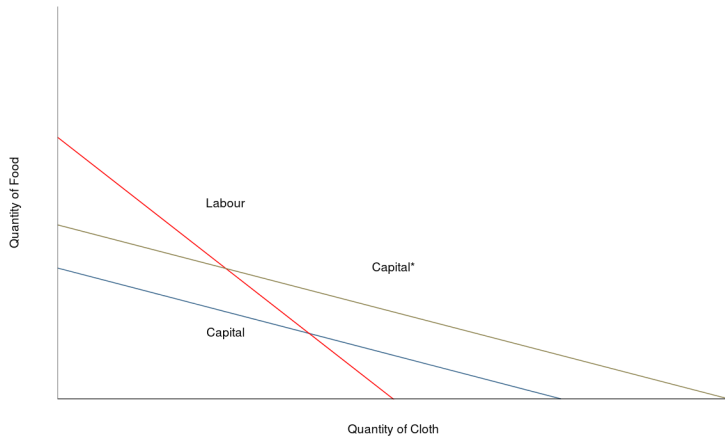- ▶ Losers can be compensated through fiscal transfers from winners

Rybczynski theorem
Role of factor endowments

For a given relative price, a higher endowment in one factor makes the production that uses this factor more intensively increase and the production that uses it less intensively decrease

Rybczynski theorem

Increase in capital

Rybczynski theorem

Role of factor endowments

- For a small economy a rise in factor endowments is beneficial because:
    - It can export more, import more, and thus consume more (*export-biased growth*)
    - It can import less, export less, but consume more (*import-substitution growth*)

Rybczynski theorem
Role of factor endowments

- In a large country where prices are endogenous a rise could have negative effects
  - Export-biased growth deteriorates terms of trade, which may offset the positive impact of higher endowment (*impoverishing growth*)
  - Justification for import-substitution policies

Trade patterns

- ▶ Recall: countries have same technology, Home is relatively labour abundant
- ▶ Following Rybczynski, Home will produce the relatively more labour intensive good

$$\frac{Q_c}{Q_f} > \frac{Q_c^*}{Q_f^*}$$

- ▶ Consumption depends on output price, equilibrium consumption ratio is

$$\frac{D_c}{D_f} = \frac{D_c^*}{D_f^*}$$

Trade patterns
Heckscher-Ohlin theorem

> *Countries with relatively more of a resource will export goods for which that resource is more useful in production.*
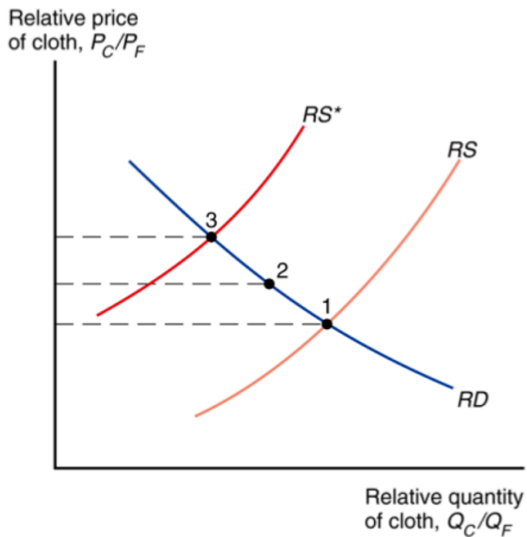
Trade patterns
Heckscher-Ohlin theorem

- Country with relatively more capital exports the capital intensive good
- Country with relatively more labour exports the labour intensive good

Trade patterns

Convergence of relative prices

Trade patterns
Convergence of relative prices

- Similar to Ricardian model, Heckscher-Ohlin predicts convergence of relative prices with trade
- Relative price changes in favour of abundant resource in each country
  - Relative price of cloth rises in relatively labour abundant country
  - Relative price of cloth falls in relatively labour scarce country

- ▶ For Home rise in relative price of cloth leads to
  - ▶ Increase in production
  - ▶ Decrease in consumption
  - ▶ Home becomes exporter of cloth, importer of food
- ▶ Similarly, Foreign will become an exporter of food and importer of cloth

- ▶ According to Stolper-Samuelson theorem owners of abundant resource will gain, owners of scarce resource lose

Factor price equalisation
Result of Stolper-Samuelson theorem

- In contrast with Ricardian model, HO-model predicts equalisation of factor prices among countries that trade
- Free trade equalises relative output prices
- Output prices and factor prices are linked (Stolper-Samuelson), means that factor prices are equalised
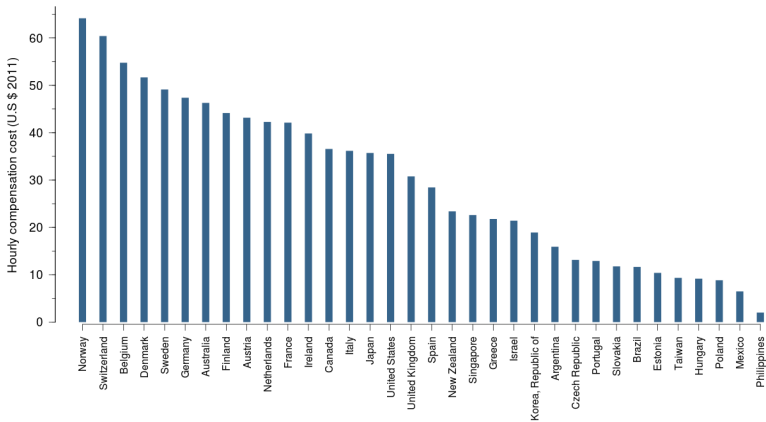
Factor price equalisation
Effect of trade

- Trade increases demand of goods produced by relatively abundant factors
- This indirectly increases the demand of these factors
- Raising the prices of relative abundant factors

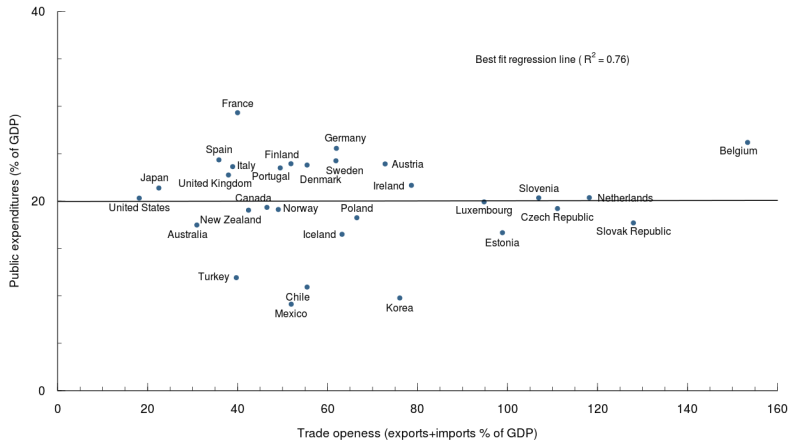# Factor-price equalisation

Absence of wage equalisation
Source: U.S. Bureau of Labor Statistics,2012

Factor price equalisation
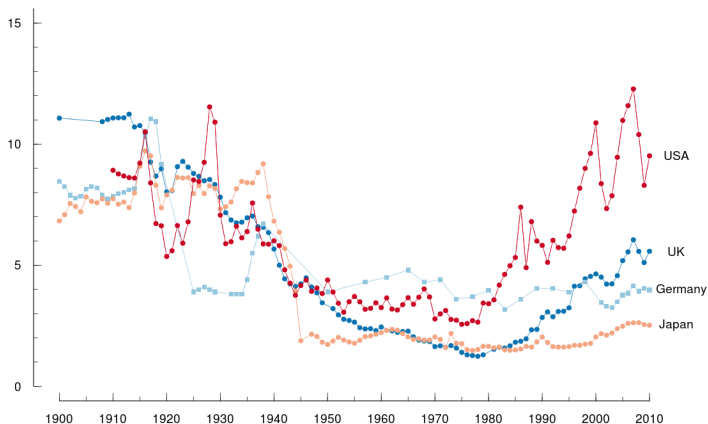
Compensating trade-losers
Source: OECD

Scatter plot with axes "Public expenditures (% of GDP)" (vertical, 0 to 40) and "Trade openess (exports+imports % of GDP)" (horizontal, 0 to 160).

Best fit regression line (R^2 = 0.76)

Data points labelled: France, Spain, Italy, Finland, Germany, Portugal, Austria, Japan, United Kingdom, Denmark, Sweden, Belgium, United States, Canada, Ireland, Slovenia, Netherlands, New Zealand, Norway, Poland, Luxembourg, Czech Republic, Australia, Iceland, Estonia, Slovak Republic, Turkey, Chile, Mexico, Korea

Factor price equalisation

Top 0.1% income share in 5 OECD countries 1900-2010

Source: Piketty, 2014

Shortcomings of the model
Model assumptions

1. Proof of theorems requires that both goods are produced in both countries
2. Assumption that technology is the same everywhere
3. Capital cannot move
4. Output goods have same price everywhere

- Model originally published in 1933, assumptions were reasonable for that time
- Poor reflection of the world nowadays

Shortcomings of the model
Discrepancy between model and real world

- In the real world factor prices are not equal across countries
- Model assumes that trading countries produce same goods
  - Countries may produce different goods if factor price ratios differ radically
- Model assumes that trading countries have the same technology
  - Different technologies could affect the productivities of factors and therefore the wages/rates paid to these factors
- Model ignores trade barriers and transport costs
  - May prevent output prices and thus factor prices from equalising

Empirical evidence
Leontief paradox

- Leontief looked at 1947 input-output data for the U.S. economy
- The U.S. was the most capital abundant country
- Found that U.S. exports are labour intensive
  - $\frac{K}{L} = 13,992$ \$/person-year
- While U.S. imports (or import-substitutes) were more capital intensive
  - $\frac{K}{L} = 18,181$ \$/person-year
- Contradicts with HO-model

Empirical evidence

Missing trade

- ▶ Western world (or North) has large share of capital, small share of labour
- ▶ Opposite is true for the global South (developing countries)
- ▶ Would expect large trade flows between North-South
- ▶ See relatively little trade between developing and industrialised countries
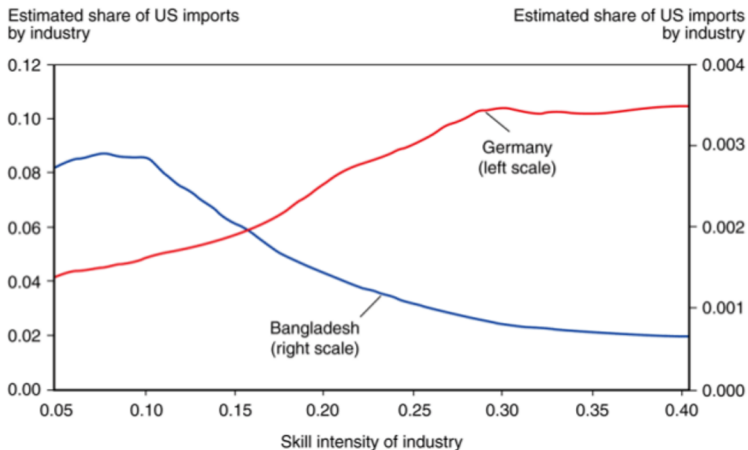
Empirical evidence

Skill intensity

- US imports from Bangladesh are highest in low-skill-intensity industries
- US imports from Germany are highest in high-skill-intensity industries

Empirical evidence

Skill intensity: US imports from two countries

Trade and income distribution

- Suppose we have two factors: skilled and unskilled labour
- The UK is abundant in skilled labour, India is abundant in unskilled labour
- Trade liberalisation should lead to India exporting goods intensive in unskilled labour
- Should lead to increase in relative price of goods intensive in unskilled labour
- Increase returns to unskilled labour relative to skilled labour
- Reduction in wage inequality

Trade and income distribution
"Trade Liberalization and Wage Inequality: Evidence From India"
Mishra and Kumar, 2005

Table 4. Tariffs and Industry Wage Premiums

Dependent Variable: Inter-Industry Wage Premium

	I	II	III
Tariff rate	-0.174**	-0.435***	-0.153**
	(0.07)	(0.10)	(0.07)
Year indicators	Yes	Yes	Yes
Industry indicators	No	No	Yes
First differencing	Yes	No	No
Number of observations	209	281	281

***, **, * denote statistical significance at 1 percent, 5 percent, 10 percent, respectively. The standard errors are denoted in parentheses.

Trade policy: Protecting Indonesian textile manufacturers

Trade Minister: Used Clothes Cause HIV

Romeo Gacad/AFP/Getty