HOS : factor endowments and comparative advantage

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1.a. Summary of Ricardo model

Free trade is a tool for raising aggregate productivity, income, and welfare
Removing barriers to trade can help :

- WTO on trade policy
- WTO trade facilitation program launched in 2004 : transparency on rules of transit, enhanced technical assistance and capacity building esp. with developing economies

Main predictions of Ricardo model

- Free trade enables decoupling production and consumption decisions
- Countries specialize according to their relative cost advantage in producing some goods
  $\Rightarrow$ productivity differences
- Specialization on **comparative advantage** industry increases World production & World income
  $\Rightarrow$ Trade opennes is expected to promote economic growth
- Free trade enables increase of the consumption of the imported good, due to **improvement of terms of trade**
  $\Rightarrow$ Economic welfare increases
- Two country model : welfare increases for both countries, and free trade is **Pareto-imporving**
  $\Rightarrow$ But small countries gain more due to higher improvement of terms of trade

Ricardo model is a very simple framework for analysing the effects of trade liberalization

Reallocation process associated with globalization however does not occur specifically *between* but *within* sectors
$\Rightarrow$ Reallocation across firms, or even within firms across different products

Still, productivity remains important to explain these phenomena
$\Rightarrow$ Eaton & Kortum (2002), Melitz (2003), Bernard, Redding & Schott (2006)

1.b. HOS : Principles

Eli Heckscher, Bertil Ohlin (Nobel 1977),
Paul Samuelson (Nobel 1970)

What motivates trade ? :

- Countries differ in terms of factor endowment (Capital vs labour, high-skill vs low-skill labour etc.)
- Differences in factor endowments imply differences in relative wages across countries
- However, countries share the same technology $\Rightarrow$ No differences in productivity across countries

- Two factors of production in the model : allows predictions regarding the redistribution effects of trade across factors of production, within countries
- Inequalities can increase or decrease according to the type of countries
- More recent theories have been developed to improve the quality of the empirical predictions
- However, HOS framework (and Stolper-Samuelson theorem) remains the basis for analyzing the effects of trade on redistribution and inequality

2. HOS model : the basics

Two-factors x two-goods model :

Skilled labour(K) with wage rate r / unskilled labour (L) with wage rate w
We suppose that Home country is relatively more endowed in skilled labour than the foreign country ($*$ notations) :

$$\frac{K}{L} > \frac{K^*}{L^*}$$

The two goods have different factor intensities.

Production of good Y is relatively more intensive in skilled labour
$\Leftrightarrow$ independently of r and w :

$$\left(\frac{K}{L}\right)_Y > \left(\frac{K}{L}\right)_X$$

Relative factor endowment, relative wages, and relative prices :

- Countries that are relatively more endowed in skilled labour pays relatively lower wages to skilled labour (the aboundant factor)

$$\frac{r}{w} < \frac{r*}{w*}$$

- The price of the good that is intensive in skilled labour is also lower :

$$\frac{P_Y}{P_X} < \frac{P_Y*}{P_X*}$$

- Home country has therefore a comparative advantage in the production of the good that is intensive in skilled labour Y.

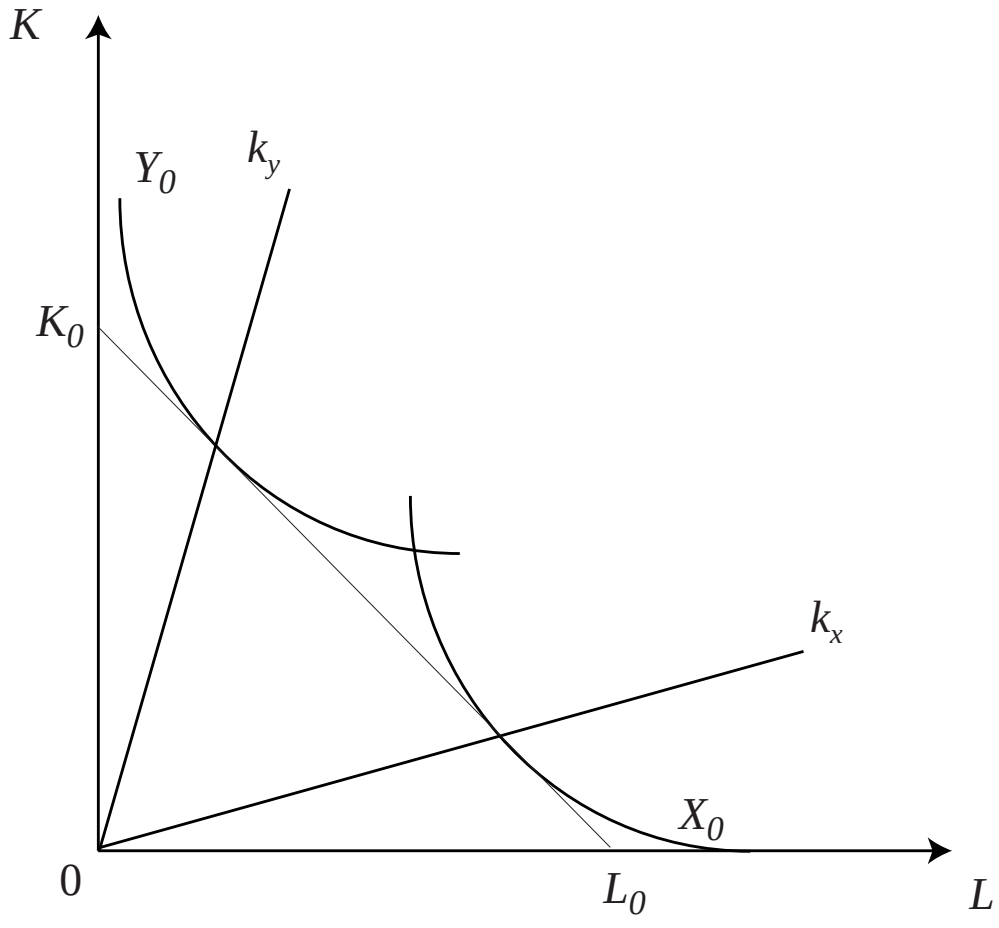
3.a. Autarky equilibrium

Factor intensity

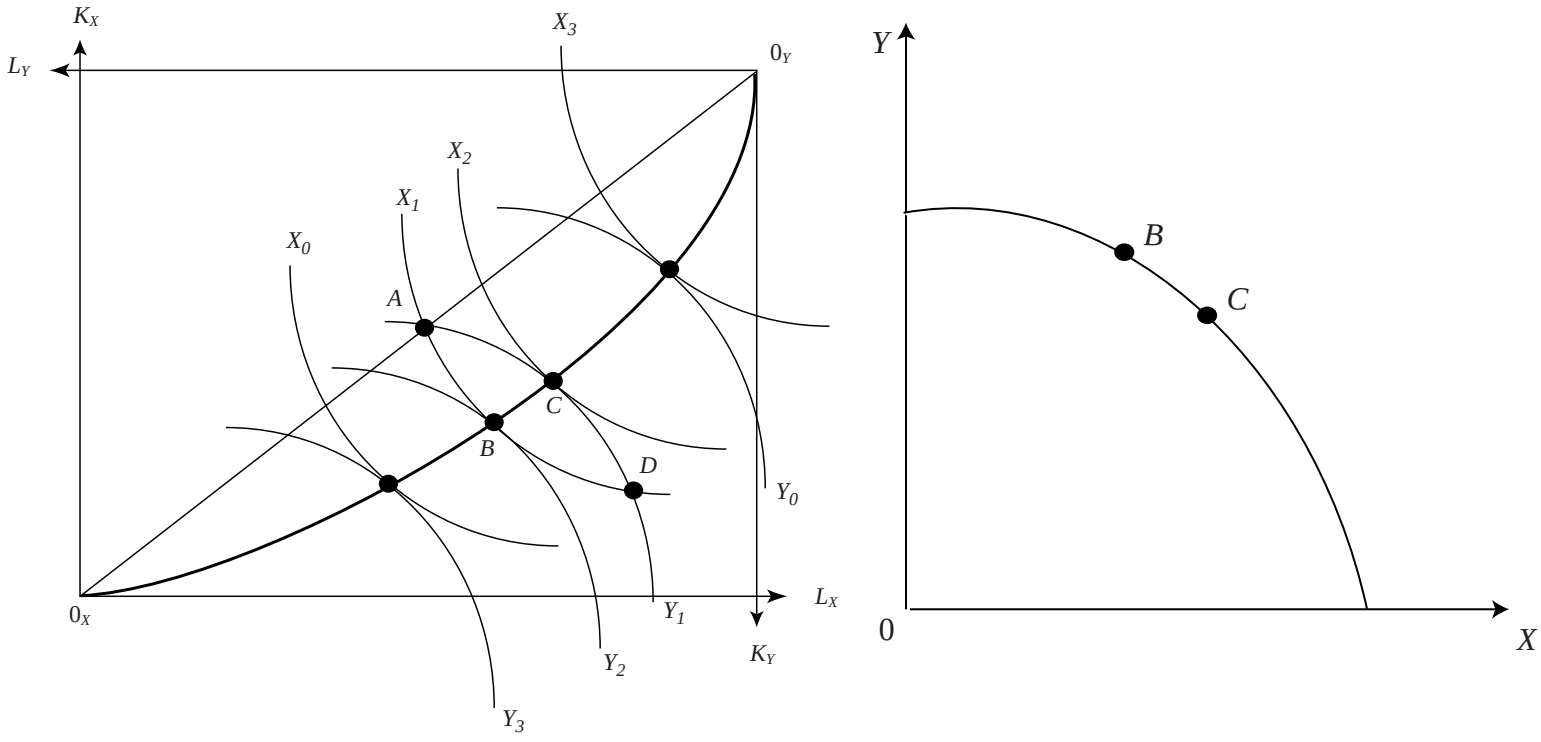
2 goods : $X = F_X(L_X, K_X)$ and $Y = F_Y(L_Y, K_Y)$

- Substitutability : $\frac{K_Y}{L_Y}$ and $\frac{K_X}{L_X}$ decreasing in $\frac{r}{w}$
- Assume w.l.o.g that X is unskilled labor-intensive $\frac{L_X}{K_X} > \frac{K_Y}{L_Y}$ at given $\frac{r}{w}$
- We can them determine optimal input demand graphically :
  - trace out isoquants in (L, K) space.
  - optimal input combinations equalize MRTs to $\frac{w}{r}$ (tangent).
  - CRS implies that for a given $\frac{w}{r}$ these combinations lie on a ray through the origin.

Factor intensities

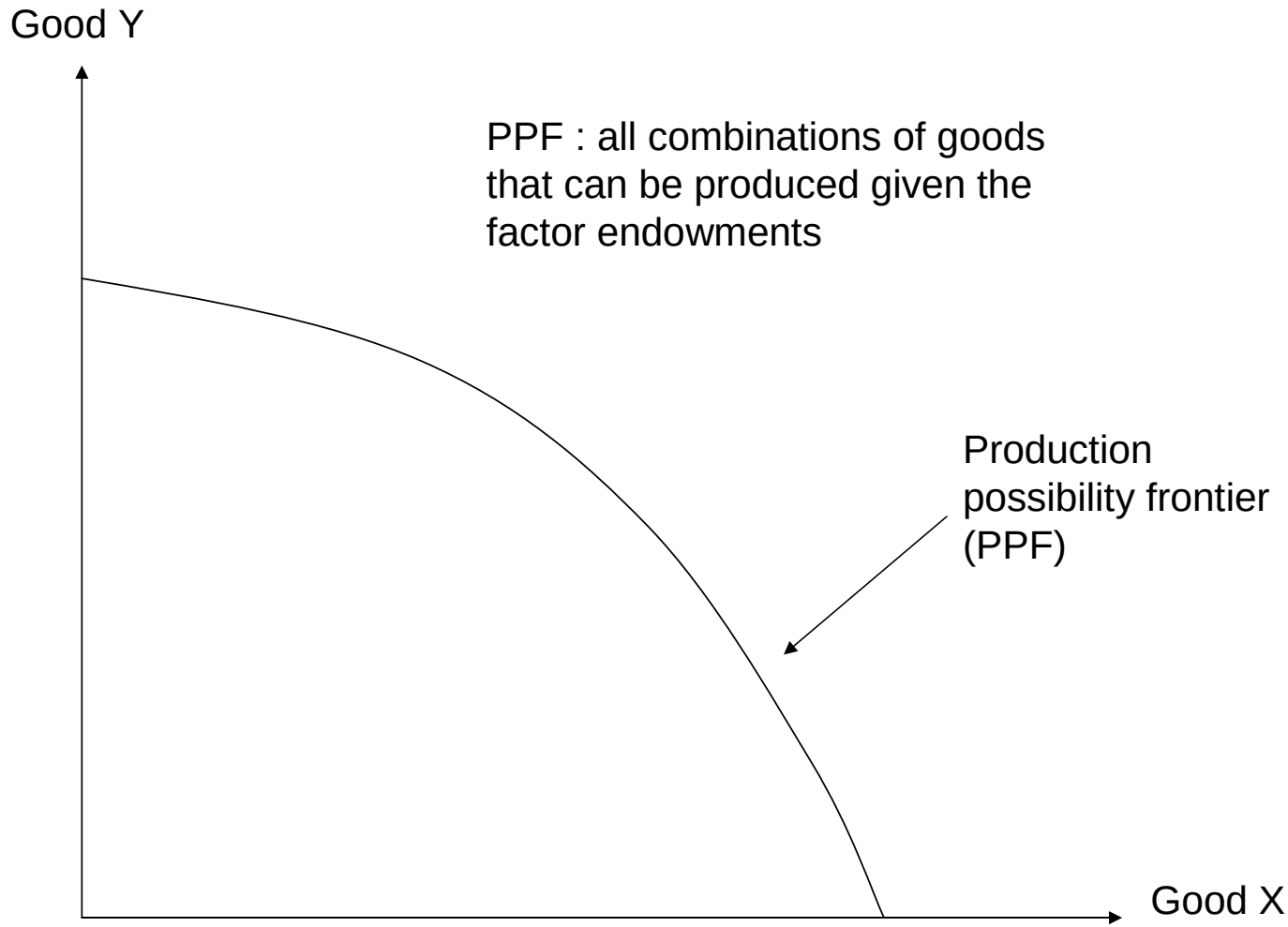


Production possibilities Frontier

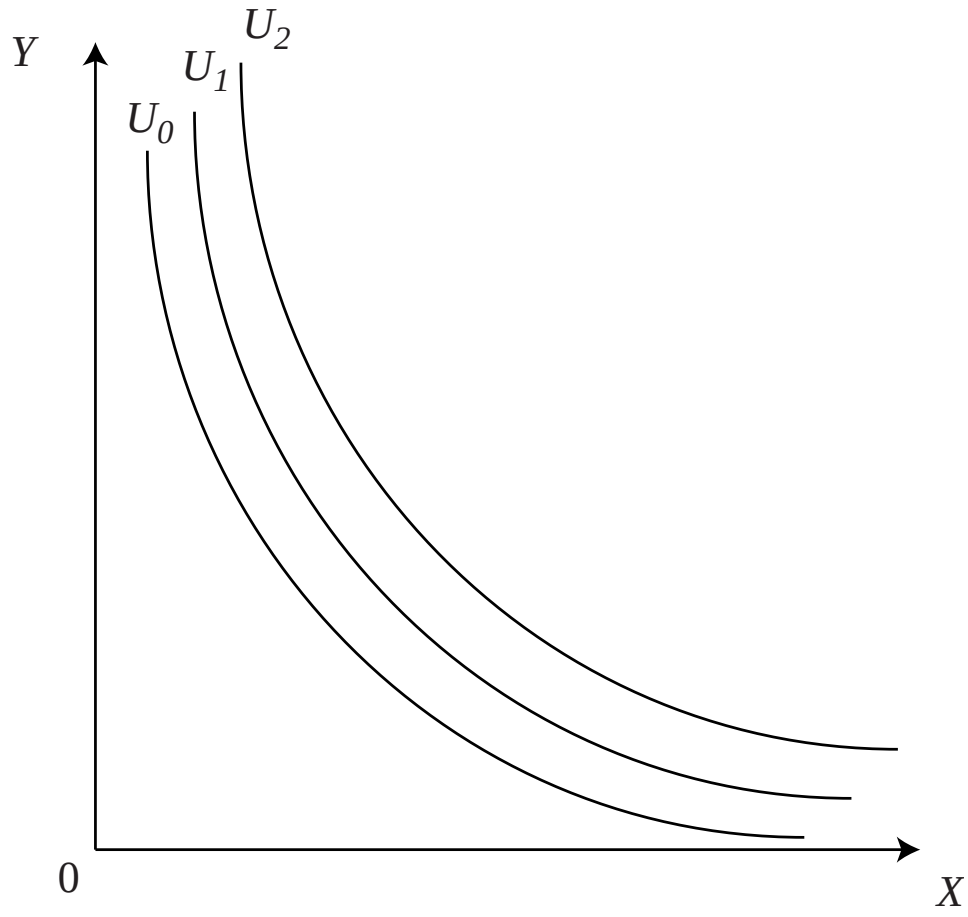


- Edgeworth box = all feasible factor uses given factor endowments.
- Optimal combinations : MRT equalized across sectors (e.g. B,C).
- Countries with different factor endowments have different PPFs

Production possibilities Frontier



Demand side



- On an indifference curve, $MRS = -\frac{dY}{dX} = \frac{\partial U/\partial X}{\partial U/\partial Y}$.
- At the consumer's optimum : $\frac{P_X}{P_Y} = MRS$.

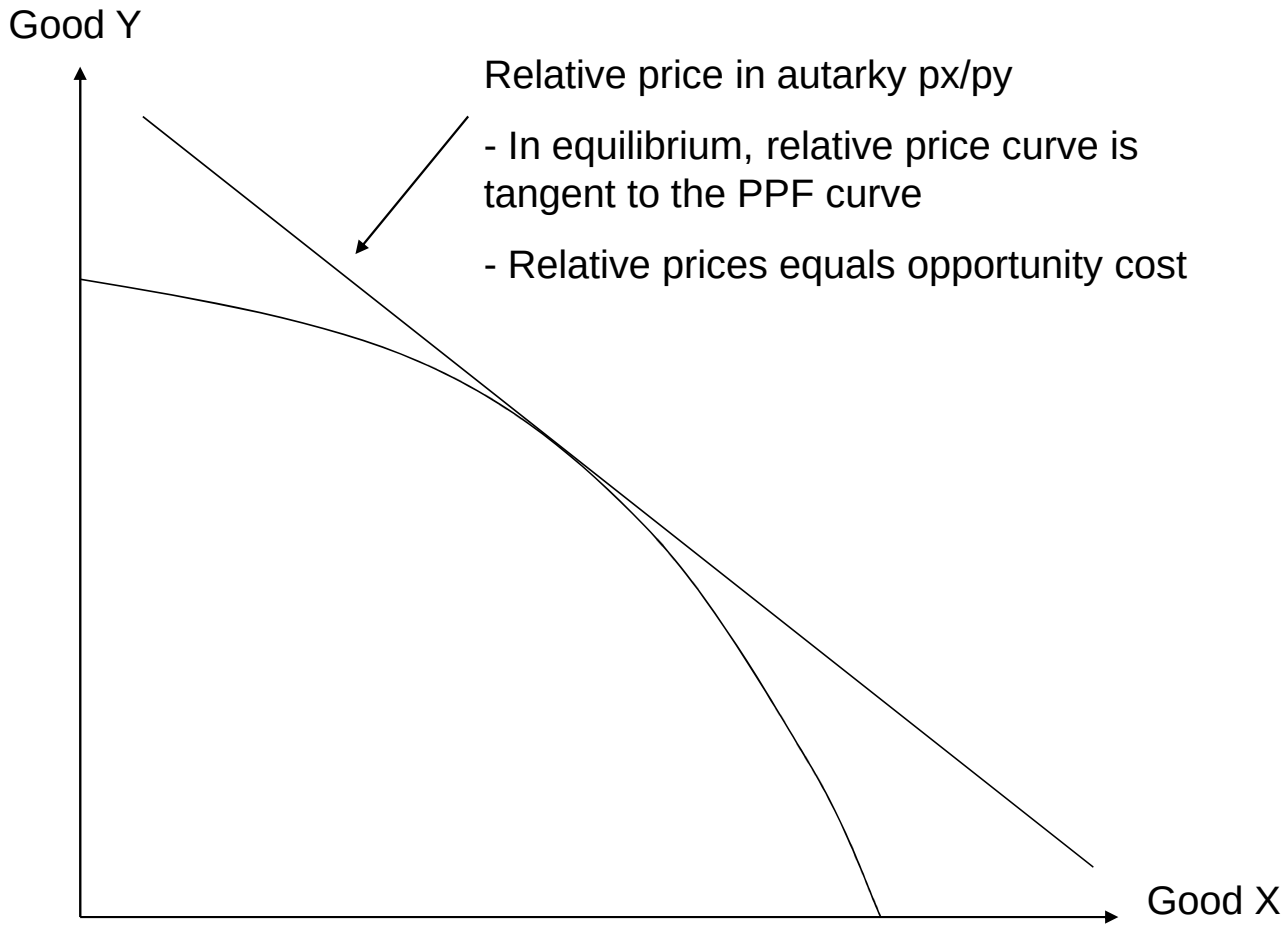
Production and consumption :

- Production and consumption levels determined by autarky price.
- Price curve also represents the budget constraint :

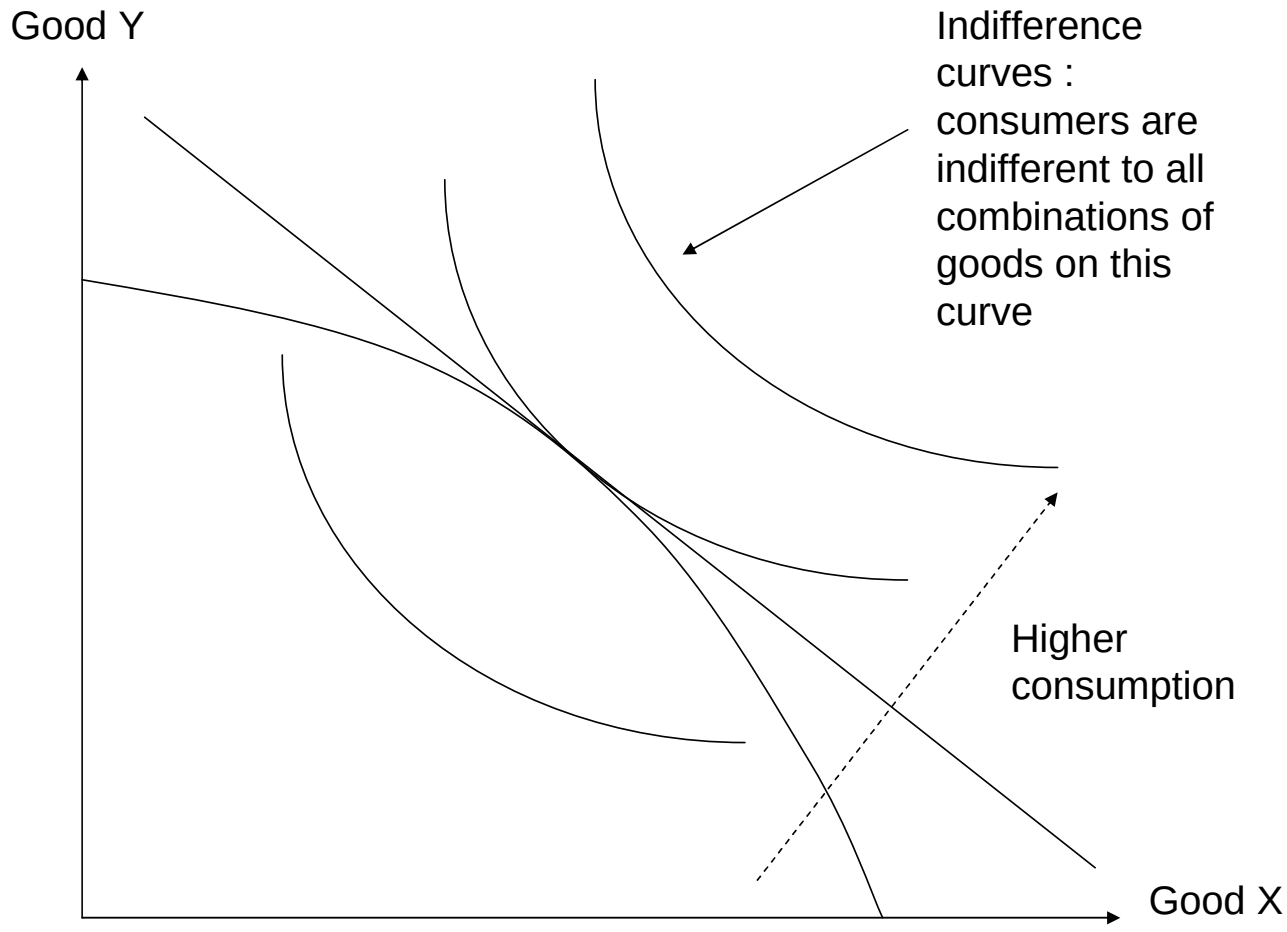
$$wL + rK = p_x X + p_y Y$$

$$\Rightarrow Y = (wL + rK) - \frac{p_x}{p_y} X$$

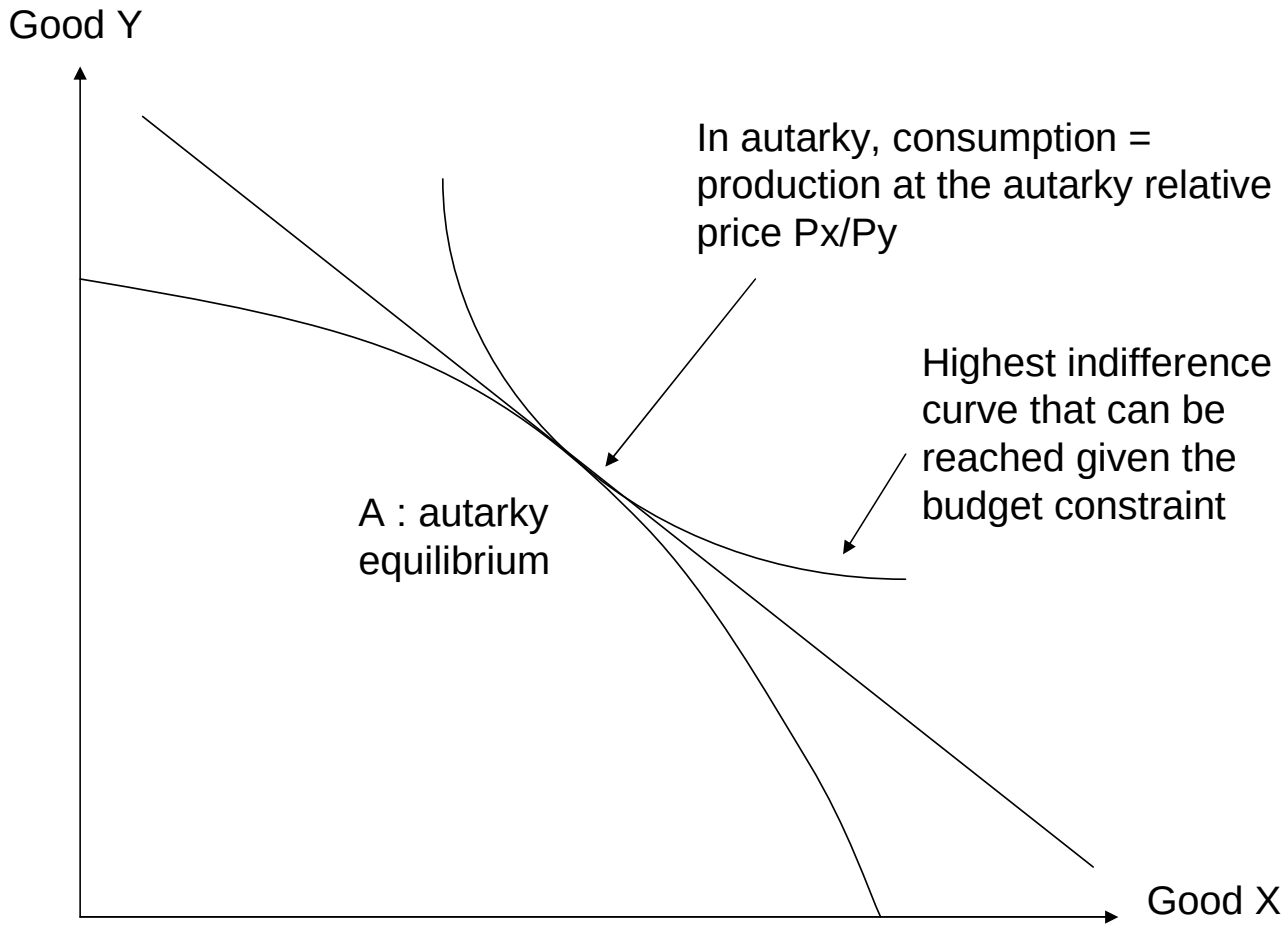
Production and prices



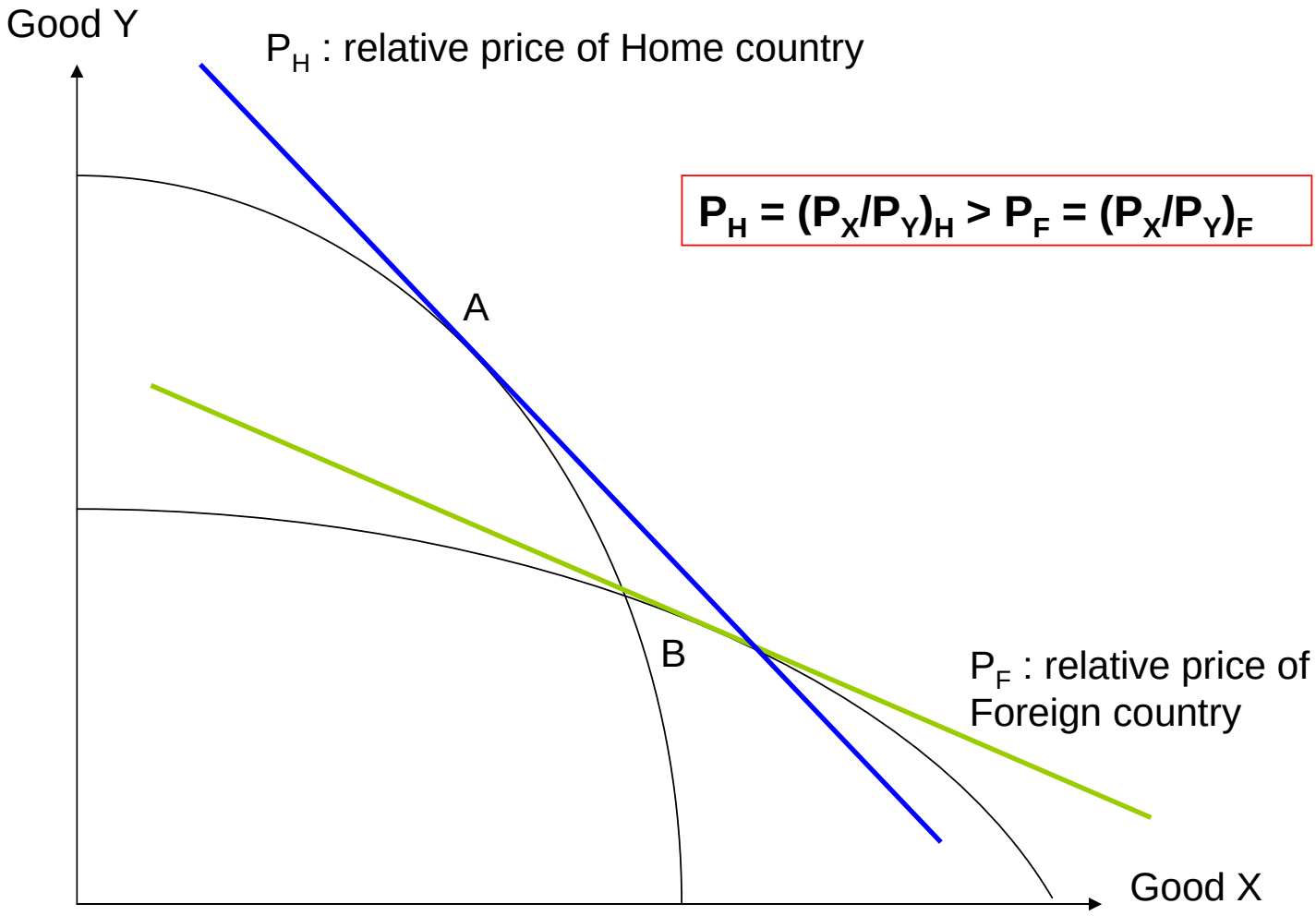
Consumption maximizes welfare given relative autarky prices



Equilibrium in Autarky



Autarky equilibria with two countries

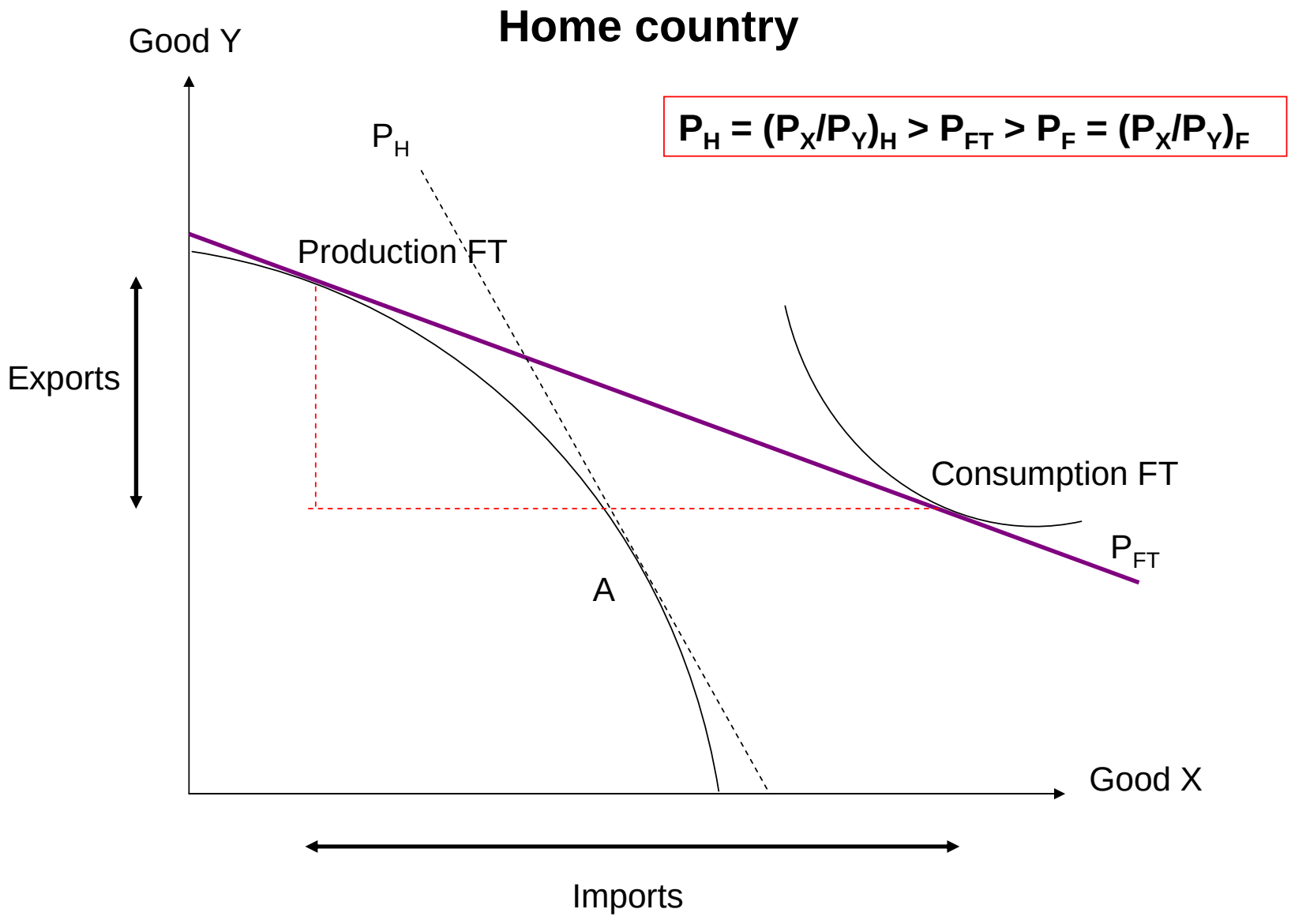


3.b. Equilibrium in Free Trade

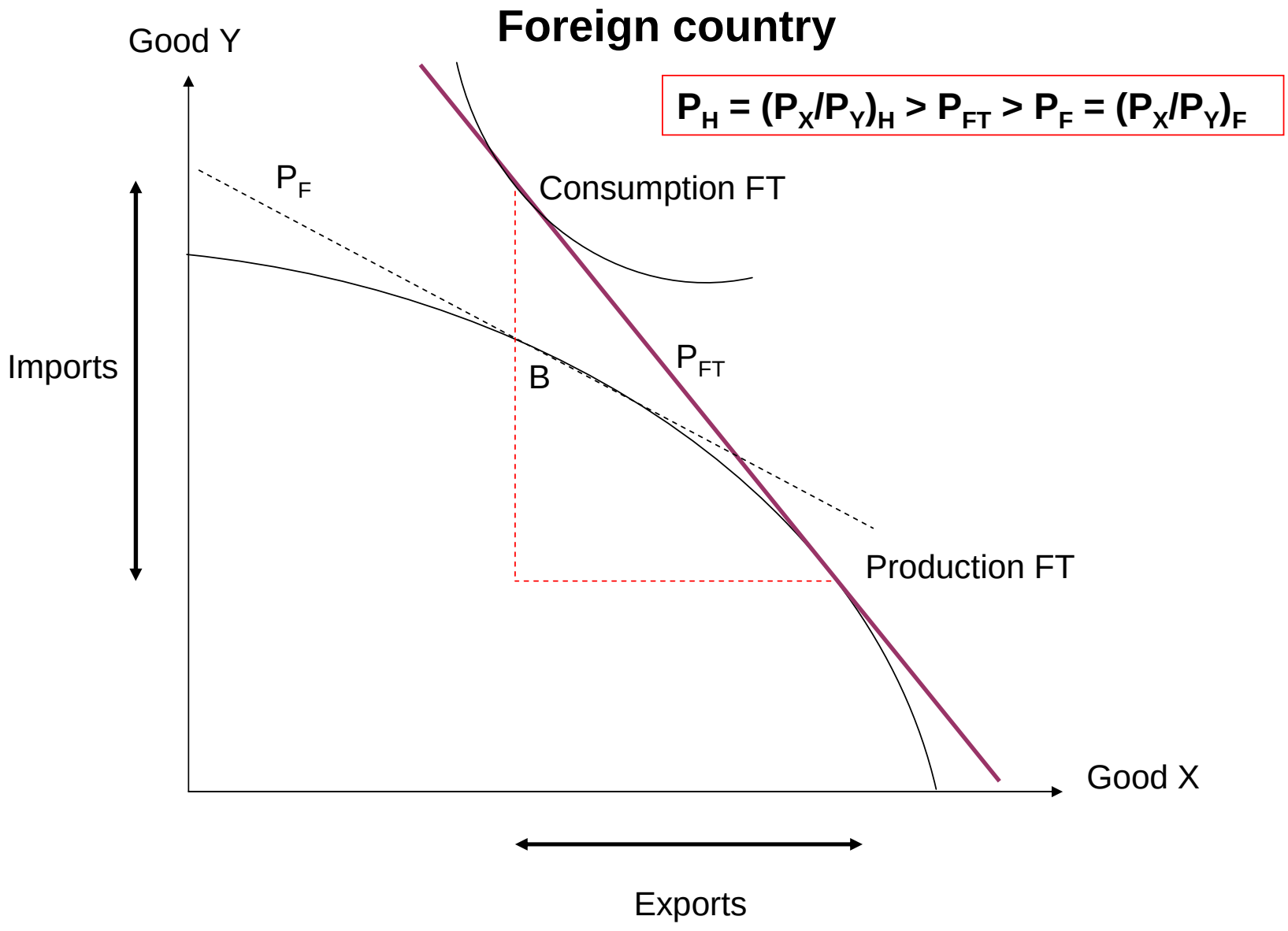
- Home country is relatively more endowed in skilled labour than the foreign country.
- The relative price of the good that is more intensive in skilled labour is lower in Home country.
- The relative price of the good that is more intensive in unskilled labour is lower in Foreign country.
- Home country will export good Y and import the good X.

H-O theorem *: The Heckscher-Ohlin theorem : In free trade, a country exports the good using intensively the factor it has in relative abundance.*

Free trade and specialization in the Home country



Free trade and specialization in the Foreign country



Summary

- Trade openness allows disconnection between production and consumption decisions
- Welfare increases due to improvement in terms of trade
- Consumption of the imported good increases
- Both countries gain from trade openness if differences in relative endowment is observed

3.c. Factor Price Equalization

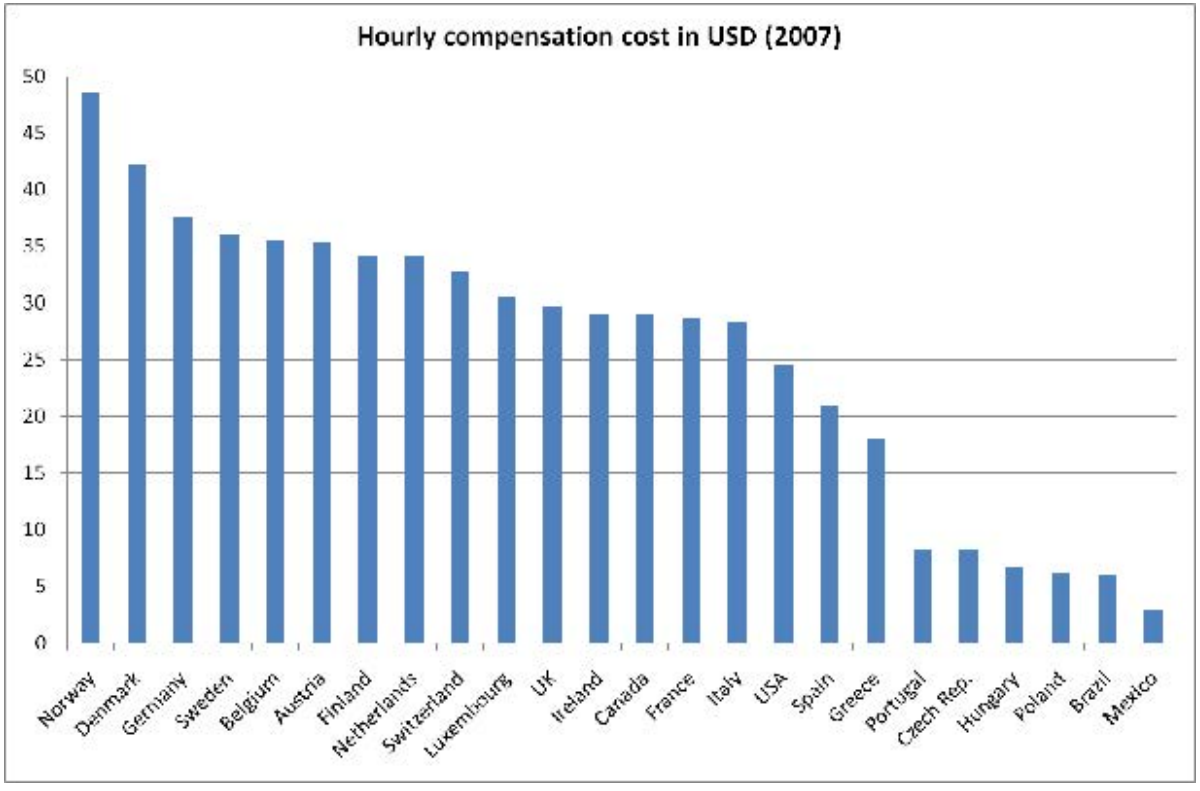
- Free trade **equalizes the relative price of goods** & production decision adapts to new price conditions
- The country that is relatively more endowed in skilled labour increases its production of the good Y
  $\Rightarrow$ Increases the demand for skilled labour in the Home country, relative to demand for unskilled labour
  $\Rightarrow w/r \downarrow$
- In the Foreign country relatively more endowed in unskilled labour, $w/r \uparrow$.

3.c. Factor Price Equalization

- Opening up the economy leads to relative factor price equalization across countries, even though factors are immobile
  - In each sector prices and therefore marginal costs converge across countries.
  - Production functions are the same in both countries.
  - The relative factor prices that solve zero-profit conditions must be the same in both countries.

FPE theorem : 'International trade leads to relative factor price equalization through international price equalization."

Empirical evidence : No wage equalization



Source : US Bureau of Labor Statistics (August 2009)

- Capital mobility implies a cross-country convergence of capital prices

Limits

- No trade costs.
- Perfect competition (hence price = marginal cost).
- Homogeneous production functions across countries.
- Perfect mobility of factors across industries.
- Homogeneous production factors.

Openness and income inequality : the Stolper-Samuelson theorem

Stolper-Samuelson Theorem : The increase of the relative price of a good increases the real wage of the factor that is used intensively in the production of this good, and decreases the real wage of the other factor..

The abundant factor wins in Free trade. This is an important prediction regarding the evolution of inequalities :

- Where skilled labour is abundant, **inequalities ere expected to increase** between high skilled and low skilled.
- Where unskilled labour is relatively more abundant, **inequalities are expected to decrease** since $r > w$ and w is expected to $\uparrow$

Intuition

- To get intuition, consider the special case where P_X falls and P_Y remains constant after opening to trade.
- Production is reallocated along the PPF towards sector Y.
- Contraction in the X sector reduces demand for labor disproportionately. Since factor supply is fixed $\frac{w}{r}$ falls.
- With a fall in $\frac{w}{r}$ each sector substitutes some labor for capital, mitigating the previous effect.
- The marginal productivity of capital (MPK) increases, while the marginal productivity of labor (MPL) falls.

- Perfect competition on the labor market implies :
  - $w = P_X MPL_X = P_Y MPL_Y and r = P_X MPK_X = P_Y MPK_Y$.
  - Since MPL $\downarrow$, $w = P_X$ and $w = P_Y \downarrow$, the real wage falls.
  - Since MPK $\uparrow$, $w = P_X$ and $w = P_Y \uparrow$, the real capital income increases.

Proof

- Zero Profit conditions :

$$P_X X = wL_X + rK_X \Rightarrow P_X = wa_{LX} + ra_{KX}$$
$$P_Y Y = wL_Y + rK_Y \Rightarrow P_Y = wa_{LY} + ra_{KY}$$

- Differentiate PX et PY for a given production structure (given aij) :

$$dP_X = a_{LX}\,dw + a_{KX}\,dr$$
$$dP_Y = a_{LY}\,dw + a_{KY}\,dr$$

- Denote $\theta_{KX} = a_{KX}\,r/P_X$ and $\theta_{KY} = a_{KY}\,r/P_Y$

$$\frac{dP_X}{P_X} = (1-\theta_{KX})\,\frac{dw}{w} + \theta_{KX}\,\frac{dr}{r}$$
$$\frac{dP_Y}{P_Y} = (1-\theta_{KY})\,\frac{dw}{w} + \theta_{KY}\,\frac{dr}{r}$$

- The evolution of factor prices then is

$$\frac{dw}{w} = \frac{\theta_{KY}\frac{dP_X}{P_X} - \theta_{KX}\frac{dP_Y}{P_Y}}{\theta_{KY}(1-\theta_{KX}) - \theta_{KX}(1-\theta_{KY})}$$

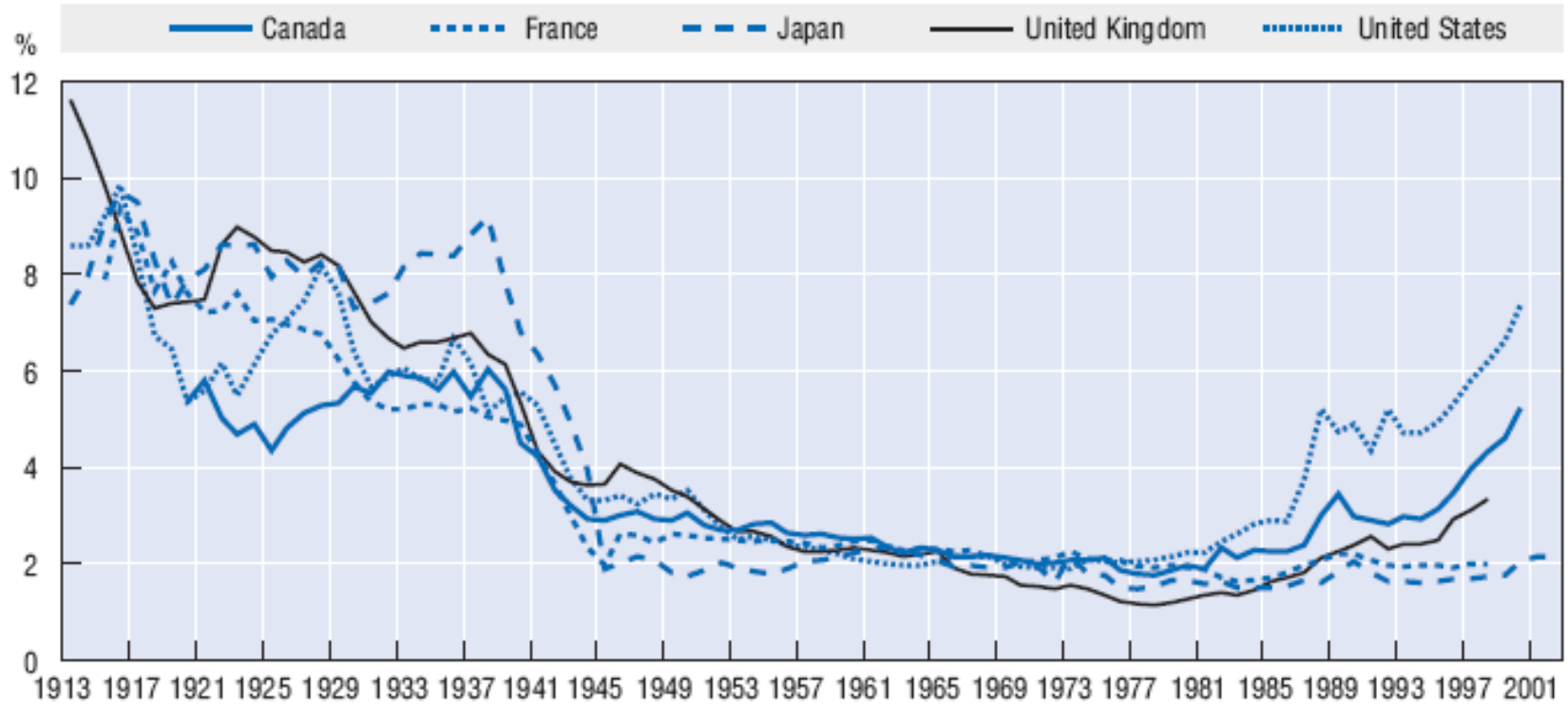
$$\frac{dr}{r} = \frac{(1-\theta_{KX})\frac{dP_Y}{P_Y} - (1-\theta_{KY})\frac{dP_X}{P_X}}{\theta_{KY}(1-\theta_{KX}) - \theta_{KX}(1-\theta_{KY})}$$

$$\Rightarrow \frac{dw}{w} - \frac{dr}{r} = \frac{1}{\theta_{KY}(1-\theta_{KX}) - \theta_{KX}(1-\theta_{KY})}\left(\frac{dP_X}{P_X} - \frac{dP_Y}{P_Y}\right)$$

- Since $\theta_{KY} > \theta_{KX}$ (Y is more skill intensive) the denominator of both expressions is positive. Therefore :
  - if the relative price of X rises, then w/r increases
  - if the relative price of Y rises, then w/r falls

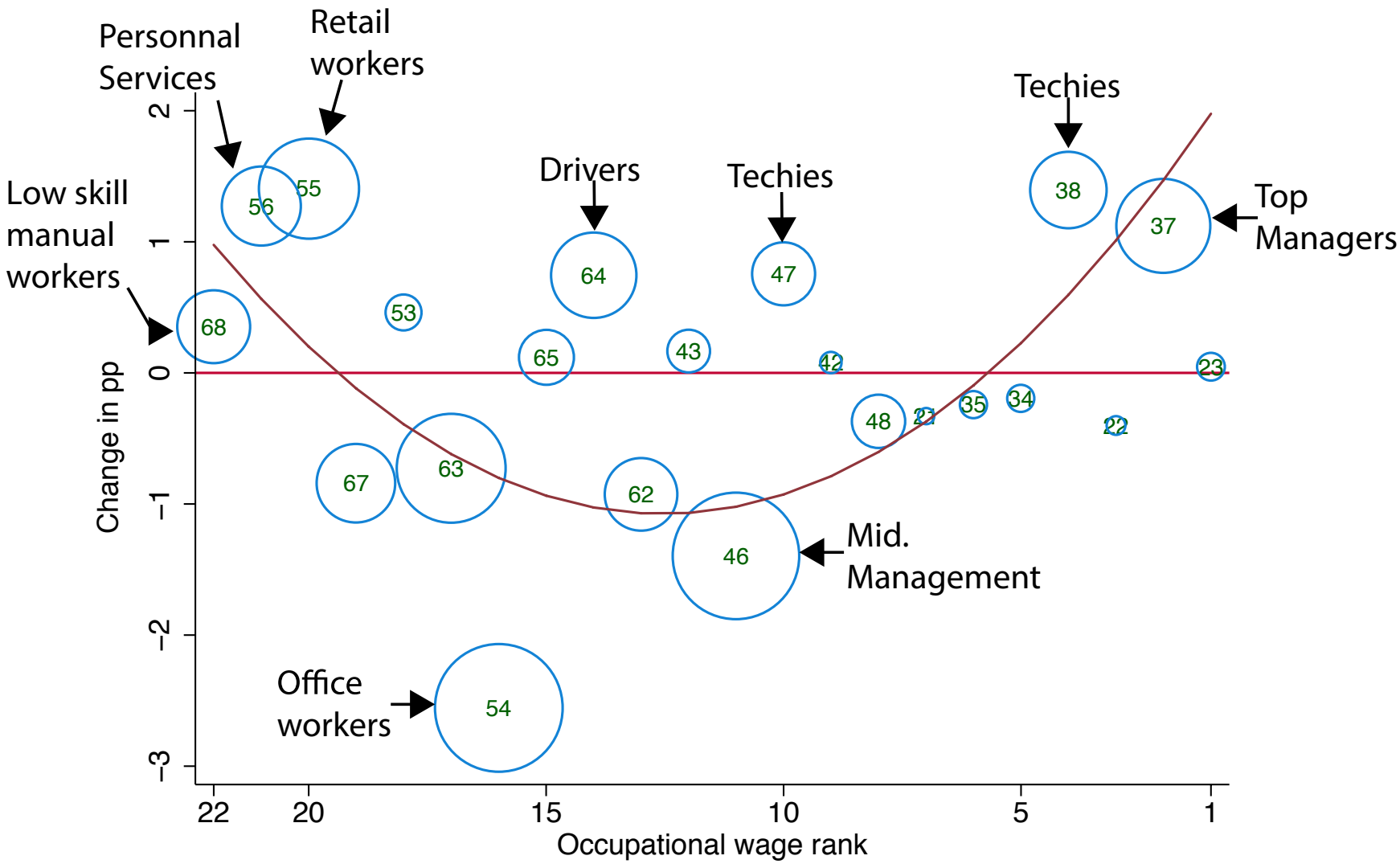
Trade openness and inequality

Top 0.1% income share in 5 OECD countries, 1913-2001

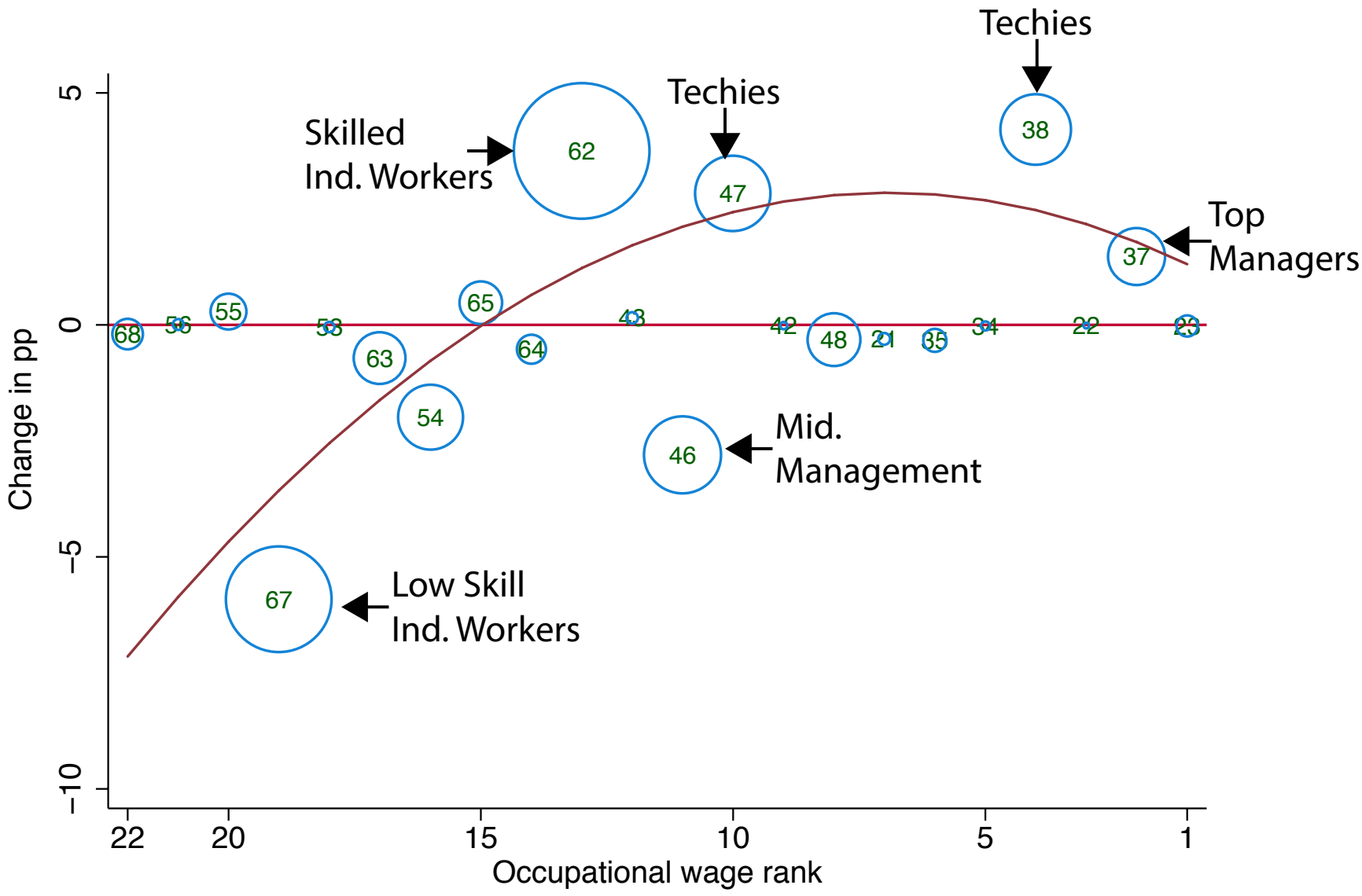


Source: Piketty and Saez (2006).

Polarization : Non-manufacturing sector France

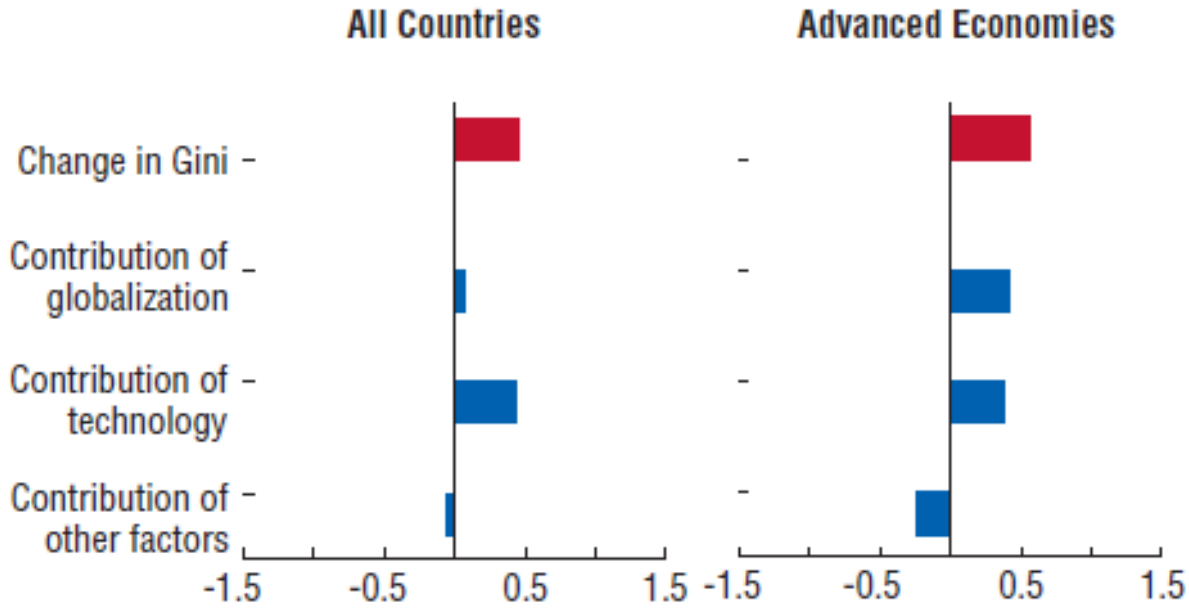


Skill-Upgrading : Manufacturing sector France



Explaining changes in income inequalities

Regression of Gini coefficient on globalization and technology-related variables



Average annual % change of Gini coefficient

Source: IMF, World Economic Outlook

The role of factor endowments : the Rybczynski theorem

4. Rybczynski : growth and terms of trade

What happens if endowements change over time ?

$\Rightarrow$ Capital accumulation

$\Rightarrow$ Demographic growth

The Rybczynski theorem :

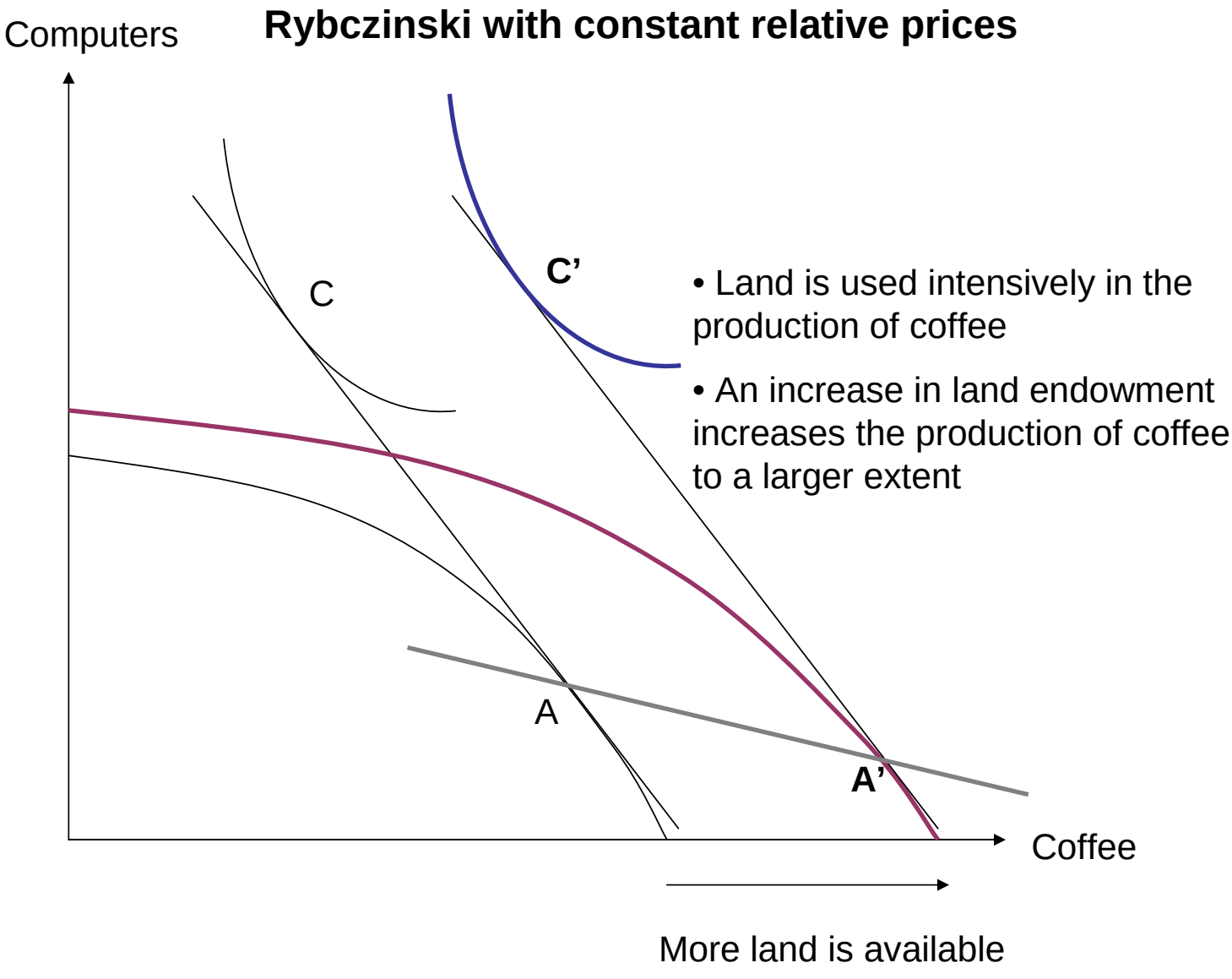
Under constant relative prices of goods and incomplete specialization, an increase in the endowment of a factor raises the production of the good using it intensively, and decreases the production of the other good.

The Rybczynski theorem *works with constant relative price of goods*.

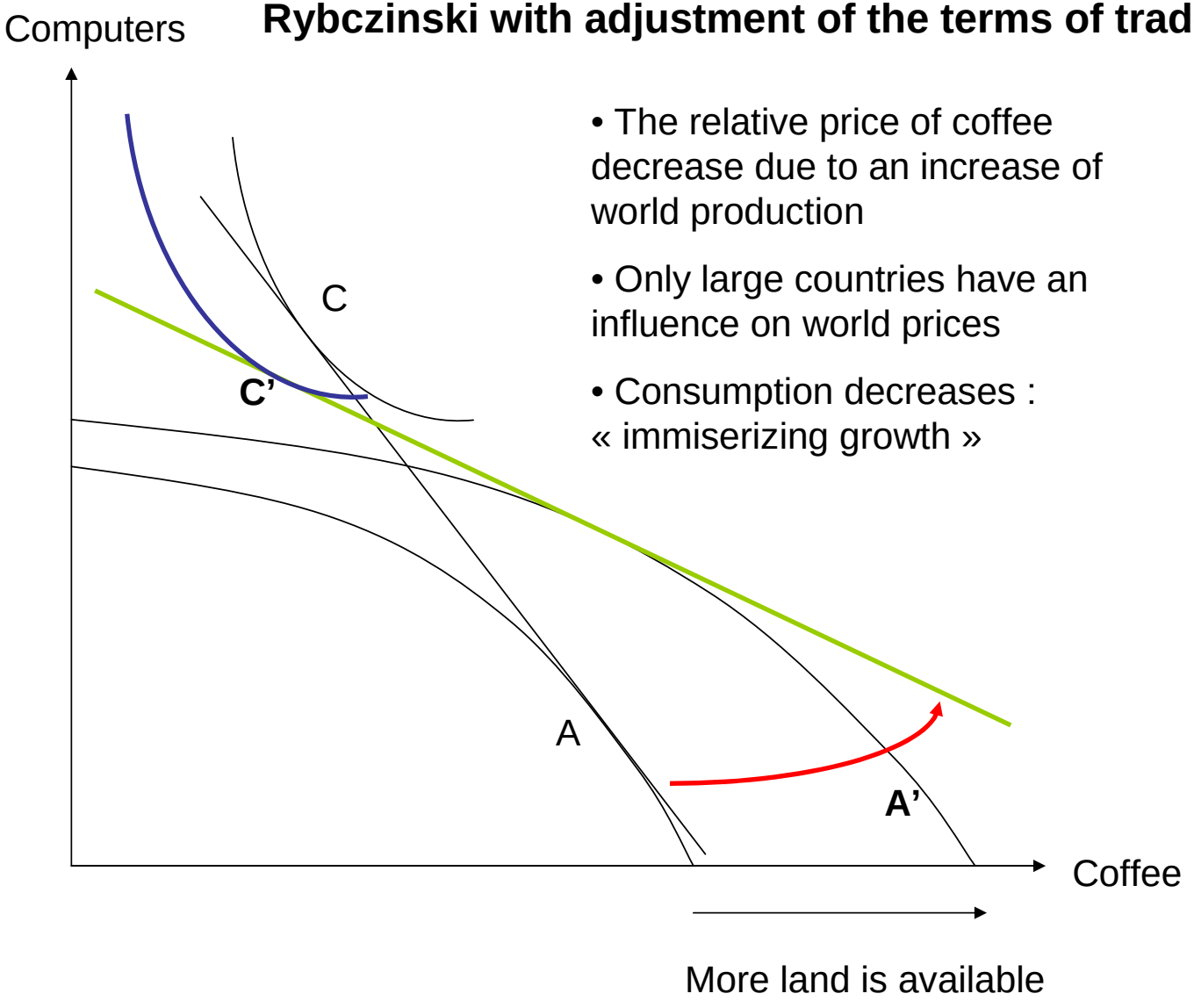
In reality, growth biased in favor of exports tends to **deteriorate the terms of trade** of the growing country to the benefit of the rest of the world.

Possibility of an Immiserizing growth.

Rybczinski with constant relative prices



Immiserizing growth



5. Empirical validations of HOS

Leontief (1953) paradox

- US Exports should be capital-intensive and imports labor-intensive.
- Input-output tables of the US economy.
- Computes $a = \frac{K_m/L_m}{K_x/L_x}$, **Ratio obtained = 1,3**.
- Imports in the US are more capital intensive than exports

TABLE: Capital and labor required for the US production of 1 million USD exports and import substitutes.

	Capital ($ 1947)	Labor (man-years)	K/L
Exports	2 550 780	182 313	13,991
Import Substitutes	3 091 339	170 004	18,184

First critics

1. Technology is different and American workers are more productive
2. Labor is heterogenous.
3. Impossible to consider imports without domestic substitutes.
4. Other factors might be important (land...).
5. US tarifs hit in particular labor intensive goods.

Bowen, Leamer, Sveikauskas (1987) :

- Use HOS model to predict directions of trade for a large number of countries
- Very disappointing results : predict less than half of trade directions

Trefler (1993 and 1995) : simple model is too restrictive. Considers 9 factors, 33 countries in 1983.

- Even when we allow for more factors, the model does not predicts well more than 50% of the trade directions between countries and industries.

Alternative specification of the model :

1. Introduces a **home bias** in preferences.
2. Introduces technological differences "à la Leontief" :

- Extension of the model allows to predict 72% of the trade directions
  $\Rightarrow$ Technology differences matter !

HOS model in its initial form is too strict. Important corrections can bring much better fit to the data.

Conclusion

- At this stage, we have explained :
  - why countries with different technologies and/or different production factor endowments trade with each other (ex : US and China)
  - why different goods are being exchanged ("inter-industry trade")
  - why openness to trade may increase wage inequality
- What about :
  - similar countries
  - similar goods
  - how/why labor and capital move across countries