II - Differences in Technology: The Ricardian Model

- **General purpose: to generalize the example of North-South trade given in the Introduction**
- **Trade based on differences in** *technology, not factors*: **polar opposite to the HO model of chapter III**

1. The Closed Economy

- **1.1 Production**
- 2 goods: X and Y
- 1 input: labor

  total labor endowment: $\bar{L}$
- Production functions:

  constant returns to scale

$$\begin{cases} X = F_X(L_X) = \alpha L_X \\ Y = F_Y(L_Y) = \beta L_Y \end{cases}$$

α, β: positive constants

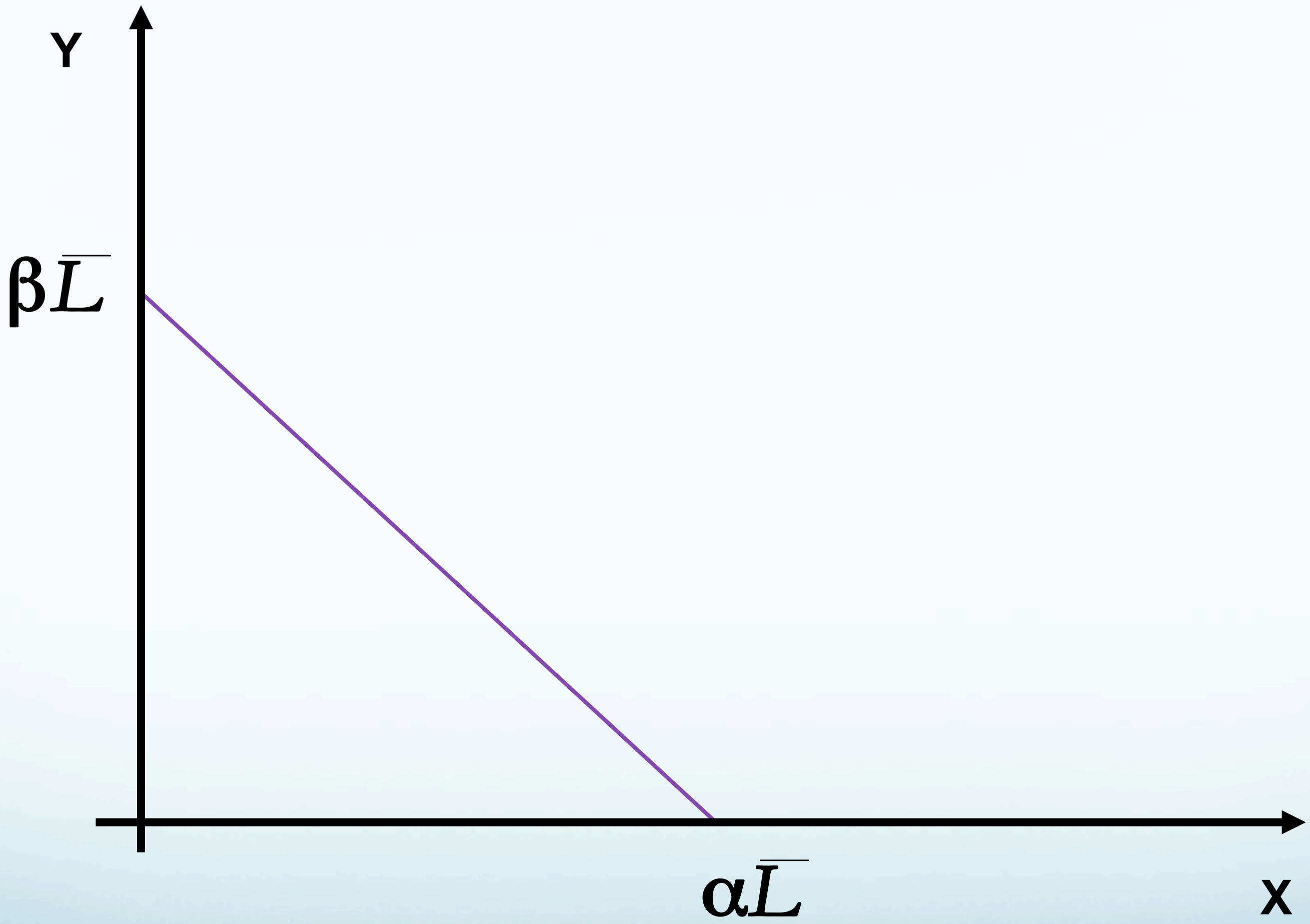
- **Perfect competition in product and labor markets**
- **Important assumption:**

  perfect mobility of labor between sectors

  ⇒ same wage in both sectors: $w_X = w_Y = w$
- **Production possibility set and frontier**

  given here by the full-employment constraint:

$$L_X + L_Y \leq \overline{L} \Leftrightarrow \frac{X}{\alpha} + \frac{Y}{\beta} \leq \overline{L}$$

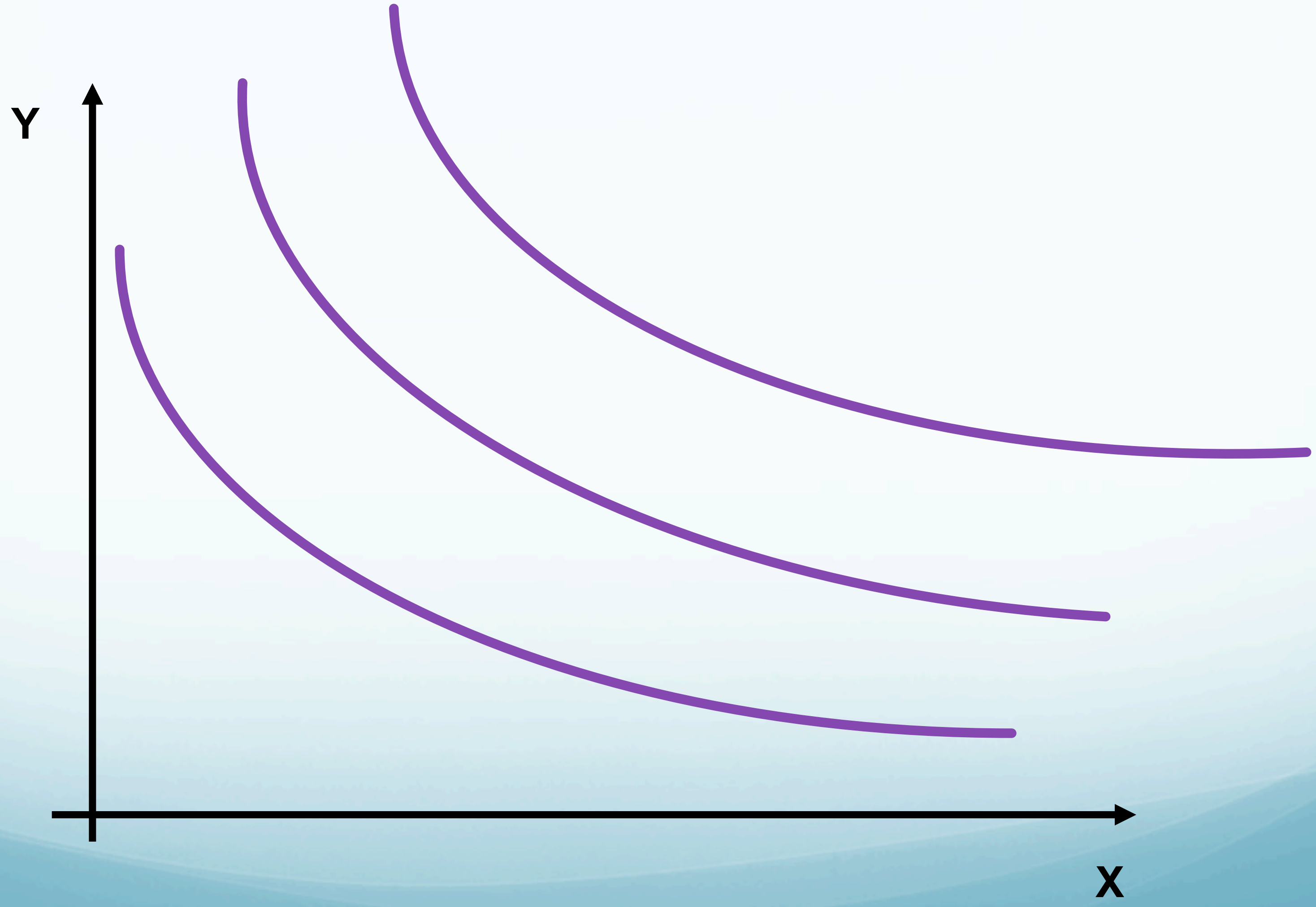

Y
$\beta\overline{L}$
$\alpha\overline{L}$
X

- **1.2 Demands**
- Assumption: identical consumers, same preferences

$\Rightarrow$ we can consider a representative consumer whose income is the country total income: $w\,\bar{L}$

- Assumption: imperfectly substitutable goods

iso-utility curves:



- **1.3 Equilibrium under Autarky**
- Perfect competition implies zero profits.

  Profits equal:

$$\pi_X = p_X X - w\frac{X}{\alpha} = \left(p_X - \frac{w}{\alpha}\right)X$$

- If $p_X < \frac{w}{\alpha}, \quad x = 0$
- If $p_X > \frac{w}{\alpha}, \quad x = \infty$

$\Rightarrow$ only possible equilibrium price: $p_X = \frac{w}{\alpha}$

- Similarly: $p_Y = \frac{w}{\beta}$

- **Remark 1:**

$\Rightarrow$ $$p = \frac{p_X}{p_Y} = \frac{\beta}{\alpha}$$ = - PPF slope

$$= MRT = \frac{\partial F_Y / \partial L_Y}{\partial F_X / \partial L_X}$$

= marginal rate of transformation

- Remark 2:

Here, production frontier = budget constraint

- budget constraint:

$$p_X X^d + p_Y Y^d = w_X L_X + w_Y L_Y = w\bar{L}$$

because no income from profits that are zero

- using equilibrium prices: $$\frac{w}{\alpha}X^d + \frac{w}{\beta}Y^d = w\bar{L}$$

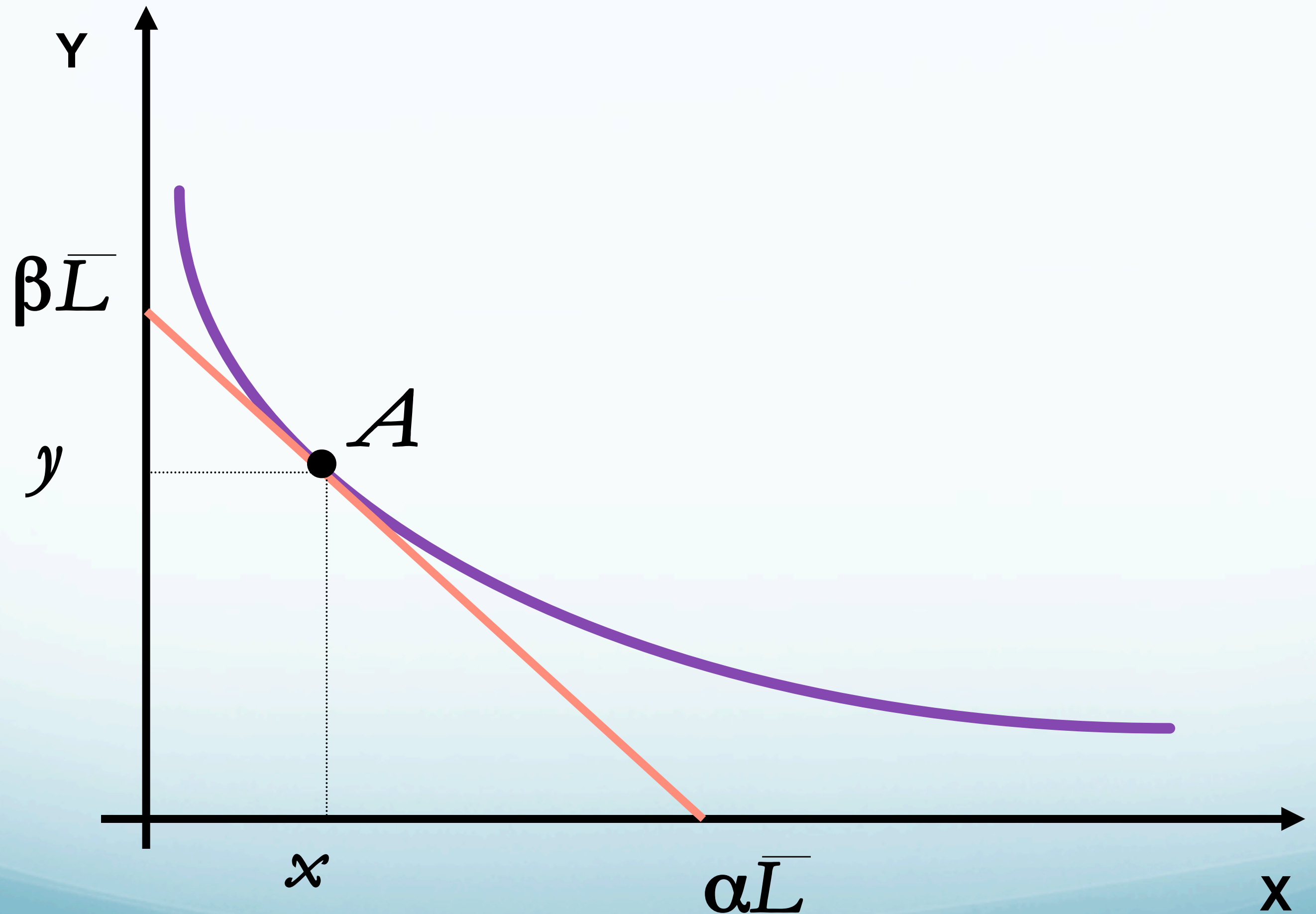
- using the good market equilibrium:

$X^d = X^s$ and $Y^d = Y^s$

$\Leftrightarrow$ i.e. the production possibility frontier (PPF)

$$\frac{X^s}{\alpha} + \frac{Y^s}{\beta} = \bar{L}$$

- Equilibrium under autarky



2. Differences Between the Closed and the Open (Trading) Economy

- **Assumption: when frontiers are open, perfect competition still applies, firms and consumers are still price and wage takers**
- **Important assumption: No international labor mobility**
- **No trade costs: world** *relative* **price of X equal to** $p^* = \frac{p_X^*}{p_Y^*}$
- p^* **is in general different from the autarky price** p

- Quantities
  - firms: constrained by the same production frontier
  - labor endowment unchanged, no migrations

$$\frac{X^s}{\alpha} + \frac{Y^s}{\beta} = \overline{L}$$

  - consumers: can buy goods on the world market

  only constraint : budget constraint

- using the zero profit and market-clearing conditions in both sectors:

$$p_X^* X^d + p_Y^* Y^d = w_X L_X + w_Y L_Y = p_X^* X^s + p_Y^* Y^s$$

$$\Leftrightarrow \quad p_X^* \left(X^s - X^d \right) + p_Y^* \left(Y^s - Y^d \right) = 0$$

$X^s - X^d$: net exports of good X

$Y^s - Y^d$: net exports of good Y

- ✓ At world prices, export value = import value.
- ✓ The zero profit condition is equivalent to balanced trade.

- The trade balance equilibrium :

$$p^*_X\left(X^s - X^d\right) + p^*_Y\left(Y^s - Y^d\right) = 0$$

implies that a country must be a net importer of one good and a net exporter of the other good

In this framework it is impossible to export (or import) both goods.

- **Conclusion: differences in equilibrium characterization**
  - **in autarky, for any country i**

$$\begin{cases} p^{a,i} = MRS^{i}\ (\text{consumer optimality}) \\ p^{a,i} = MRT^{i}\ (\text{firm optimality}) \\ X^{i,d} = X^{i,s}\ and\ Y^{i,d} = Y^{i,s}\ (market\ equilibrium) \end{cases}$$

  - **under free trade**

$$\begin{cases} p^{*} = MRS^{i}, for\ any\ country\ i \\ p^{*} = MRT^{i}, for\ any\ country\ i \\ \sum_i X^{i,d} = \sum_i X^{i,s}\ and\ \sum_i Y^{i,d} = \sum_i Y^{i,s} \end{cases}$$

$\Rightarrow$ **differences in price levels and market clearing conditions**

- We can rearrange conditions under free trade to make the trade balance condition appear.

$$
\begin{cases}
p^* = MRS^{i}, \forall i \\
p^* = MRT^{i}, \forall i \\
p_X^*\left(X^{i,s} - X^{i,d}\right) + p_Y^*\left(Y^{i,s} - Y^{i,d}\right) = 0, \forall i \\
\sum_i X^{i,d} = \sum_i X^{i,s}
\end{cases}
$$

- **Price and quantities variations**
  - <u>case 1:</u> $p^* < p^a$

✓ $p^* < MRT$ ⇒ reallocation of production towards good Y

✓ the reason is that the marginal productivity of labor in sector Y is *relatively* higher than in sector X in this country

$$p^* < p^a \Rightarrow \frac{p_X^*}{p_Y^*} < \frac{\partial F_Y / \partial L_Y}{\partial F_X / \partial L_X} \Rightarrow p_X^* \frac{\partial F_X}{\partial L_X} < p_Y^* \frac{\partial F_Y}{\partial L_Y}$$

⇒ complete specialization in good Y

$$Y = \overline{Y} = \beta \overline{L} \qquad\qquad p^* \neq MRT$$

✓ We reach a corner solution because only one input is used and production frontiers are straight lines. (See in chapter III the HO model with 2 inputs for an interior solution.)

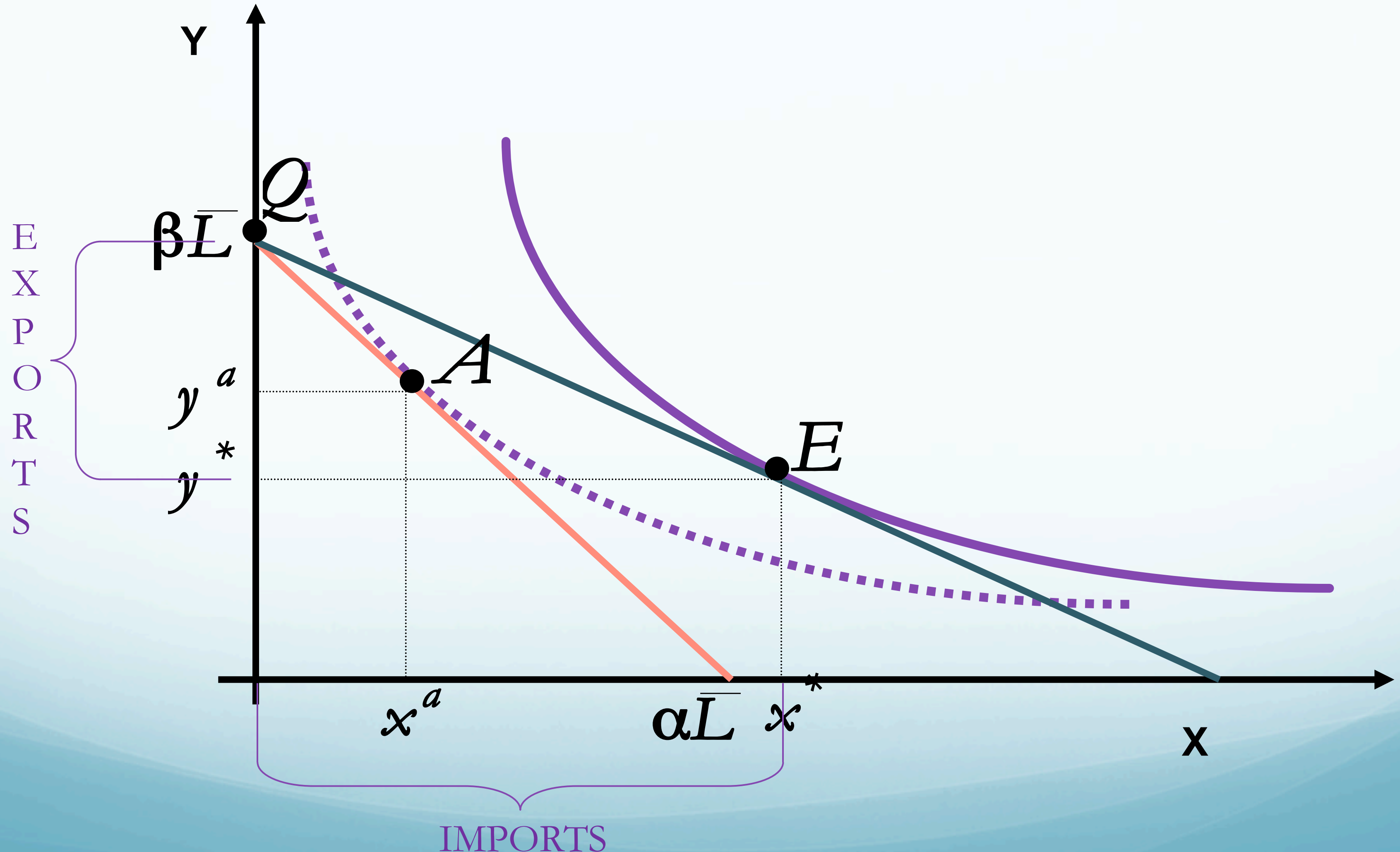
✓ Consumers'budget constraint:

$$p_X^* X^d + p_Y^* Y^d = p_Y^* \overline{Y} = p_Y^* \beta \overline{L}$$

$$\Leftrightarrow \quad Y^d = \beta \overline{L} - p^* X^d$$

Figure: Open Economy Equilibrium with

$p^* < p^a$



- <u>case 2</u>: $p^* > p^a$

$\Rightarrow$ same analysis but with complete specialization in the production of good X

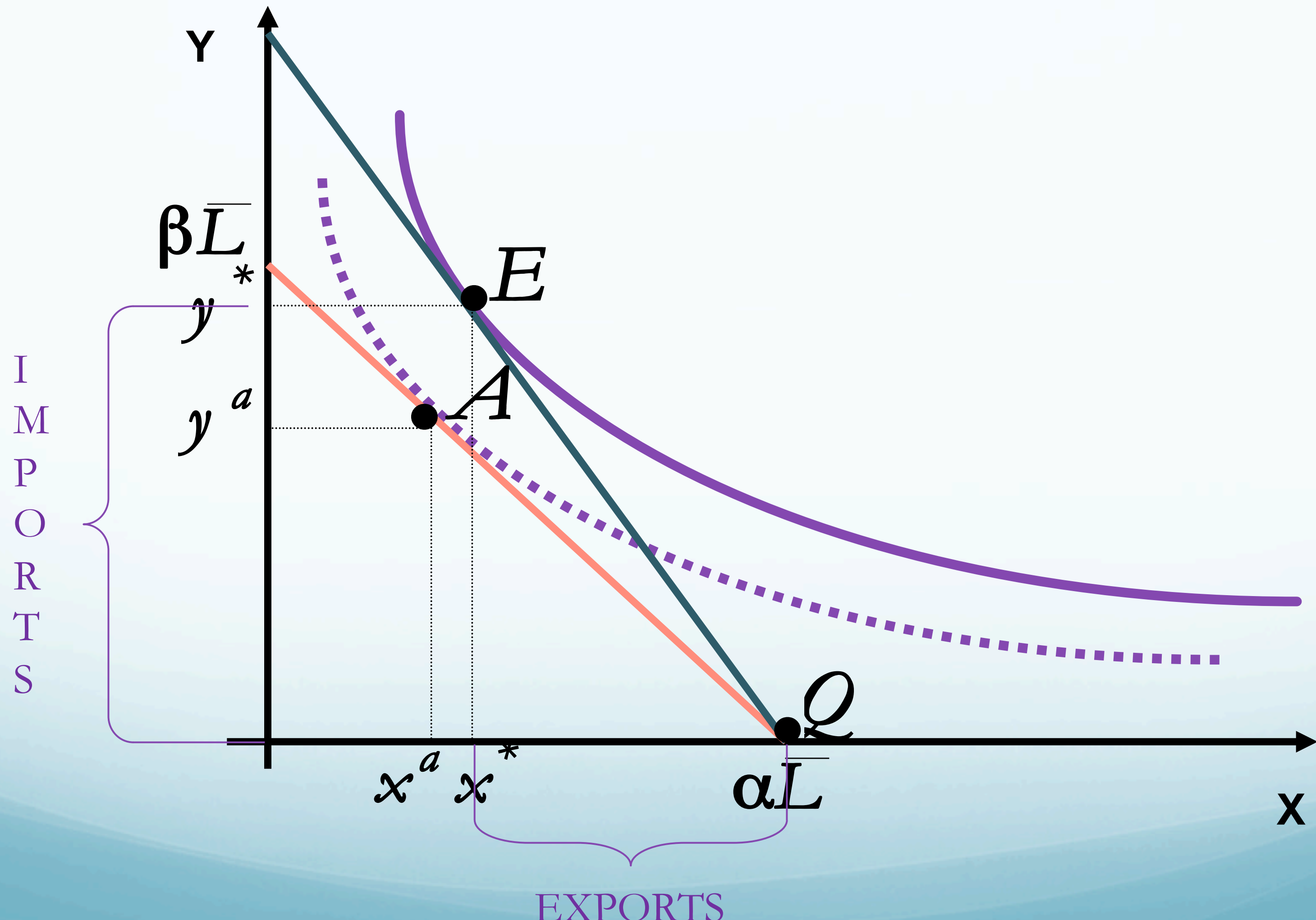
✓ consumers budget constraint:

$$p_X^* X^d + p_Y^* Y^d = p_Y^* \alpha \bar{L}$$

$$\Leftrightarrow \quad X^d = \alpha \bar{L} - \frac{1}{p^*} Y^d$$

Figure: Open Economy Equilibrium with

$p^* > p^a$



- <u>case 3</u>: $p^* = p^a$
  - ✓ it is optimal for firms to produce any bundle on the PPF
  - ✓ equilibrium consumption is the same as in autarky

⇒ production depends on foreign demand

- ✓ there are no gains from trade

- **Useful tool: excess demand function:**
  - ✓ **difference between the local demand and the local production as a function of the world price**

$$\Rightarrow \left(X^d - X^s\right)(p^*) = E(p^*)$$

  - ✓ **usually, the inverse excess demand function is plotted**

- Determination of the excess demand function: We go through all three possible cases
  - if $p^* = p^a$ then $X^d = X^{d,a}$ and $X^s \in [0, \alpha \bar{L}]$

$$\Rightarrow \quad X^d - X^s \in \left[X^{d,a} - \alpha \bar{L}, X^{d,a}\right]$$

- If $p^* < p^a$

✓ complete specialization in Y, then $X^s = 0$

and $Y^s = \beta\overline{L}$ irrespective of p^*

✓ X^d decreases with p^*

$\Rightarrow$ $(X^d - X^s)(p^*)$ is a decreasing function

- If $p^* > p^a$

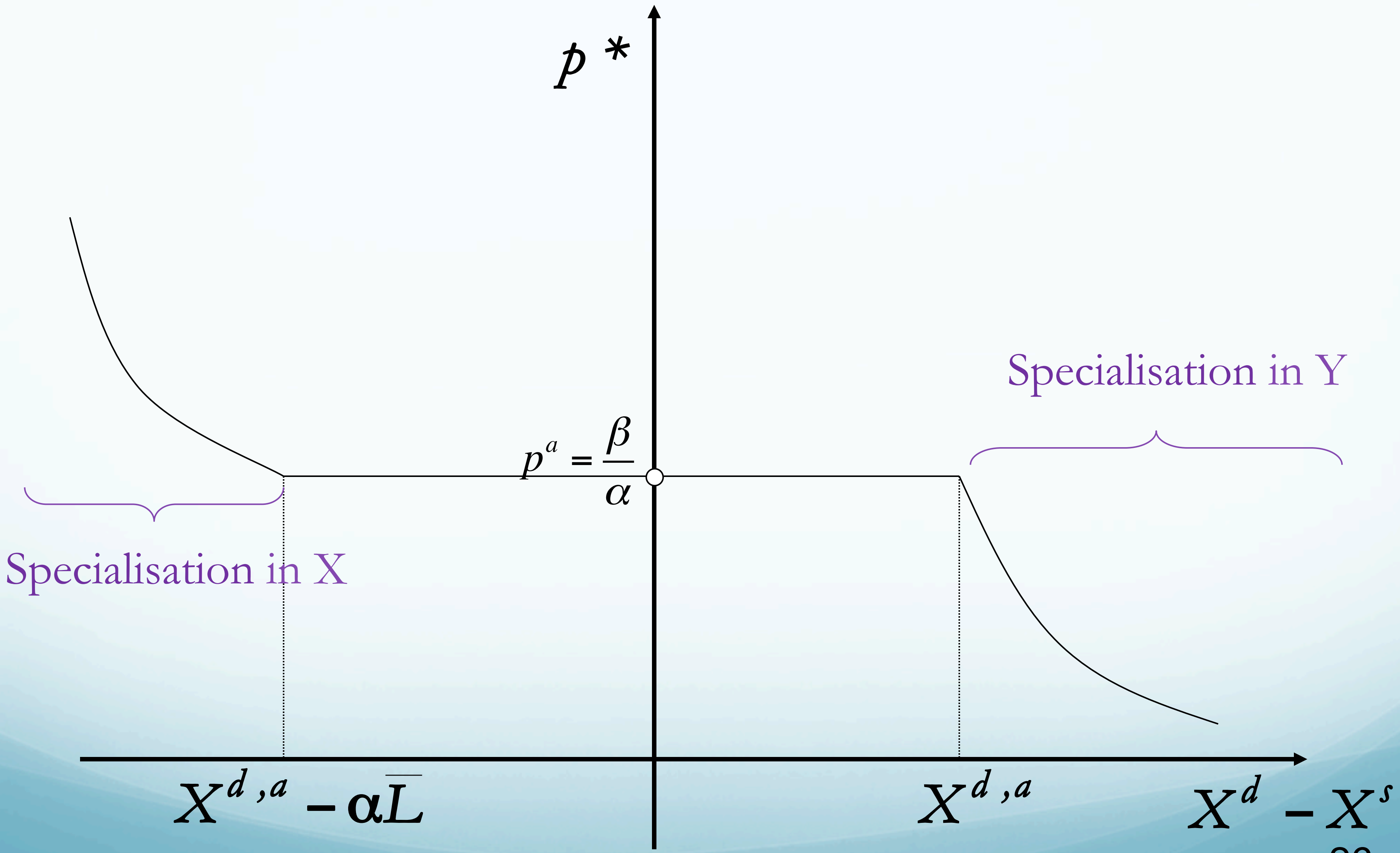
✓ complete specialization in Y, then $X^s = \alpha\overline{L}$

and $Y^s = 0$ irrespective of p^*

✓ X^d decreases with p^*

$\Rightarrow$ $(X^d - X^s)(p^*)$ is a decreasing function

- **Figure: Excess demand function**



3. Equilibrium in the Open Economy

- **3.1 Technology**
- **Trade liberalization between 2 countries (1 and 2) with the same labor endowment but different technologies.**
- **Autarky prices must be different.**
- **By convention we assume that** *country 1 has comparative advantage in the production of Y*, **with relative productivities**

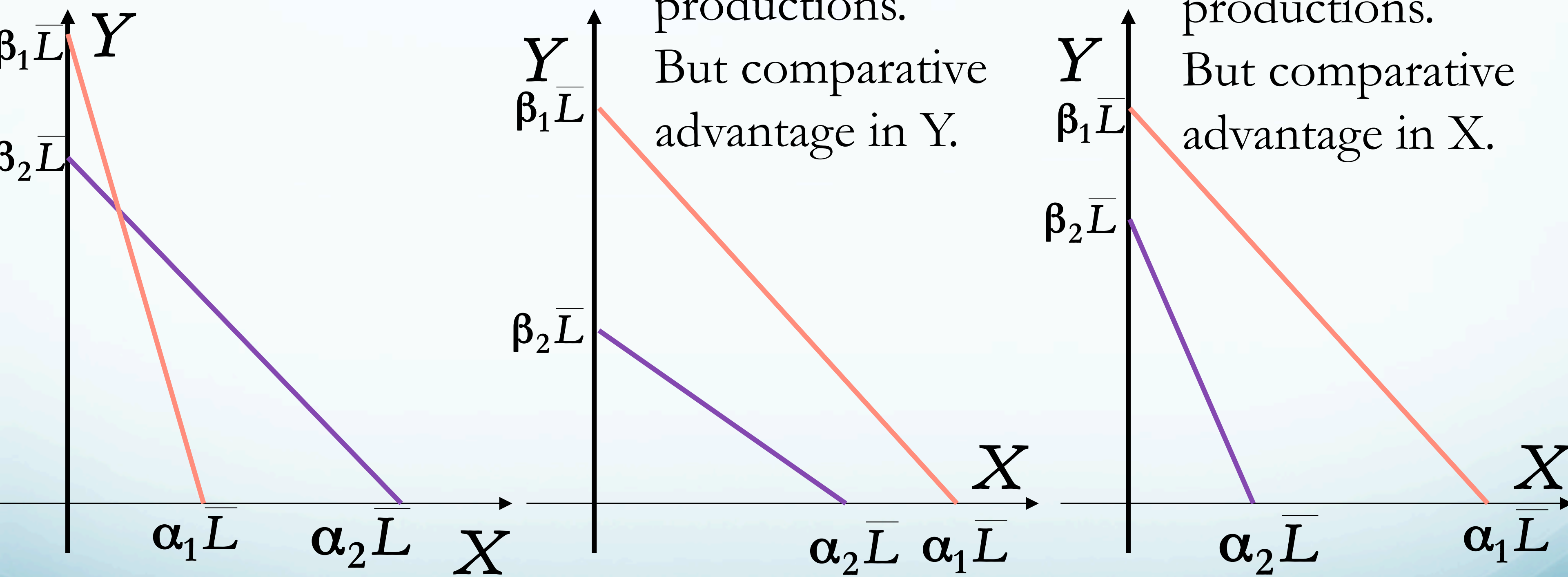
$$\frac{\beta_1}{\alpha_1} > \frac{\beta_2}{\alpha_2} \Leftrightarrow \quad p_1^a = \frac{\beta_1}{\alpha_1} > \frac{\beta_2}{\alpha_2} = p_2^a$$

Figure: Examples of production frontiers

Comparative advantage of country 1 in Y.

Absolute advantage of country 1 in both productions. But comparative advantage in Y.

Absolute advantage of country 1 in both productions. But comparative advantage in X.



- **3.2 World Price**
- Good X world market equilibrium

$\Rightarrow$ world Price

$$\Leftrightarrow \quad X_1^d + X_2^d = X_1^s + X_2^s$$

$$\Rightarrow \quad X_1^d - X_1^s + X_2^d - X_2^s = 0$$

$$\Rightarrow \quad E_1 + E_2 = 0$$

- Plot of good X excess demand function in both countries and determination of the free trade equilibrium price

- **Remark:**
  - we assume identical preferences in both countries
  - country 1 has comparative advantage in Y ⇒

$$p_1^a > p_2^a$$

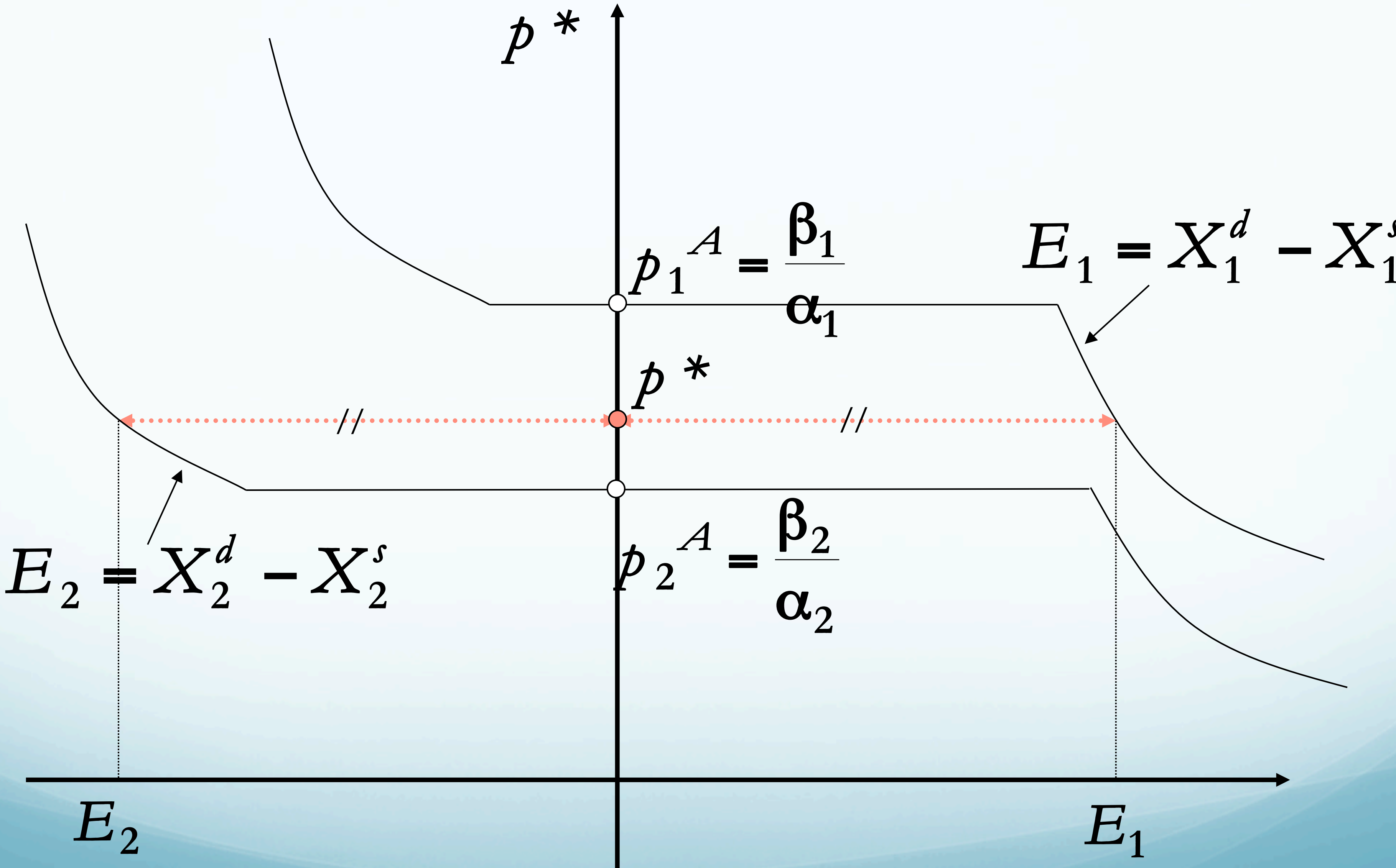
  - bth assumptions imply

$$X_1^{d,a} < X_2^{d,a}$$

  - but

$$X_1^{d,a} - \alpha_1 \overline{L} \; ? \; X_2^{d,a} - \alpha_2 \overline{L}$$

Figure: Graphic determination of world price



- Conclusion:
  - in equilibrium markets clear and excess demands are zero
  - that implies a world relative price that lies between both autarky relative prices

⇒ when trade is liberalized, the relative price increases in one country and decreases in the other one

⇒ each country fully specializes in their comparative advantage good: 1 specializes in Y, 2 specializes in X

- Intuitions:

  - country 1: the relative price of good X *decreases*

  ⇒ firms in sector Y can offer greater wages than in sector X up until all labor has gone to sector Y

  ⇒ consumers consume more good X and less good Y

  ⇒ good Y is exported, good X is imported

  - country 2: the relative price of good X *increases*

  ⇒ firms in sector X offer higher wages and the country specializes in X

  ⇒ consumers consume more good Y and less good X

  ⇒ good Y is imported, good X is exported

4. Welfare Analysis

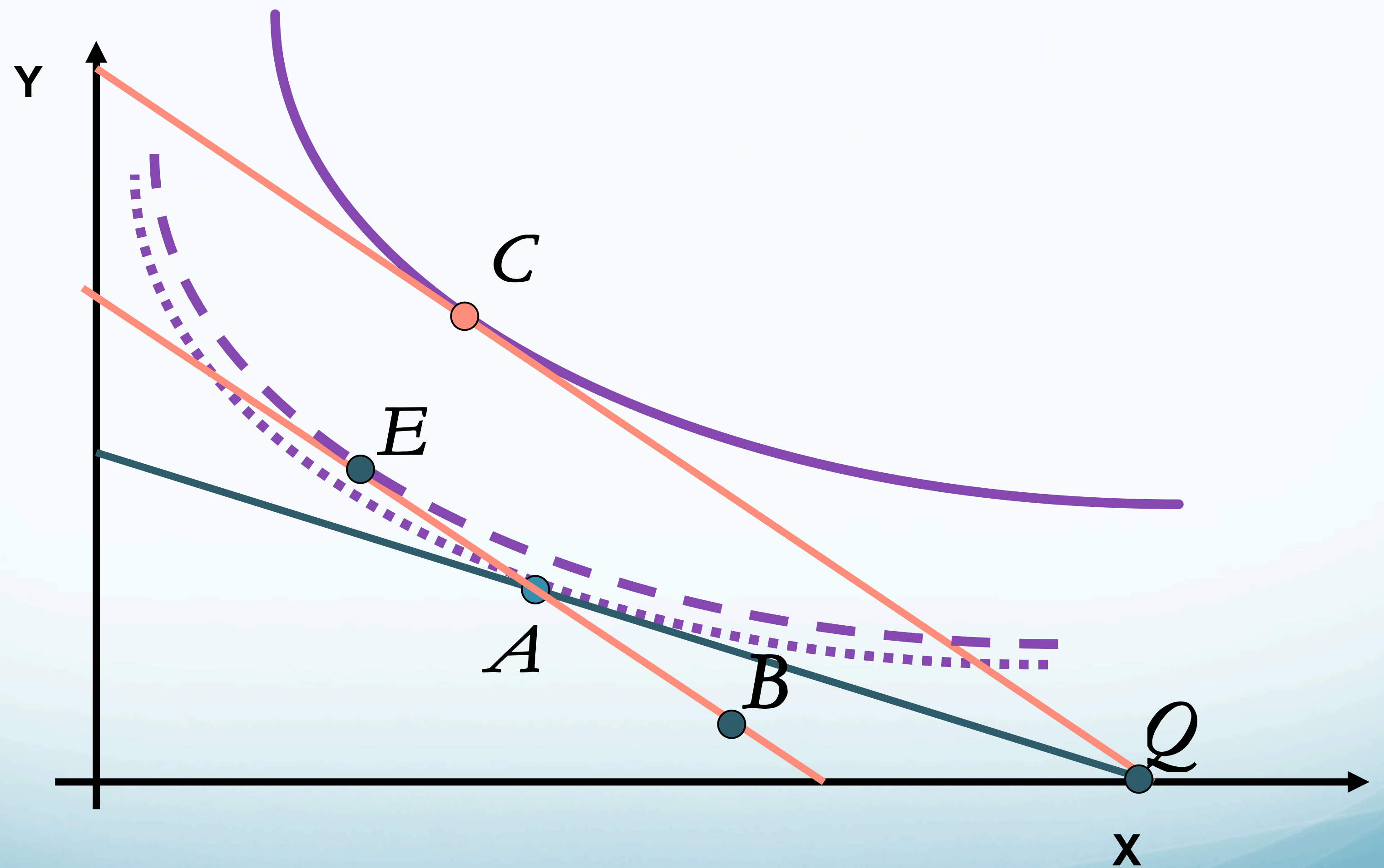
- **Gains from trade theorem:**

Trade liberalization increases welfare of each country

- gains from exchange: consumers consume more of a good whose price decreases
- gains from specialization: firms produce more of a good whose price increases

⇒ welfare increases because consumers expand their consumption possibilities (their income increases due to specialization) and because they substitute their consumption in favor of the lower price good

Figure: Welfare gains decomposition



- Welfare gains decomposition
  - Start from point A. Opening to trade yields a new relative price equal to the slope of the orange curve.
  - Step 1: gains from exchange: A $\rightarrow$ E
    - keep the same production bundle despite the price change
    - p increases $\Rightarrow$ substitution in consumption towards good Y
  - Step 2: gains from specialization: E $\rightarrow$ C
    - at free trade prices producing at A is inefficient
    - specialization allows to reach a higher income (at Q and C)

- Comparative advantage depends only on the ratio of labor productivity in both sectors.

$\Rightarrow$ that is to say, only on technology, it doesn't depend on relative wages between countries

- Real wages under autarky
  - $p_X^{i,a} = \dfrac{w^{i,a}}{\alpha_i}$ and $p_Y^{i,a} = \dfrac{w^{i,a}}{\beta_i}$

$$\Rightarrow \quad \frac{w^{i,a}}{p_X^{i,a}} = \alpha_i \quad \text{and} \quad \frac{w^{i,a}}{p_Y^{i,a}} = \beta_i$$

- Real wage in open economy
  - country 1, full specialization in good Y

$$\Rightarrow \quad w^{1,*} = \beta_1 p_Y^*$$

  - country 2, full specialization in good X

$$\Rightarrow \quad w^{2,*} = \alpha_2 p_X^*$$

- Country 1: $$\frac{w^{1,*}}{p_Y^*} = \beta_1 = \frac{w^{1,a}}{p_Y^{1,a}} \Rightarrow \text{unchanged}$$

$$\frac{w^{1,*}}{p_X^*} = \frac{\beta_1}{p^*} > \alpha_1 = \frac{w^{1,a}}{p_X^{1,a}} \Rightarrow \text{increases}$$

- Country 2: $$\frac{w^{2,*}}{p_X^*} = \alpha_2 = \frac{w^{2,a}}{p_X^{2,a}} \Rightarrow \text{unchanged}$$

$$\frac{w^{2,*}}{p_Y^*} = \alpha_2 p^* > \beta_2 = \frac{w^{2,a}}{p_Y^{2,a}} \Rightarrow \text{increases}$$

⇒ real labor income increases

- Final remarks
  - the real wage ratio between countries equals the ratio of nominal wages (since prices are the same) and depends on absolute advantage, as under autarky

for instance:

$$\frac{w^{1,a} / p_X^{1,a}}{w^{2,a} / p_X^{2,a}} = \frac{\alpha_1}{\alpha_2} \quad \text{and} \quad \frac{w^{1,*} / p_X^{*}}{w^{2,*} / p_X^{*}} = \frac{\beta_1}{\alpha_2 p^*} > \frac{\alpha_1}{\alpha_2}$$

⇒ welfare increases in both countries, but inequalities between countries may either increase or decrease

  - role of labor mobility assumption

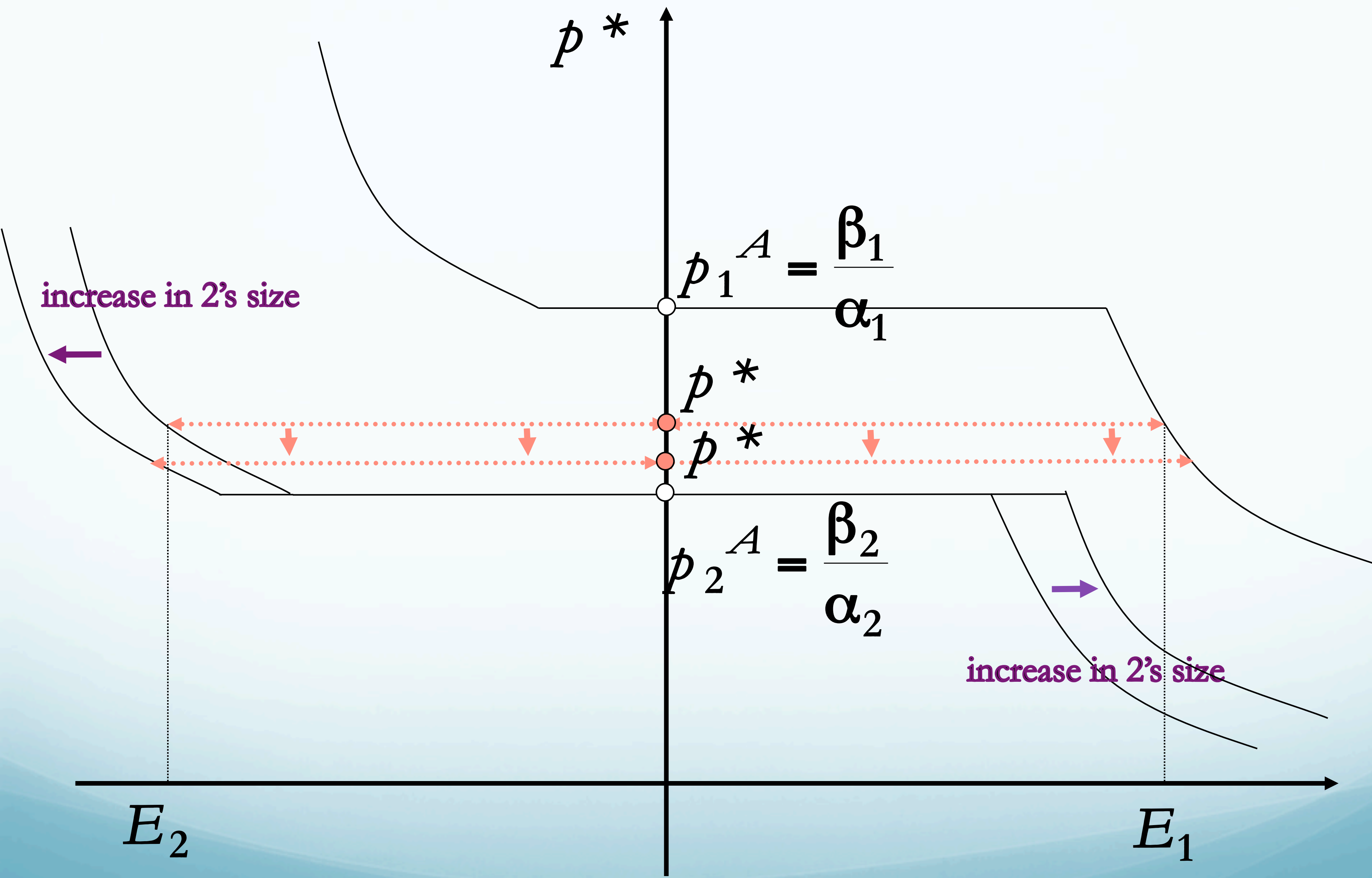
5. Country Size and Growth

- Suppose now that the production set of country 2 grows, while that of country 1 is the same. This may come from:
  - labor endowment growth
  - productivity growth in all sectors
- Country 2 will now want to export and import *more* at the same world relative price.
- The relative price of country 2's export good falls.

⇒ the small country gains more than the large country

- Intuition: the world price is closer to the autarkic price of the larger country

Figure: Graphic determination of world price



- In the case of very large country size differences, the world price may be equal to the large country price under autarky

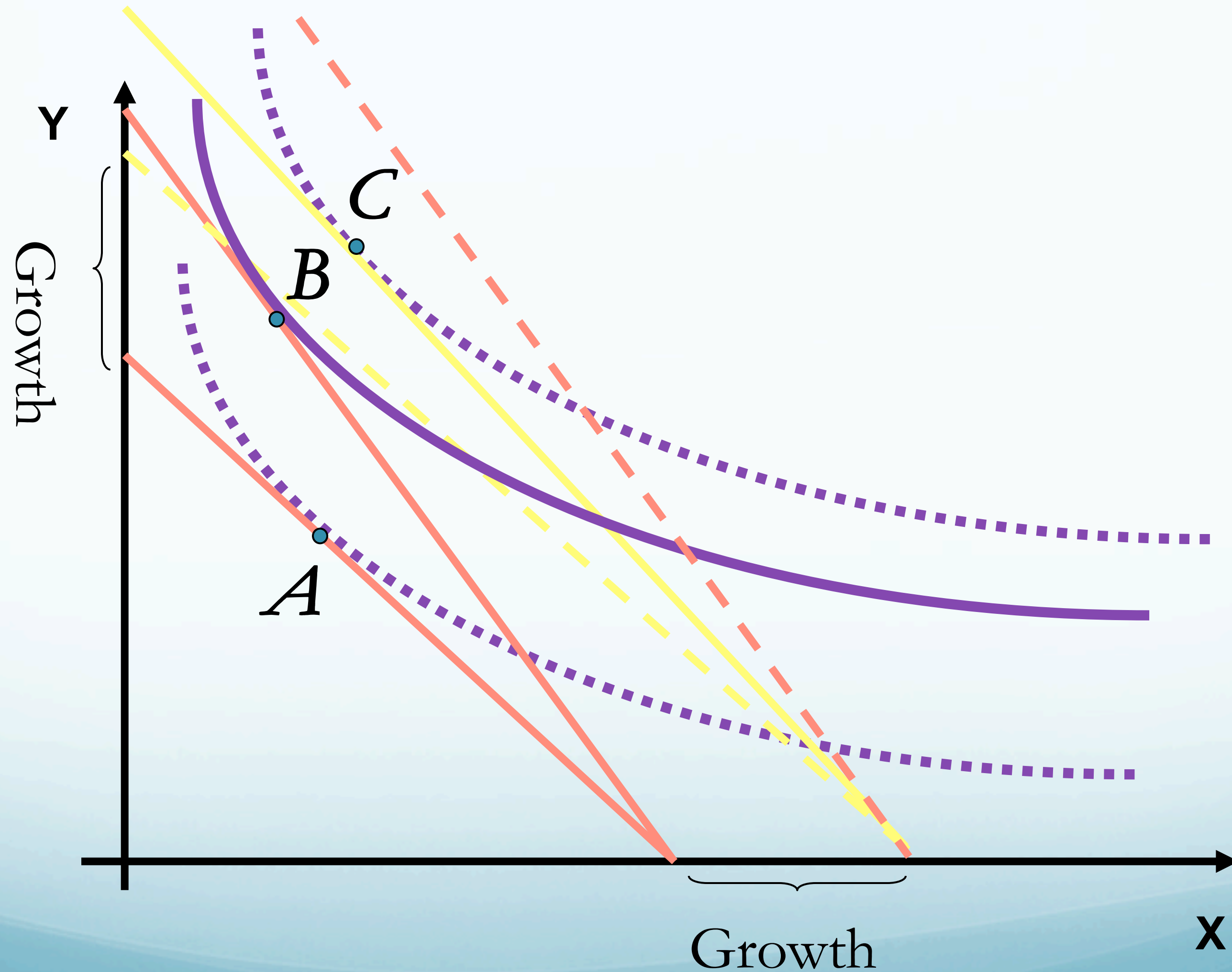
$\Rightarrow$ the large country is indifferent between the closed and the open economy in this case

$\Rightarrow$ the small country still gains from free trade

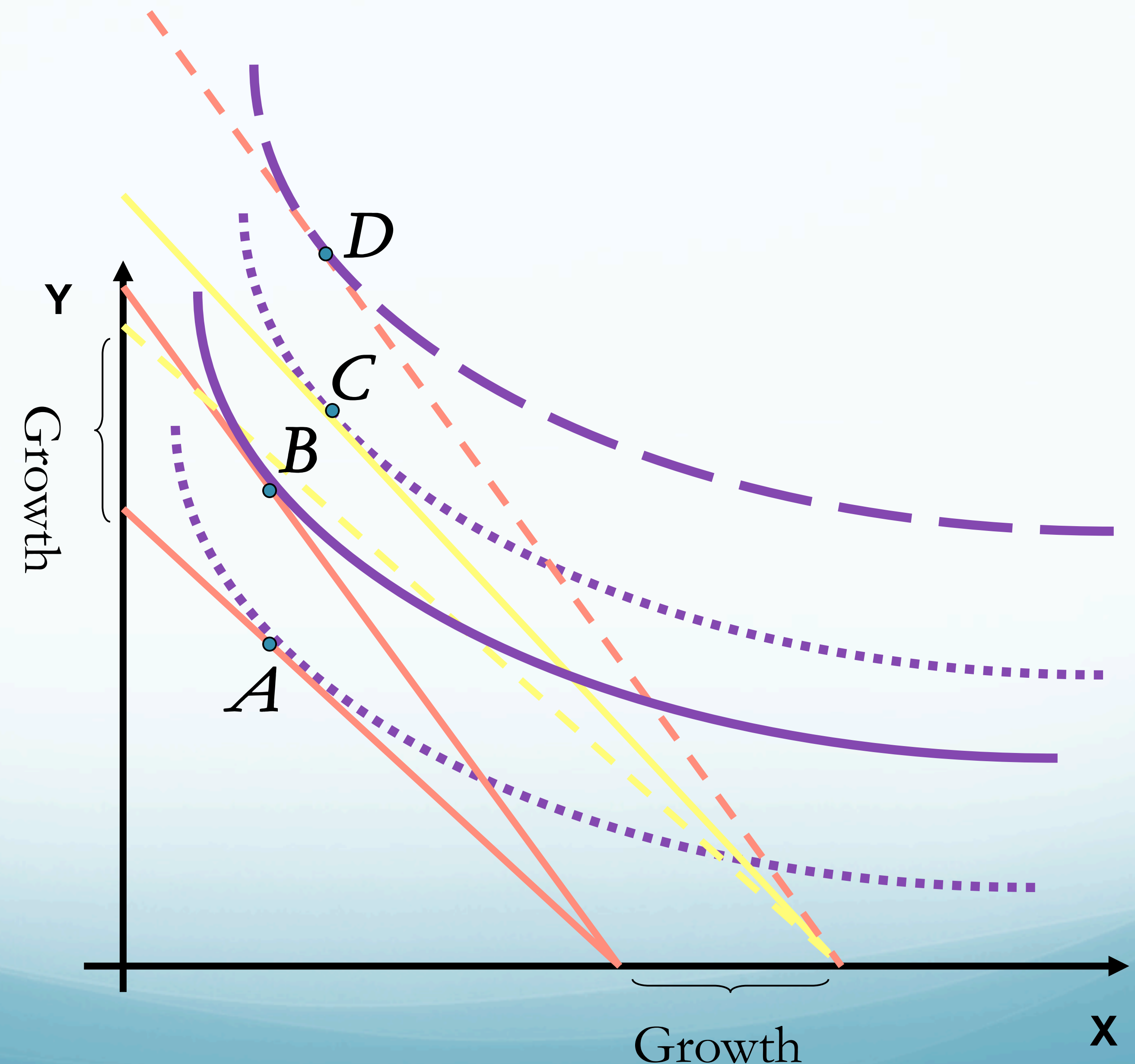
- Impact of country 2's growth
  - the price of the good country 2 exports decreases
  - intuitions: country 2 fully specializes in the production of X, thus an increase in its labor force increases the quantity of good X produced, and thus decreases the good X price
  - define the *terms of trade* as the ratio of the price of exports over the price of imports

  ⇒ terms of trade have deteriorated in country 2 while they have improved in country 1

Figure: Country 2 situation after country 2 growth



- **Figure: Country 2 situation after country 2 growth if the world price had not changed**

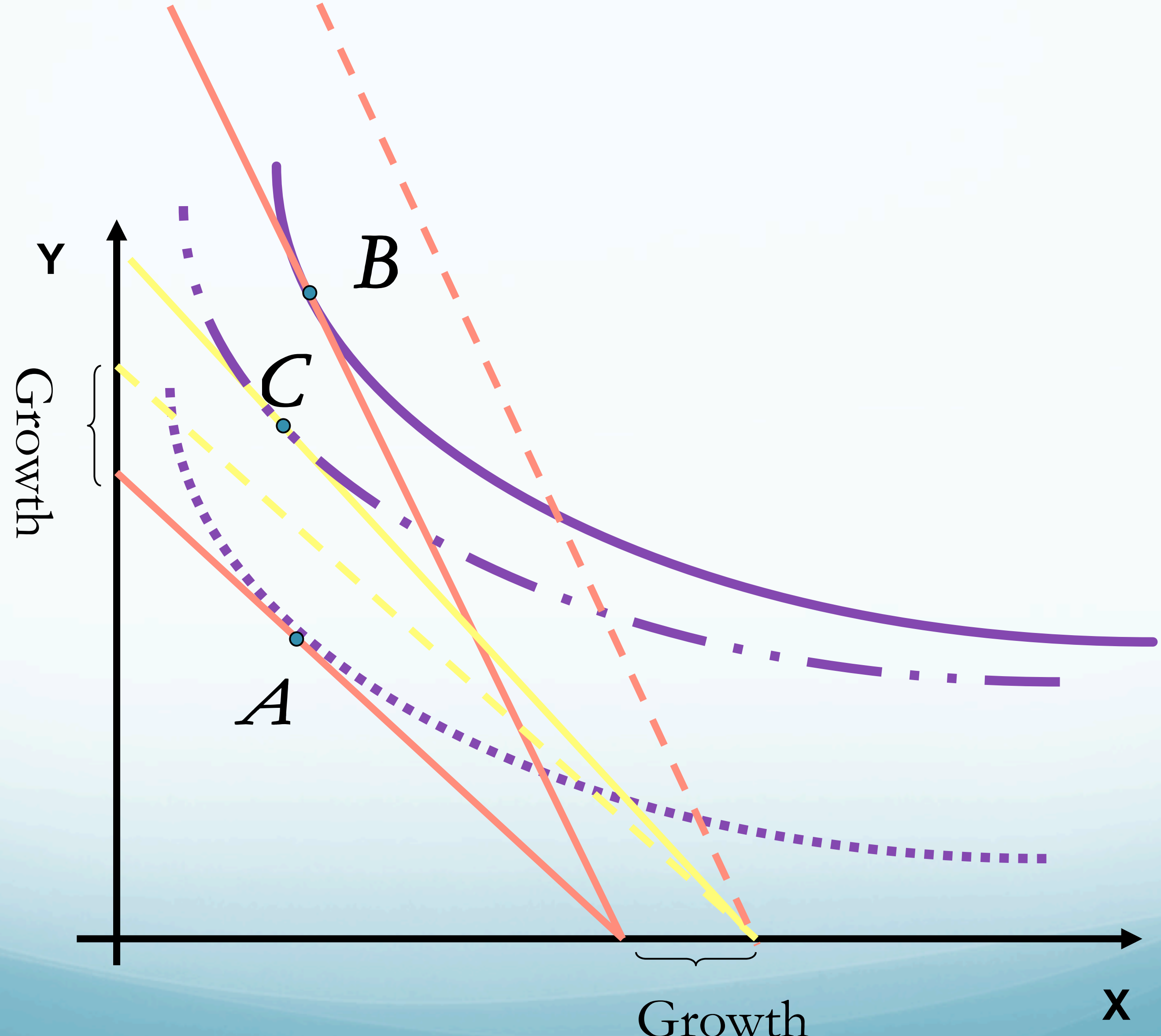


- terms of trade effect: the slope of the budget constraint under free trade and growth (going through C) lies between the autarky and the free trade/no growth slopes.
- in country 2, the impact of growth on welfare is lower than if the world price had remained constant
- but country 2 still prefers free trade to autarky

- ‘Immiserizing growth’
  - if demand is very elastic, the situation in country 2 can be worse after growth than with no growth: C below B

  ⇒ this is referred to as "immiserizing growth“
  - still, the country will be better off than under autarky
  - Applicable to commodities with large supply shocks like cocoa, coffee?

Figure: Immiserizing growth



4. References

Markusen, J., J. Melvin, W. Kaempfer, and K. Maskus, 1995. *International Trade - Theory and Evidence*, Mc Graw-Hill. Chapter 7.