Resources and Trade: The Heckscher-Ohlin Model

Krugman Ch.5
International Economics
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Topics

- Model of a Two-Factor Economy
- Effects of International Trade between Two-Factor Economics
- Empirical Evidence on the Heckscher-Ohlin Model

Model of Two-Factor Economy

Model Settings

- $2 \times 2 \times 2$ model
  - Two countries: [H]ome and [F]oreign
  - Two goods: [C]loth and [F]ood
  - Two factors of production: K (capital) and L (labor)
    - K,L: Now mobile (in the long run)

Notation

- $Q_C = Q_C(K_C, L_C)$, $Q_F = Q_F(K_F, L_F)$
  - Q_C, Q_F : Output level of Cloth and Food
    - Cloth: yard, Food: calory
  - K_C, K_F : Amounts of **capital** employed for Cloth and Food
  - L_C, L_F : Amounts of **labor** employed for Cloth and Food

Factors used to produce one unit of output

	Capital (K)	Labor (L)
Cloth (C)	a_{KC}	a_{LC}
Food (F)	a_{KF}	a_{LF}

Factors used to produce one unit of output

Capital (K) used to produce one unit of cloth (C)

	Capital (K)	Labor (L)
Cloth (C)	a_{KC}	a_{LC}
Food (F)	a_{KF}	a_{LF}

Factors used to produce one unit of outp

Capital (K) used to produce one unit of cloth (C)

Labor (L) used to produce one unit of cloth (C)

	Capital (K)	Labor (L)
Cloth (C)	a_{KC}	a_{LC}
Food (F)	a_{KF}	a_{LF}

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Factors used to produce one unit of outp

Capital (K) used to produce one unit of cloth (C)

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Cloth (C)	a_{KC}	a_{LC}
Food (F)	a_{KF}	a_{LF}

Labor (L) used to produce one unit of food (F)

Factors used to produce one unit of outp

Labor (L) used to produce one unit of cloth (C)

Capital (K) used to produce one unit of cloth (C)

	Capital (K)	Labor (L)
Cloth (C)	a_{KC}	a_{LC}
Food (F)	a_{KF}	a_{LF}

Capital (L) used to produce one unit of food (F)

Labor (L) used to produce one unit of food (F)

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$a_{KC}, a_{KF}, a_{LC}, a_{LF}$

- Similar to a_{LW}, a_{LC} : Labor REQUIRED to produce one unit of final product (W or C)
    - One factor: only one method
- $a_{KC}, \cdots, a_{LF}$: Labor (or Capital) USED to produce one unit of final product (W or C)
    - Two factors: more than one method
    - Method choice depends on the factor prices of labor (wage) and capital
- At first, we will look at a special case: production method is fixed = only one method

Special Case:

$$a_{KC} = 2; a_{KF} = 3; a_{LC} = 2; a_{LF} = 1$$

- $Q_C(L, K) = Q_C(a_{LC}, a_{KC}) = Q_C(2,2) = 1(yard)$,
- $Q_F(L, K) = Q_F(a_{LF}, a_{KF}) = Q_F(1,3) = 1(cal)$.
- Factor endowment:
  - L: 3,000 units of machine-hours
  - K: 2,000 units of work-hours
- Assumption of one production method implies: No substitution between L and K

Factor Constraints

$$Q_C(L,K) = Q_C(a_{LC}, a_{KC}) = Q_C(2,2) = 1(yard),$$
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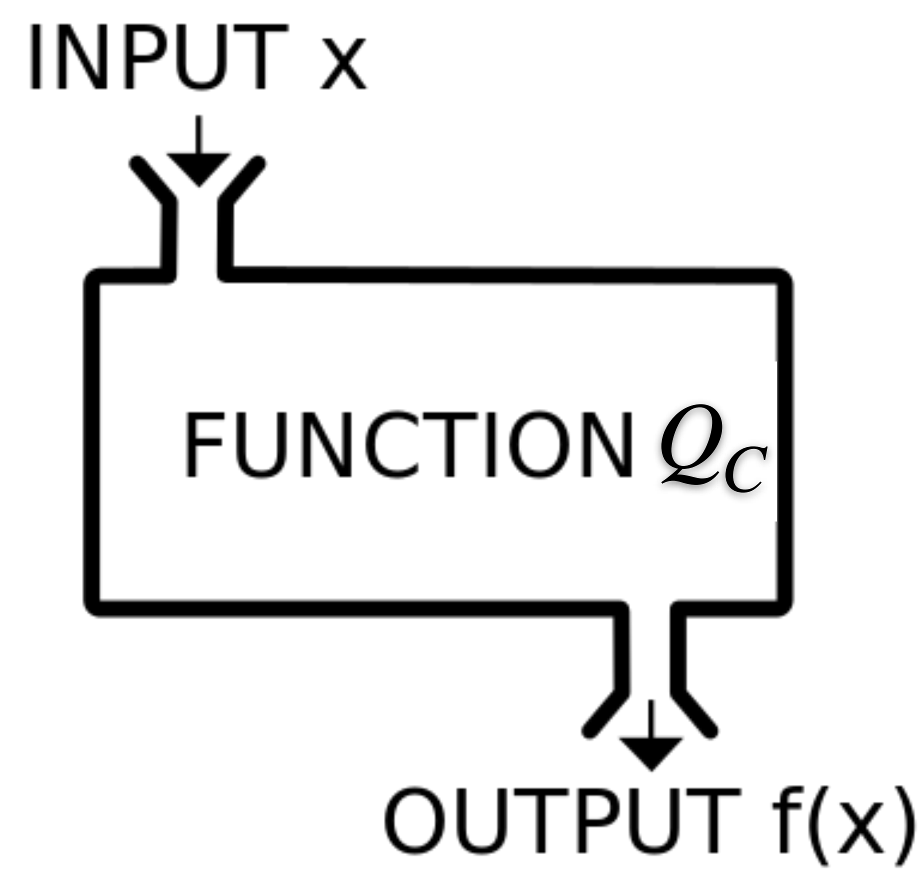

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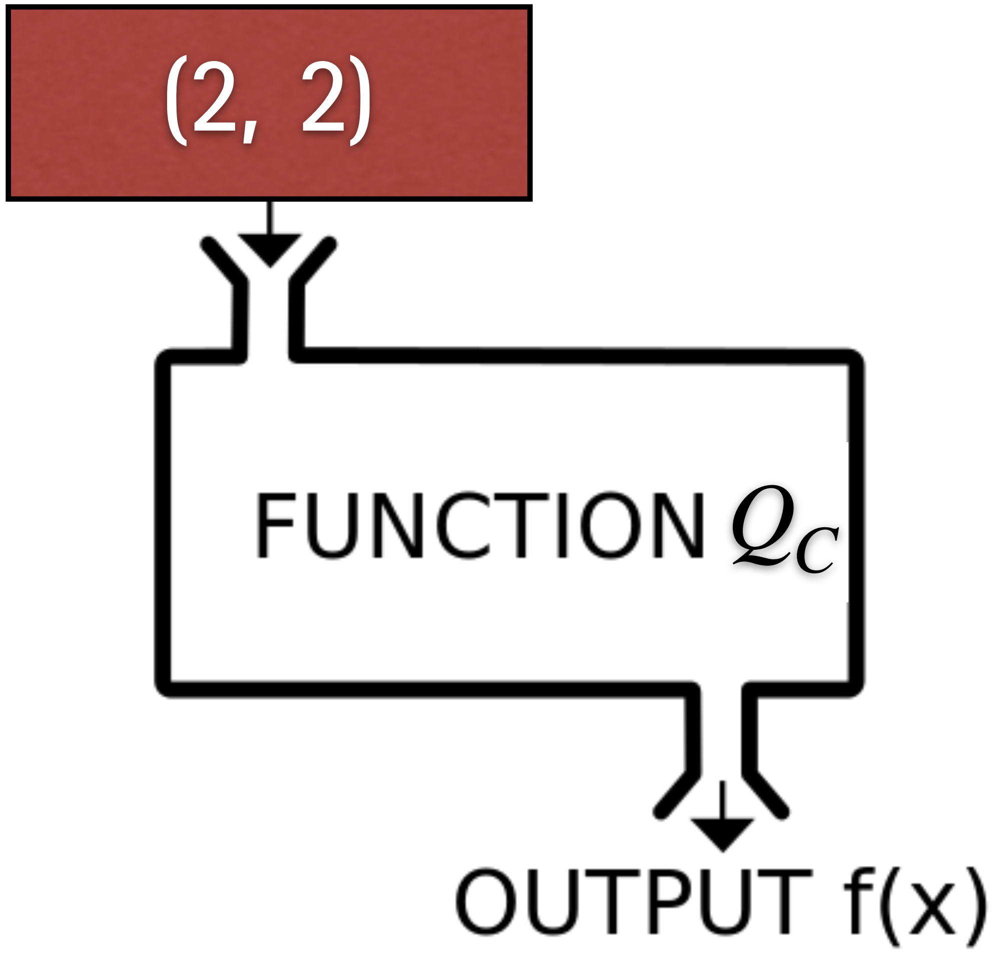

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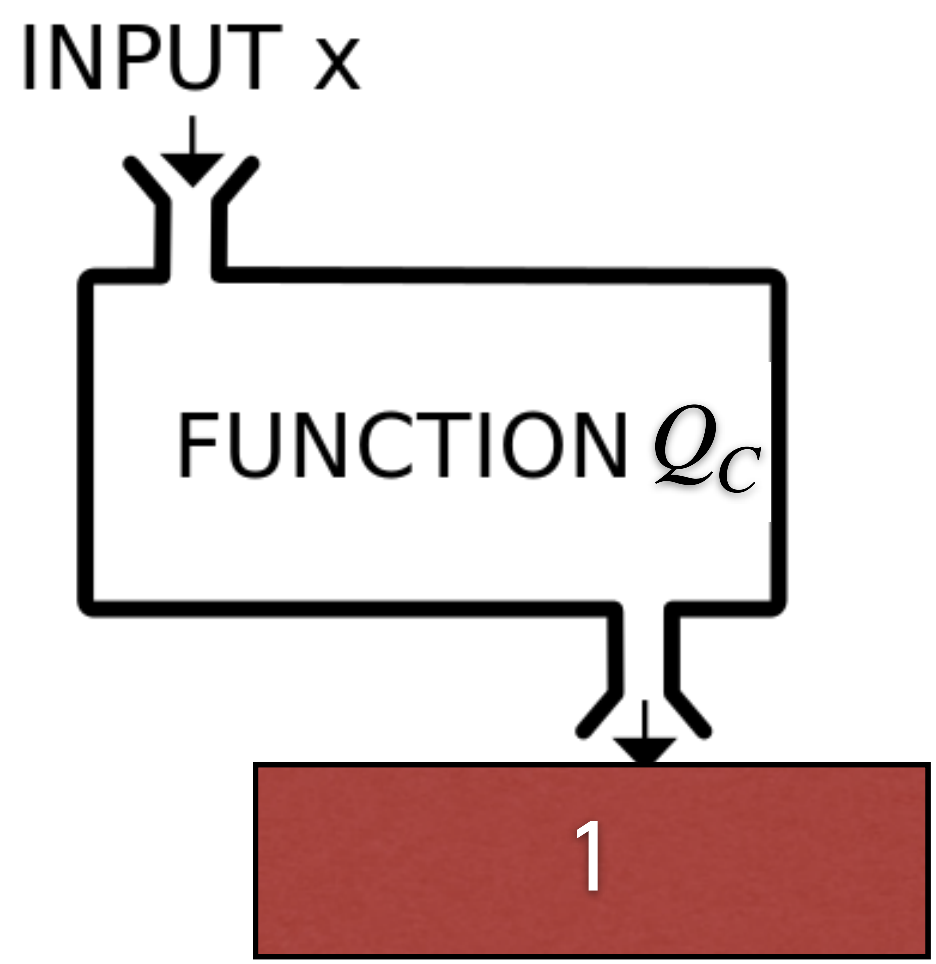

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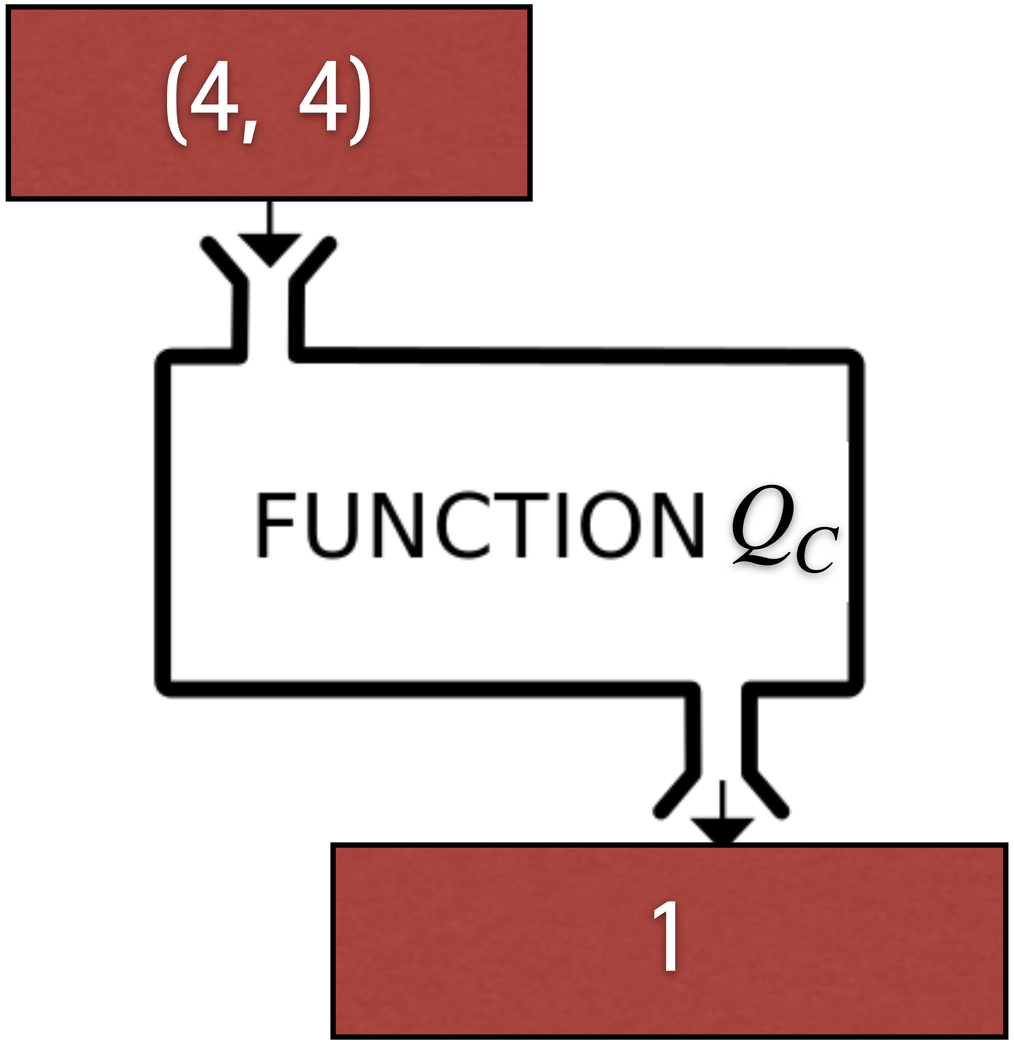

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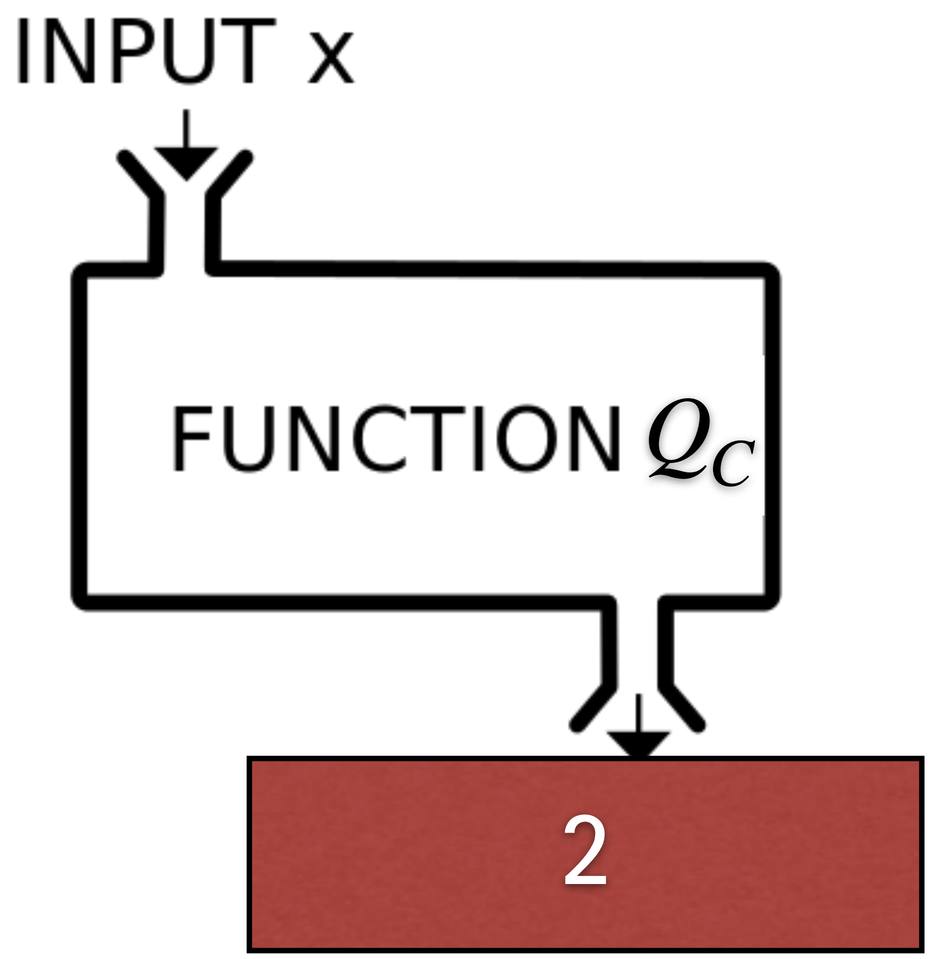

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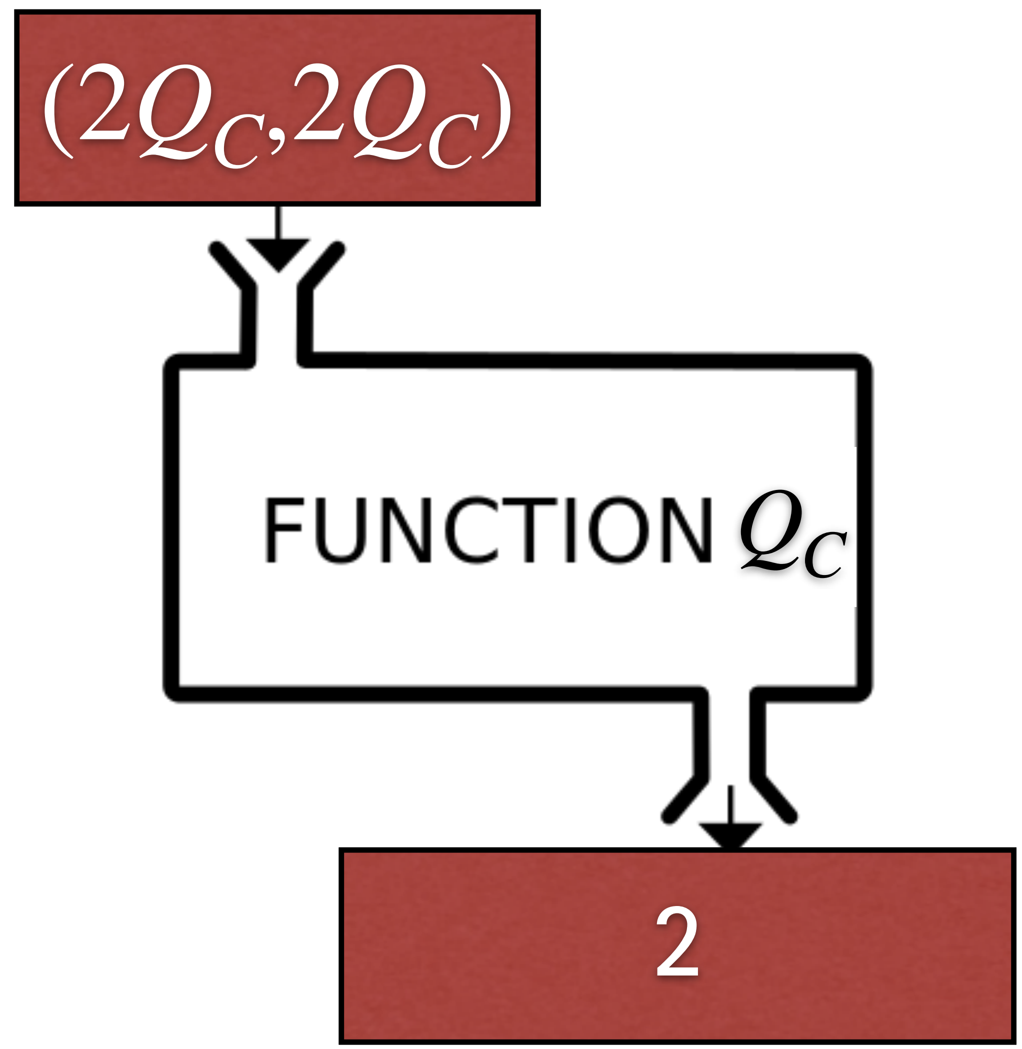

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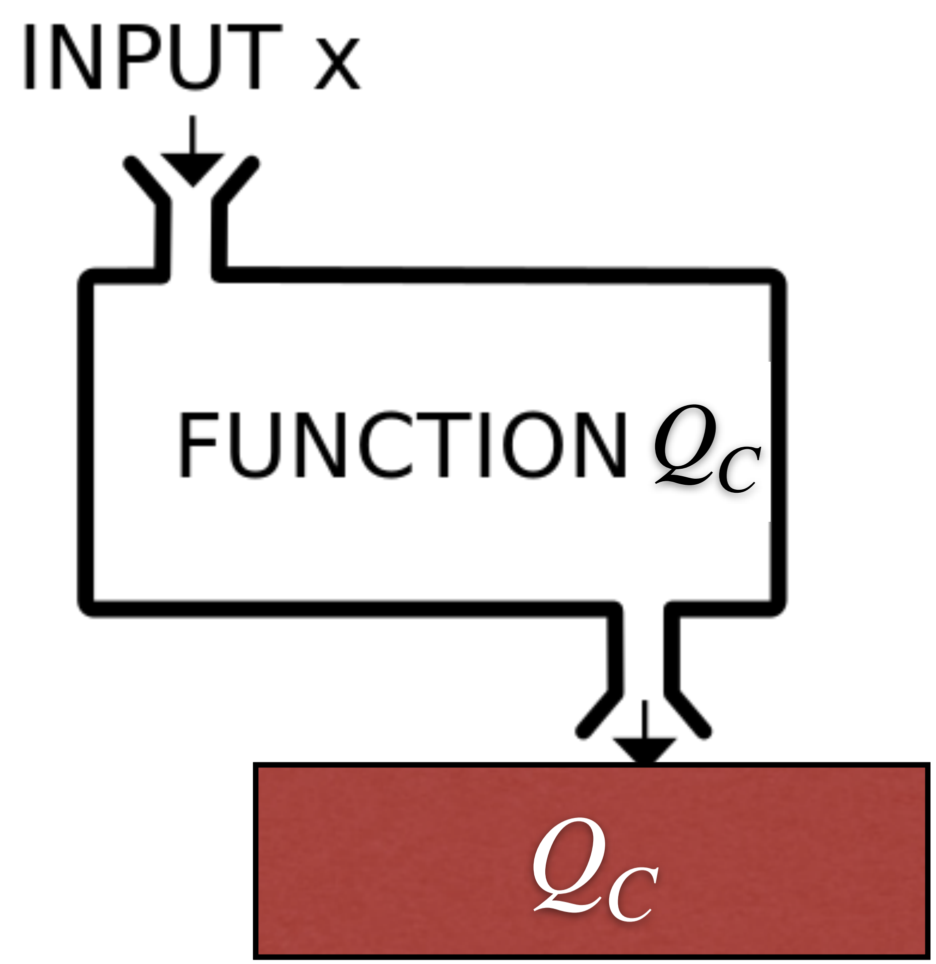

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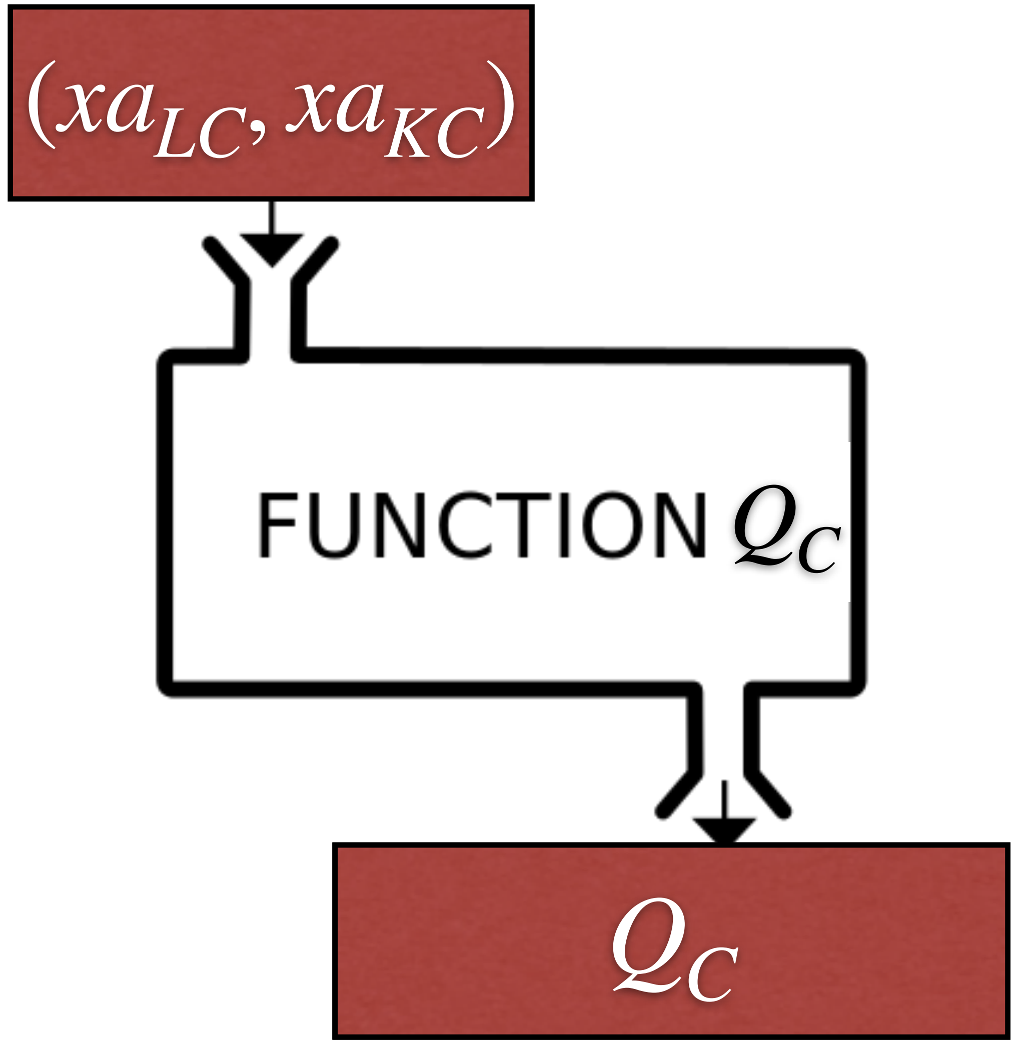

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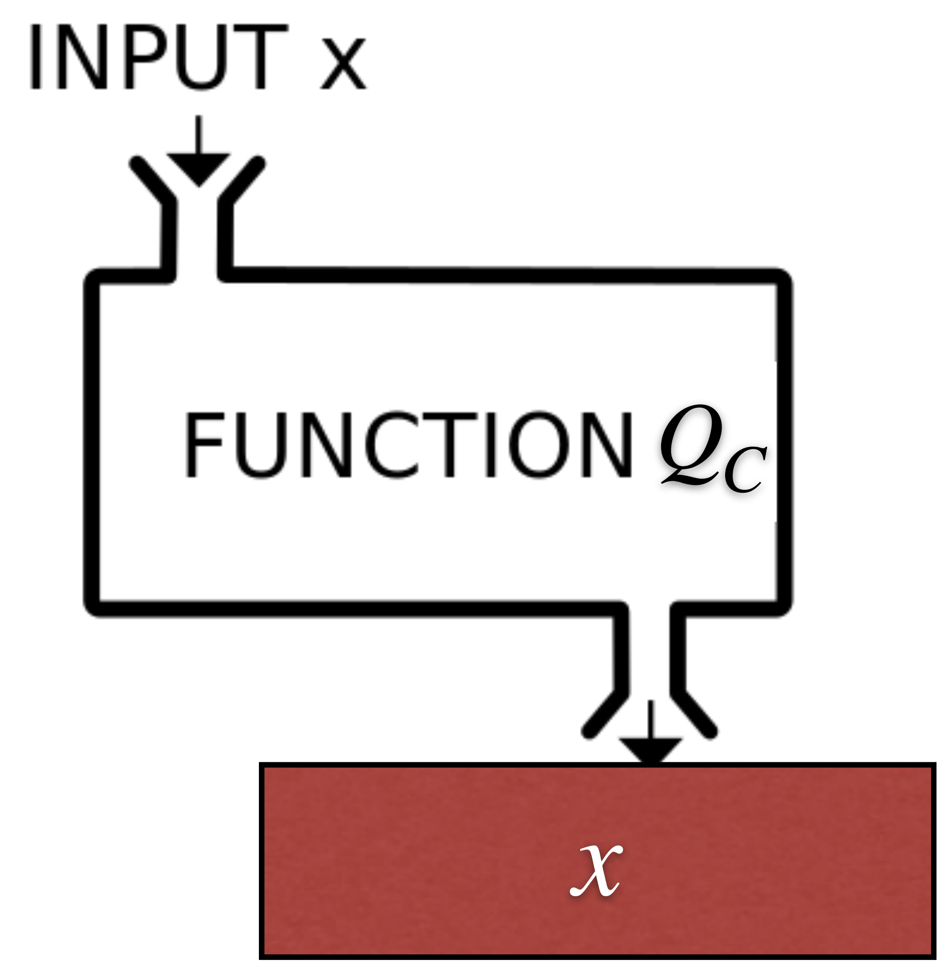

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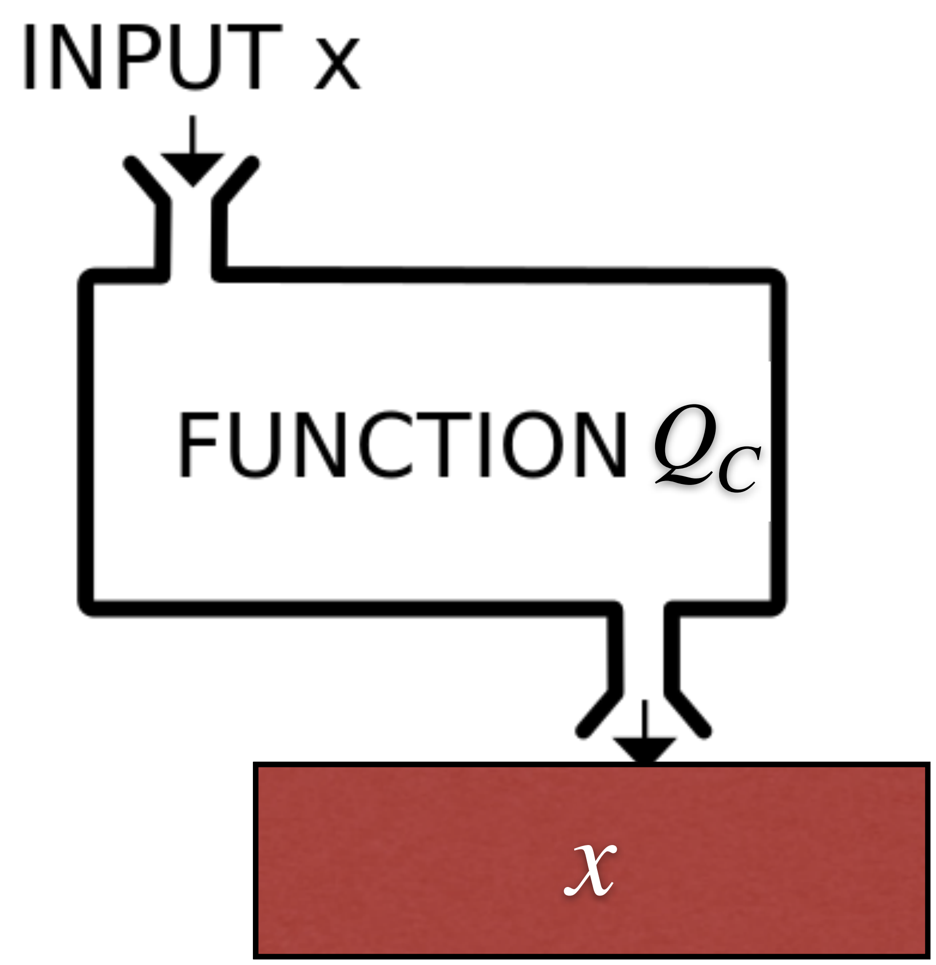

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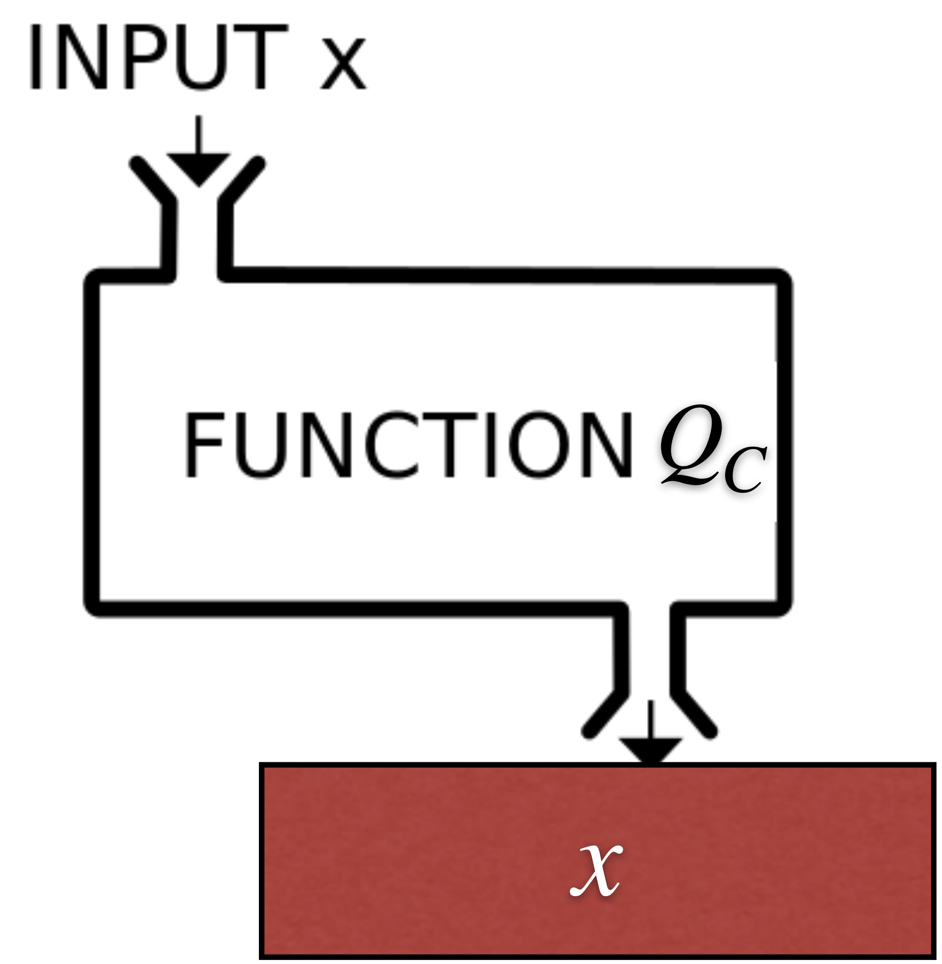

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PPF without Factor Substitution

- Labor constraint
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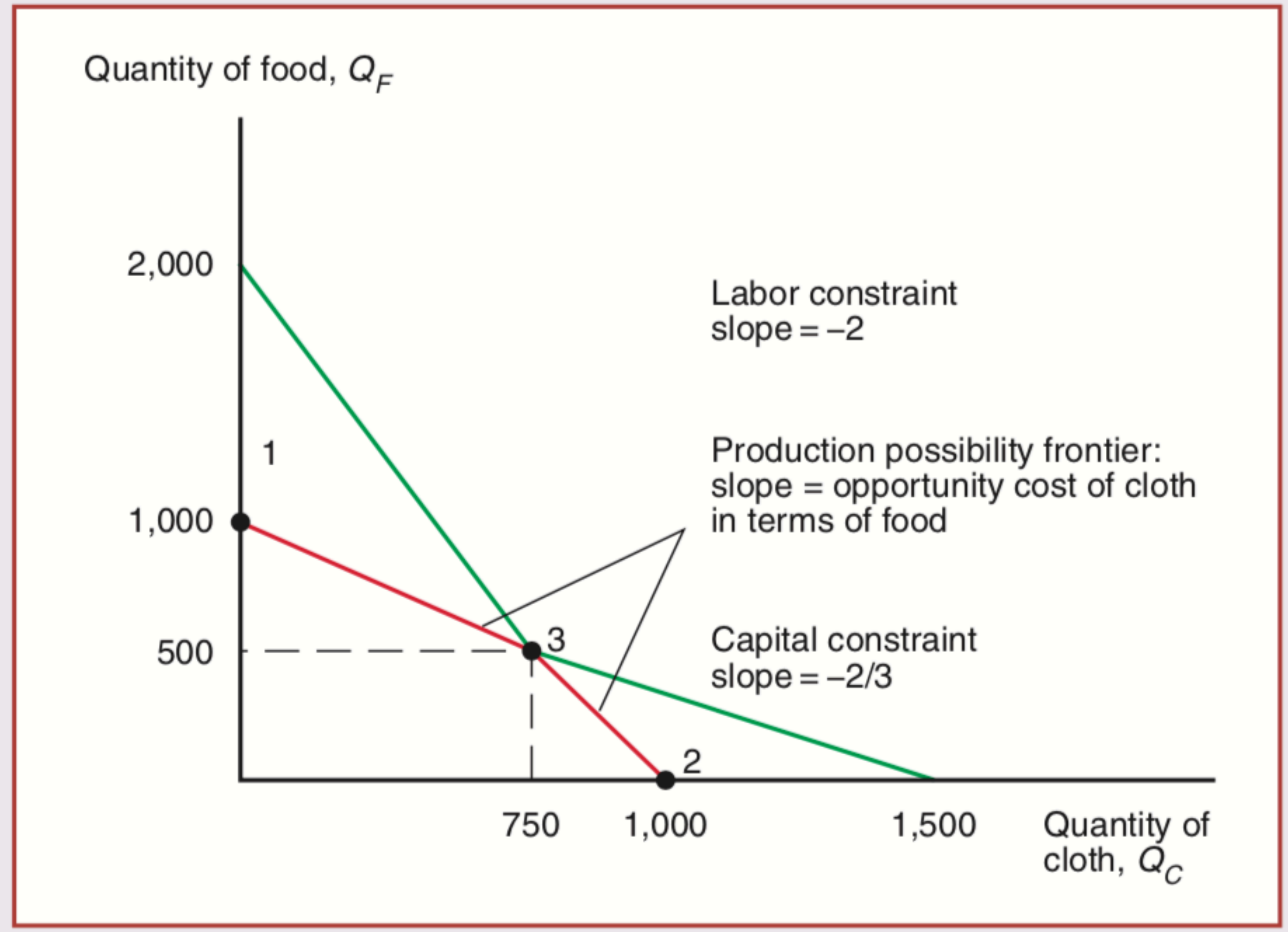

FIGURE 5-1

The Production Possibility Frontier without Factor Substitution: Numerical Example

Opportunity cost of cloth: 2/3 ⇒ 2

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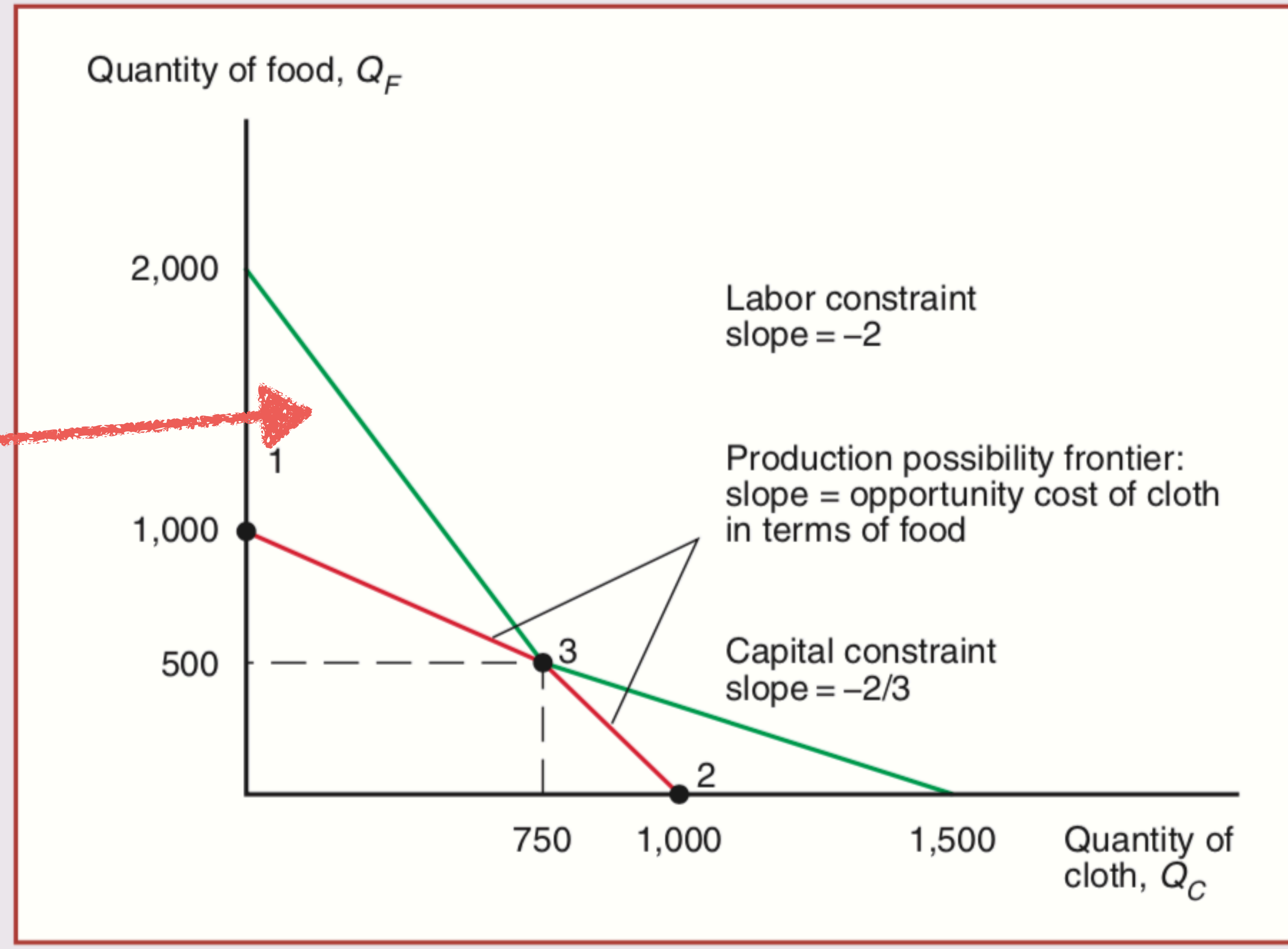

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The Production Possibility Frontier without Factor Substitution: Numerical Example

Opportunity cost of cloth: $2/3 \Rightarrow 2$

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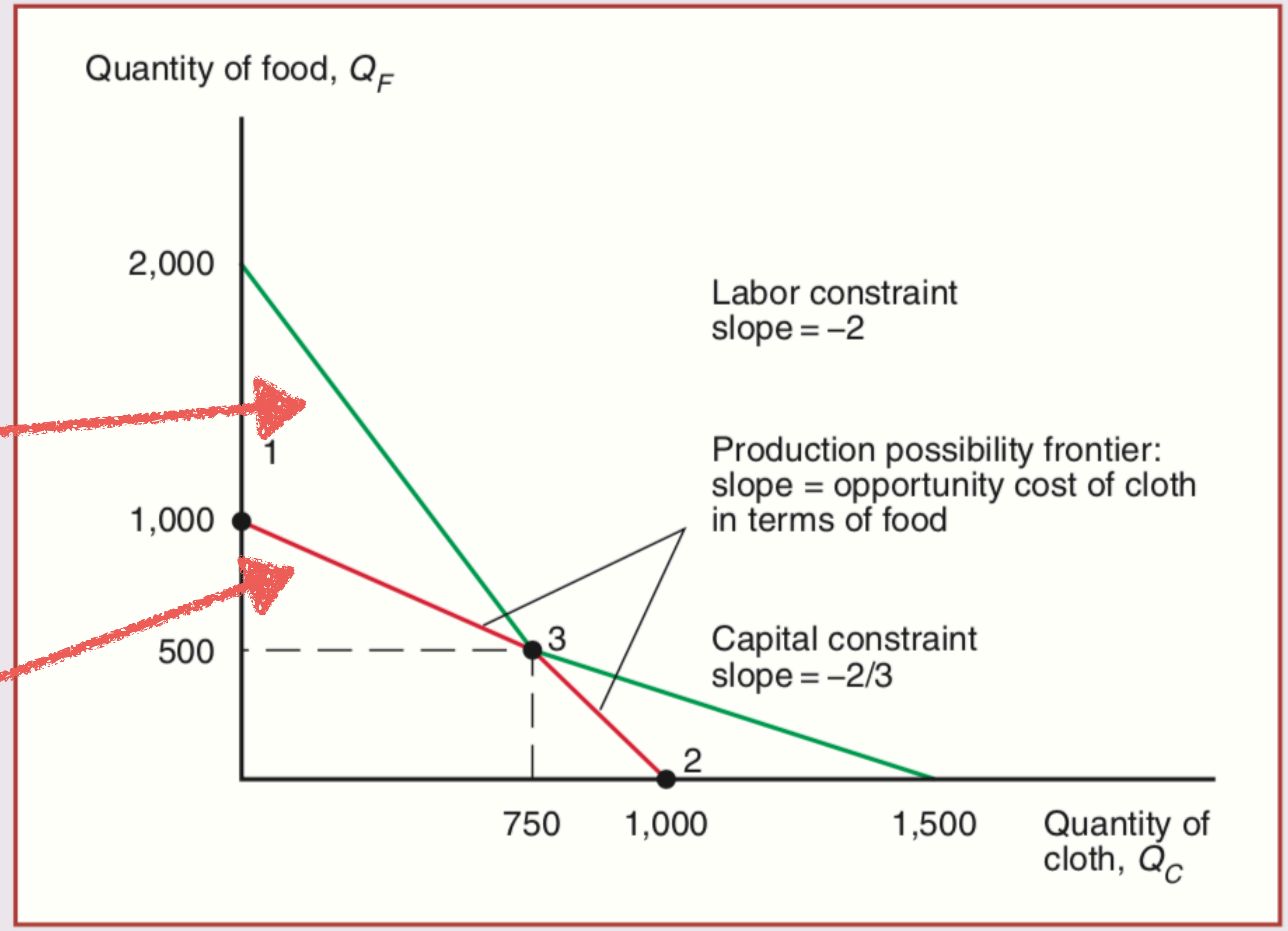

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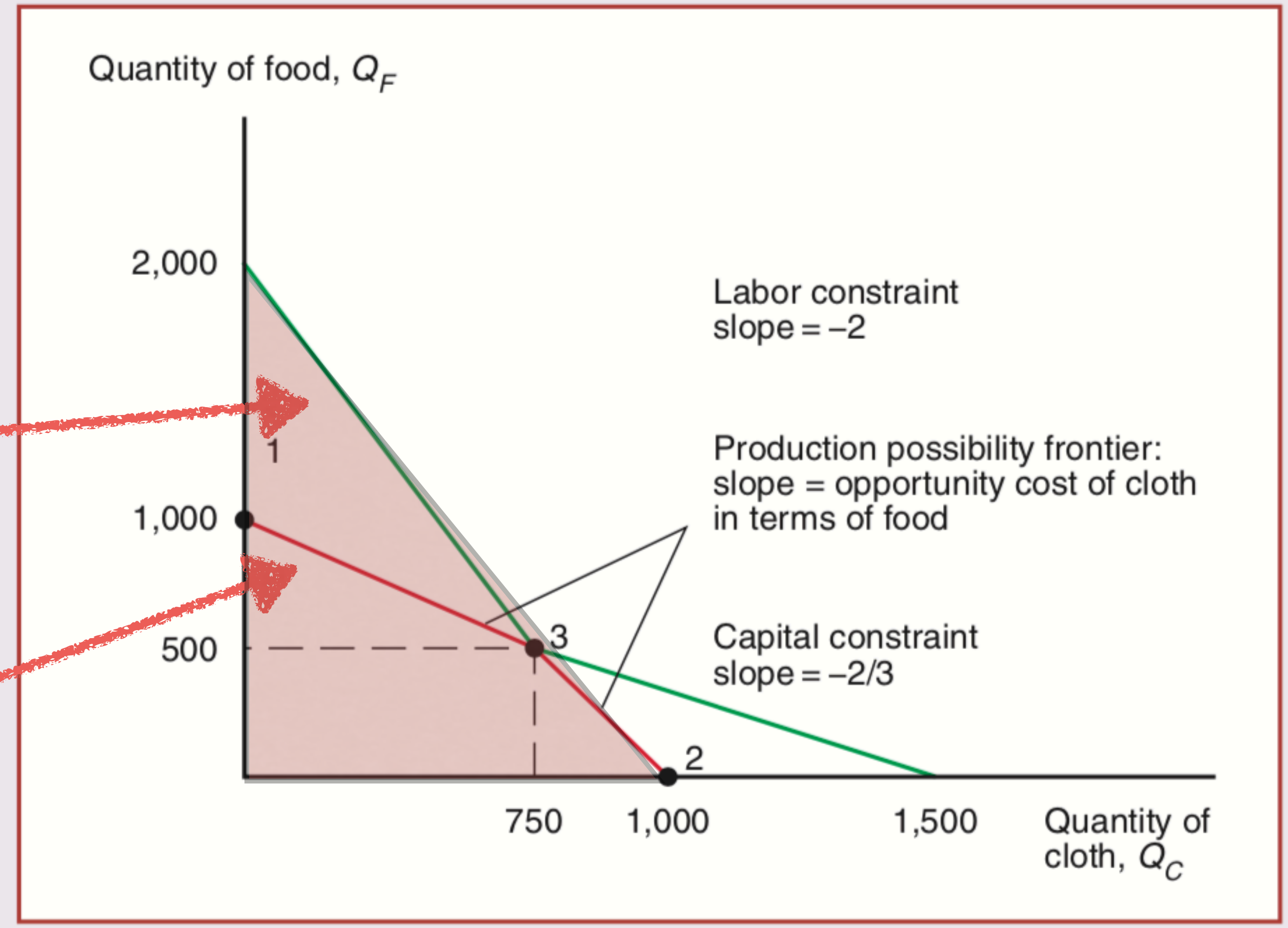

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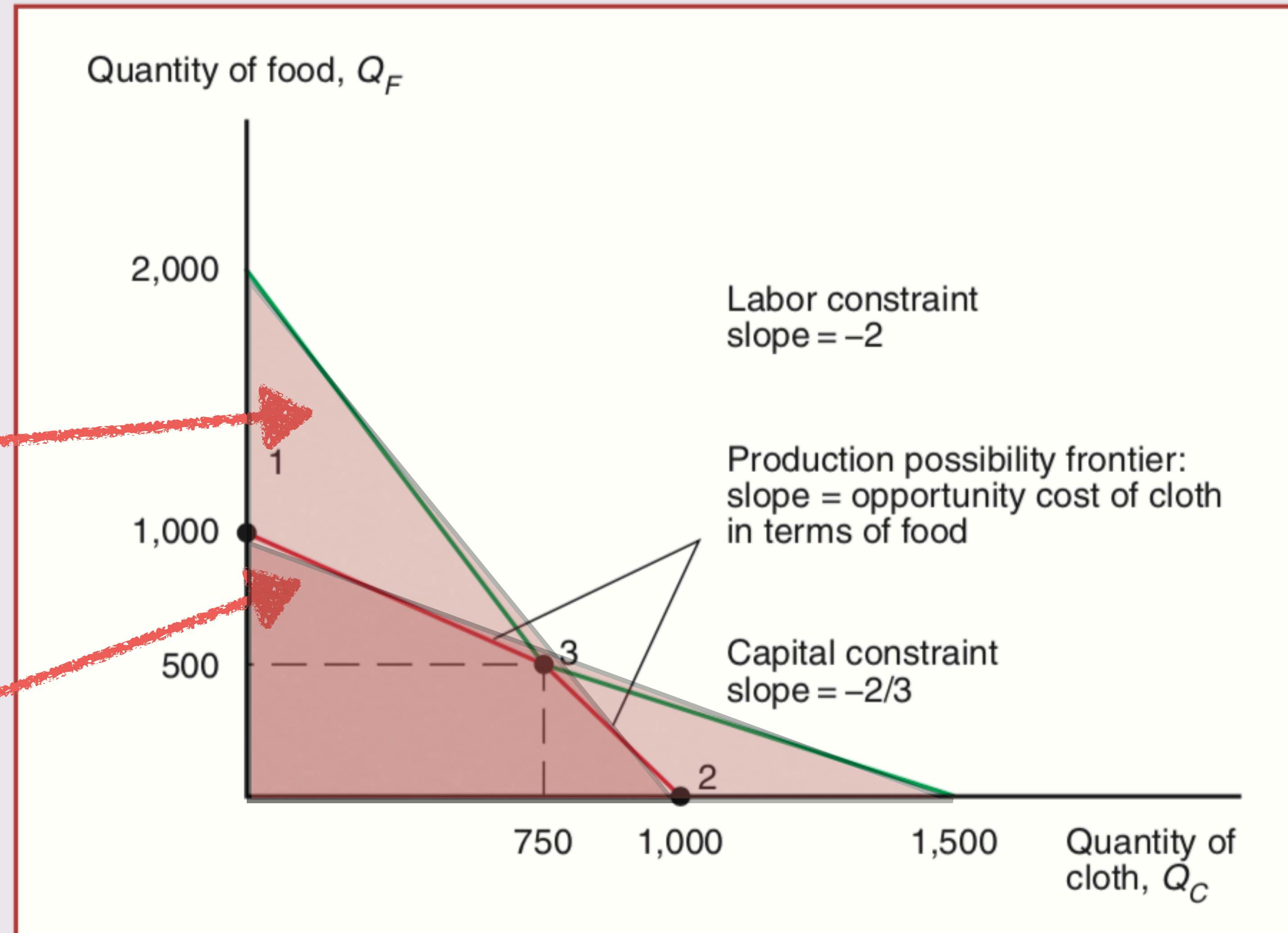

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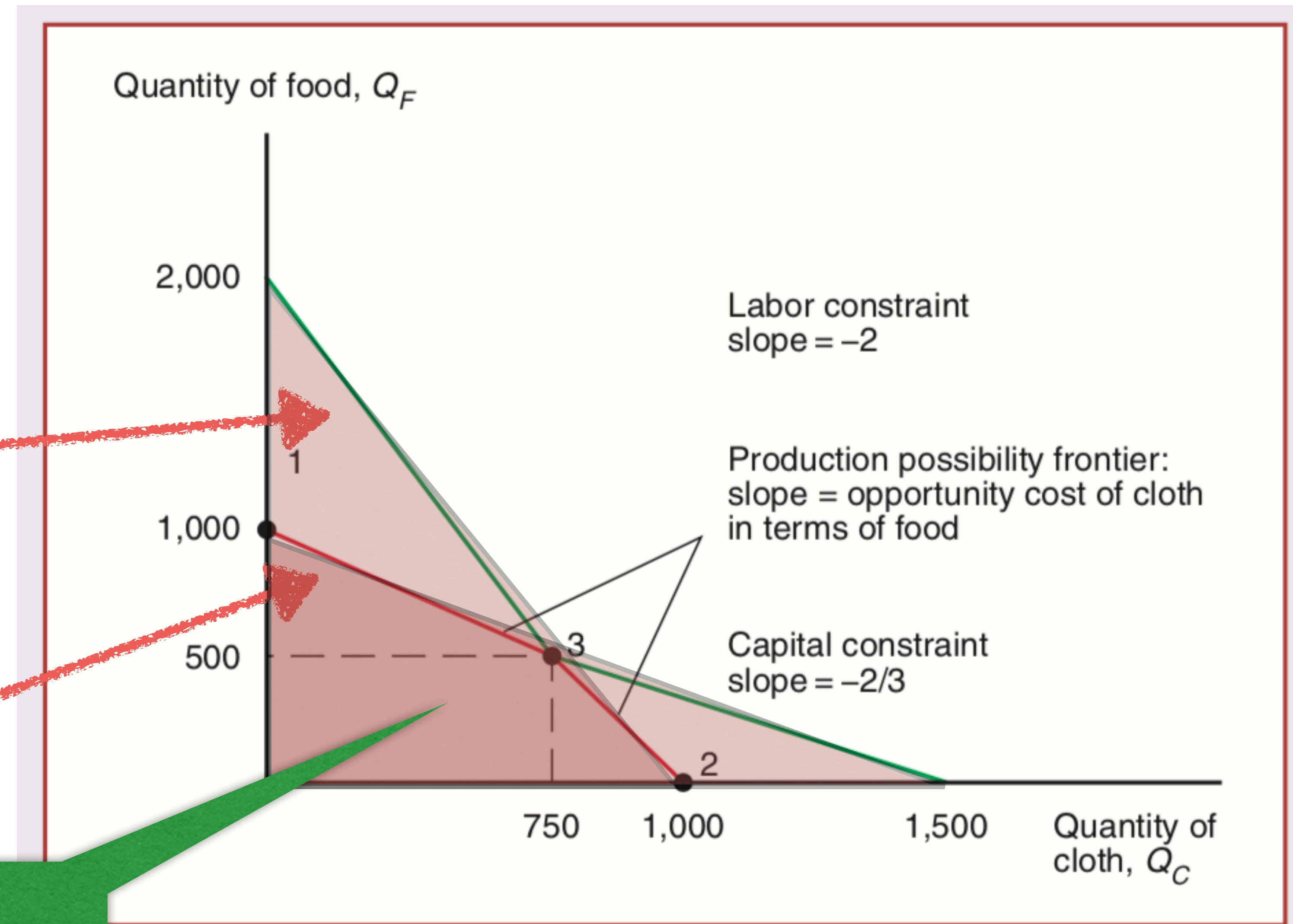

Possible Combination

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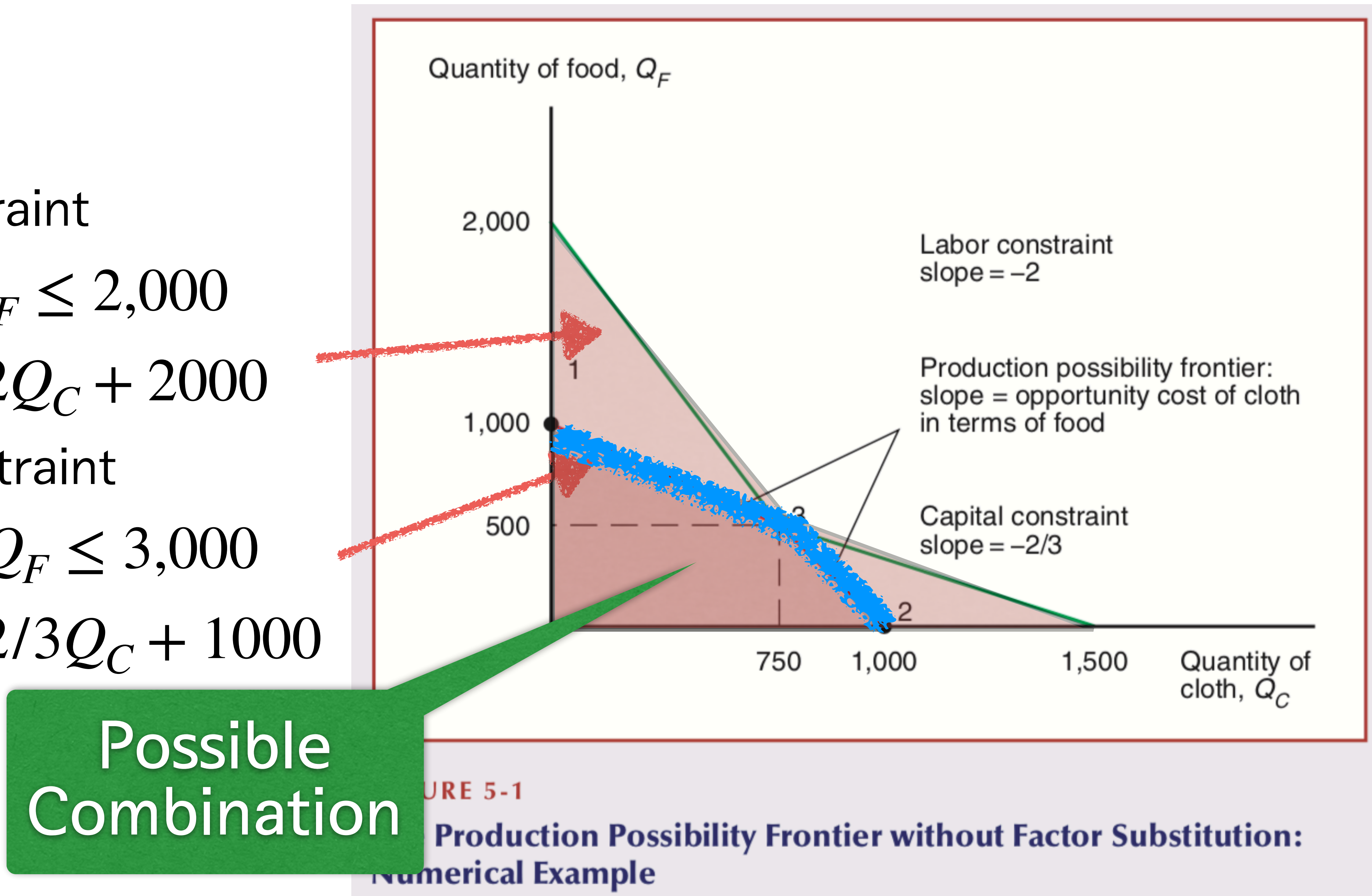

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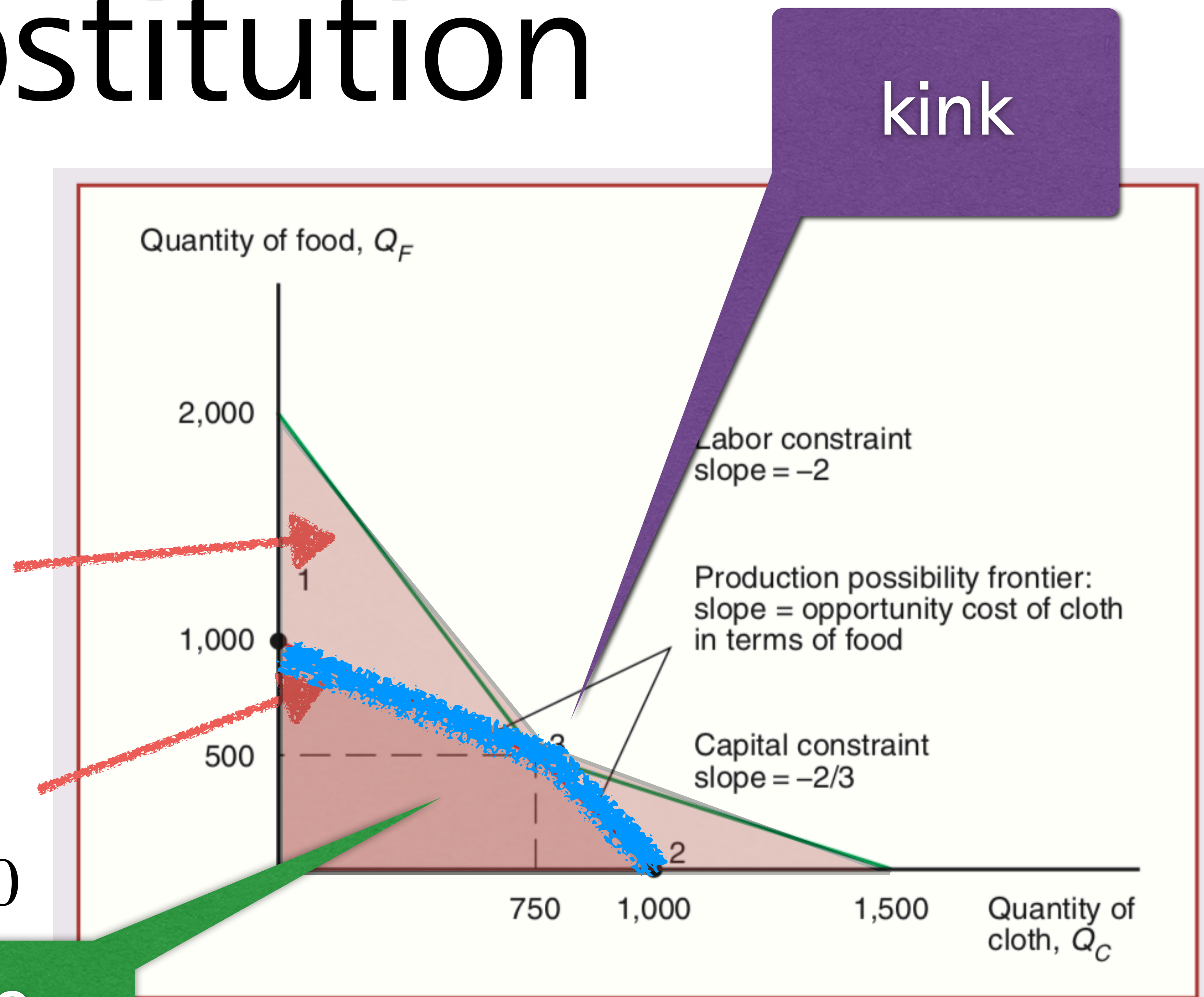

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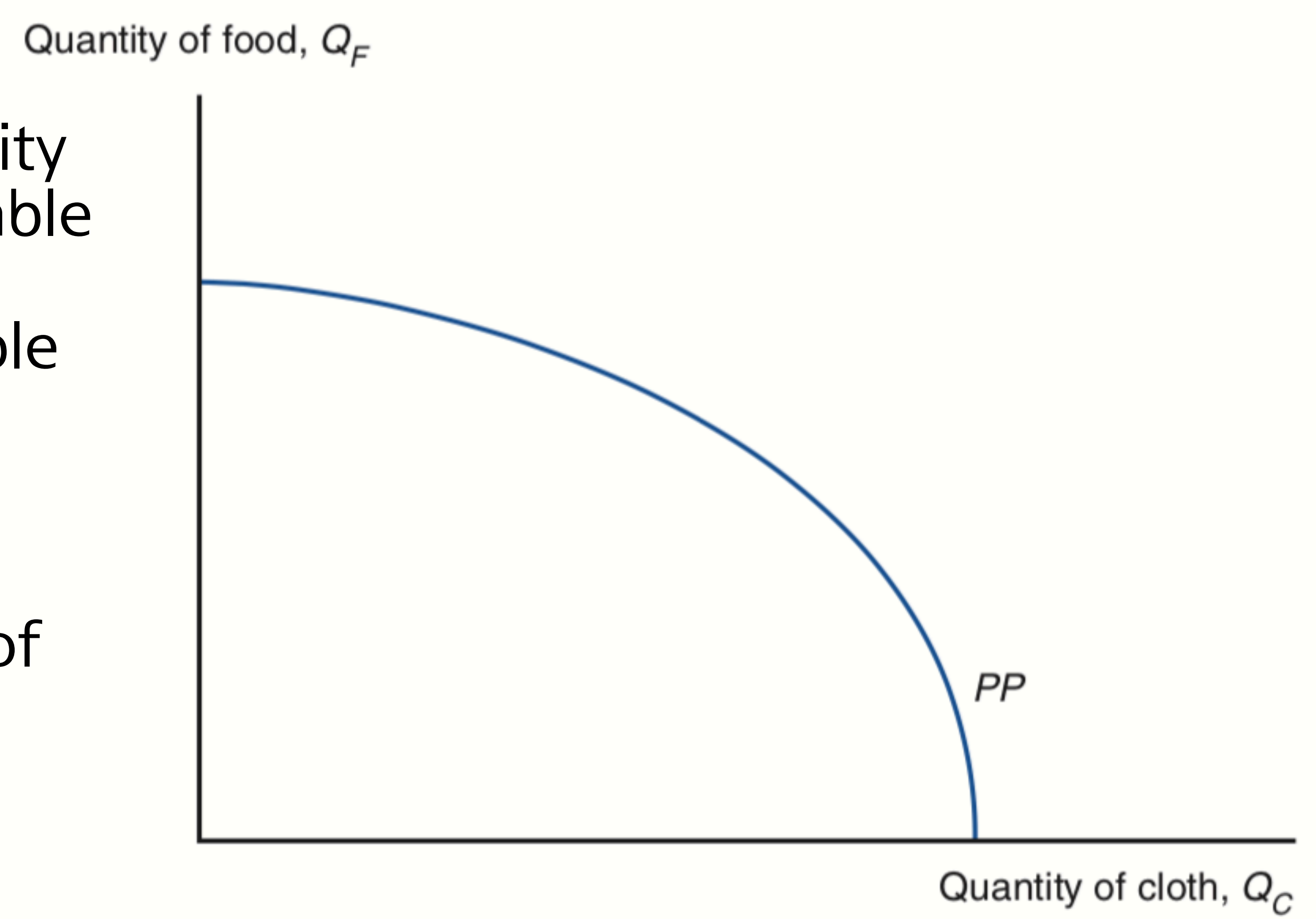
Production Possibility Frontier without Factor Substitution: Numerical Example

Opportunity cost of cloth: 2/3 ⇒ 2

PPF with Factor Substitution

- More realistic case
- Slope means opportunity cost of horizontal variable (in this case, cloth) in terms of vertical variable (in this case, food)
- The most valuable production bundle depends on the value of each product:
  - $V = P_C Q_C + P_F Q_F$



Opportunity cost of cloth: increasing

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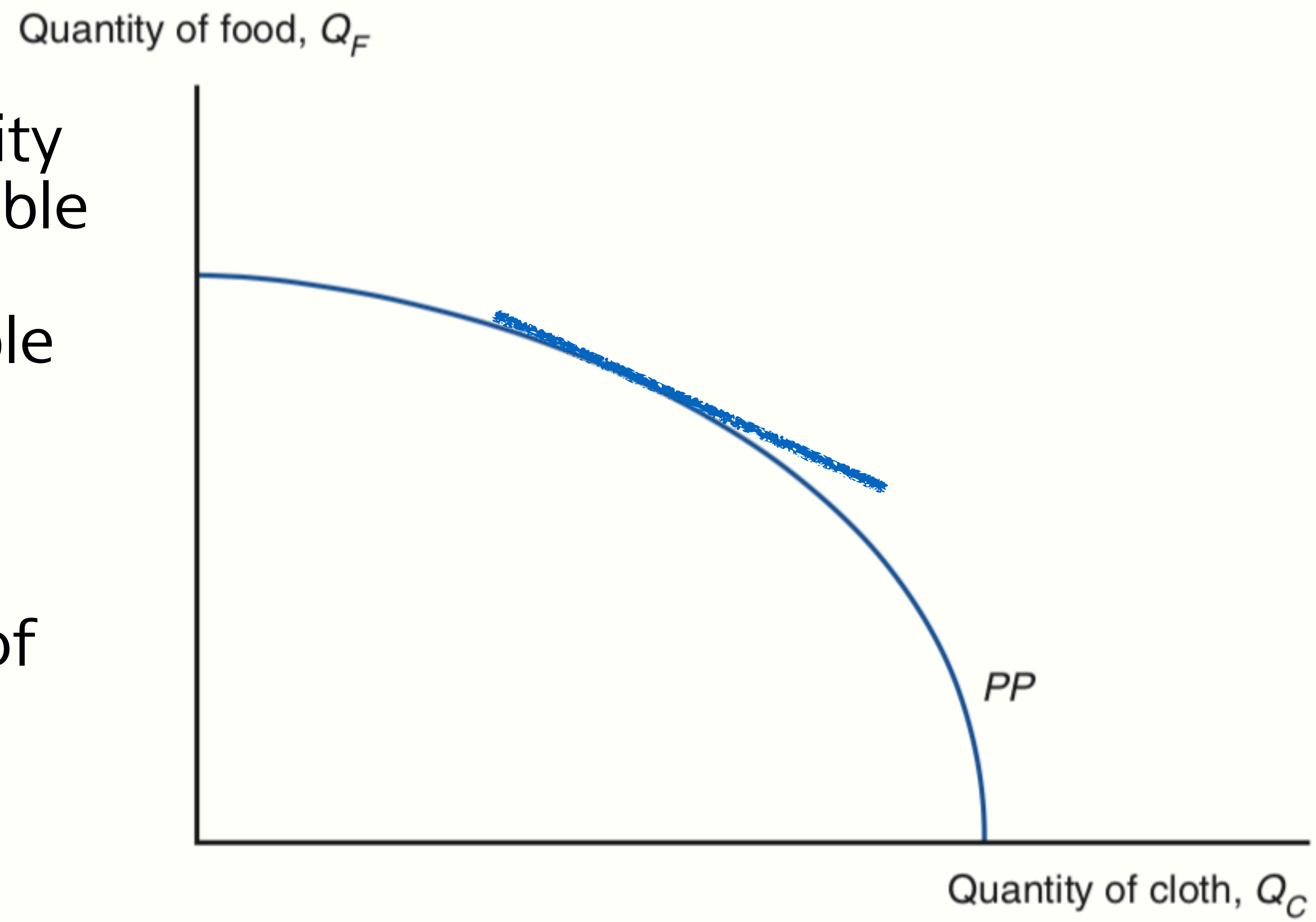

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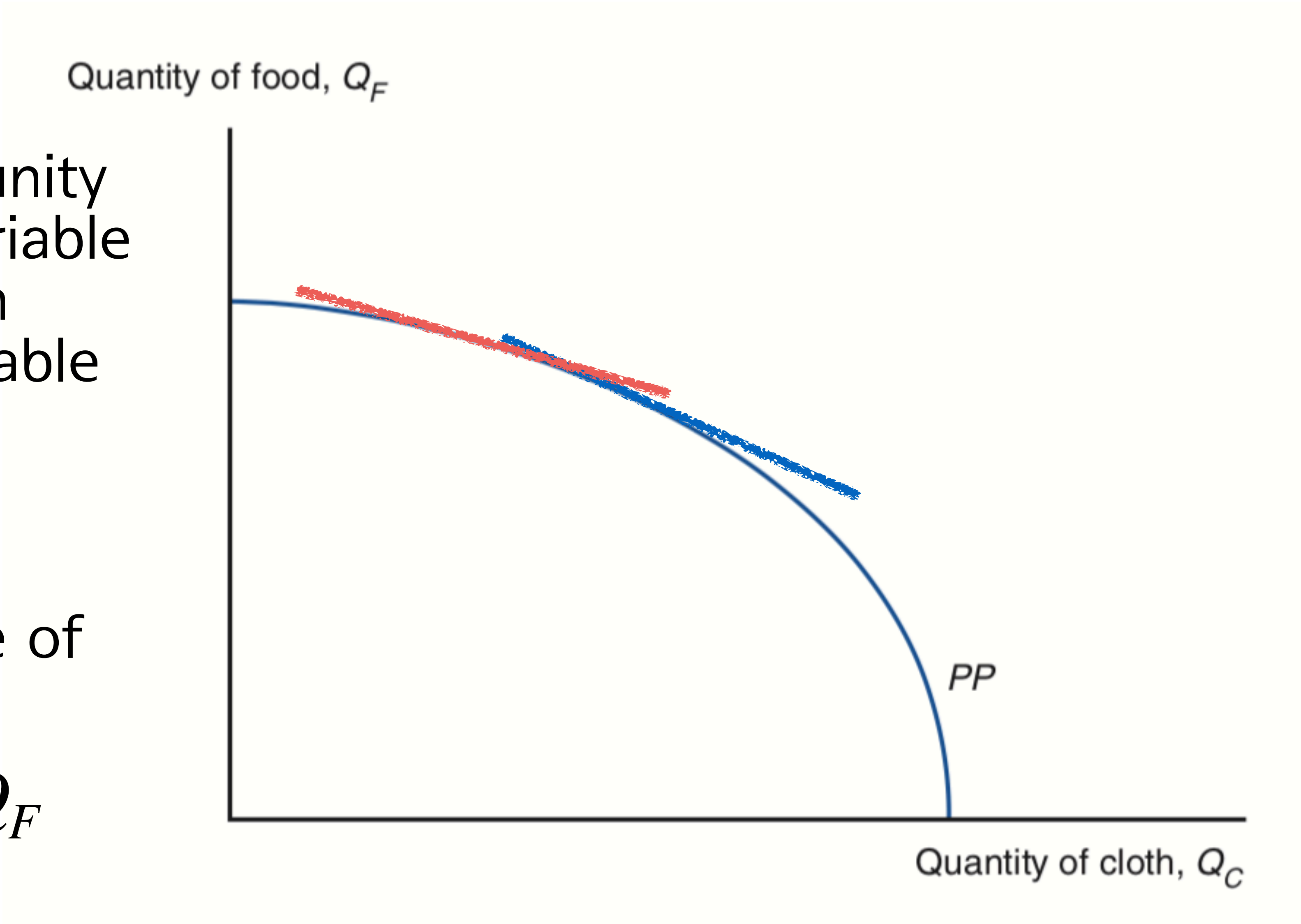

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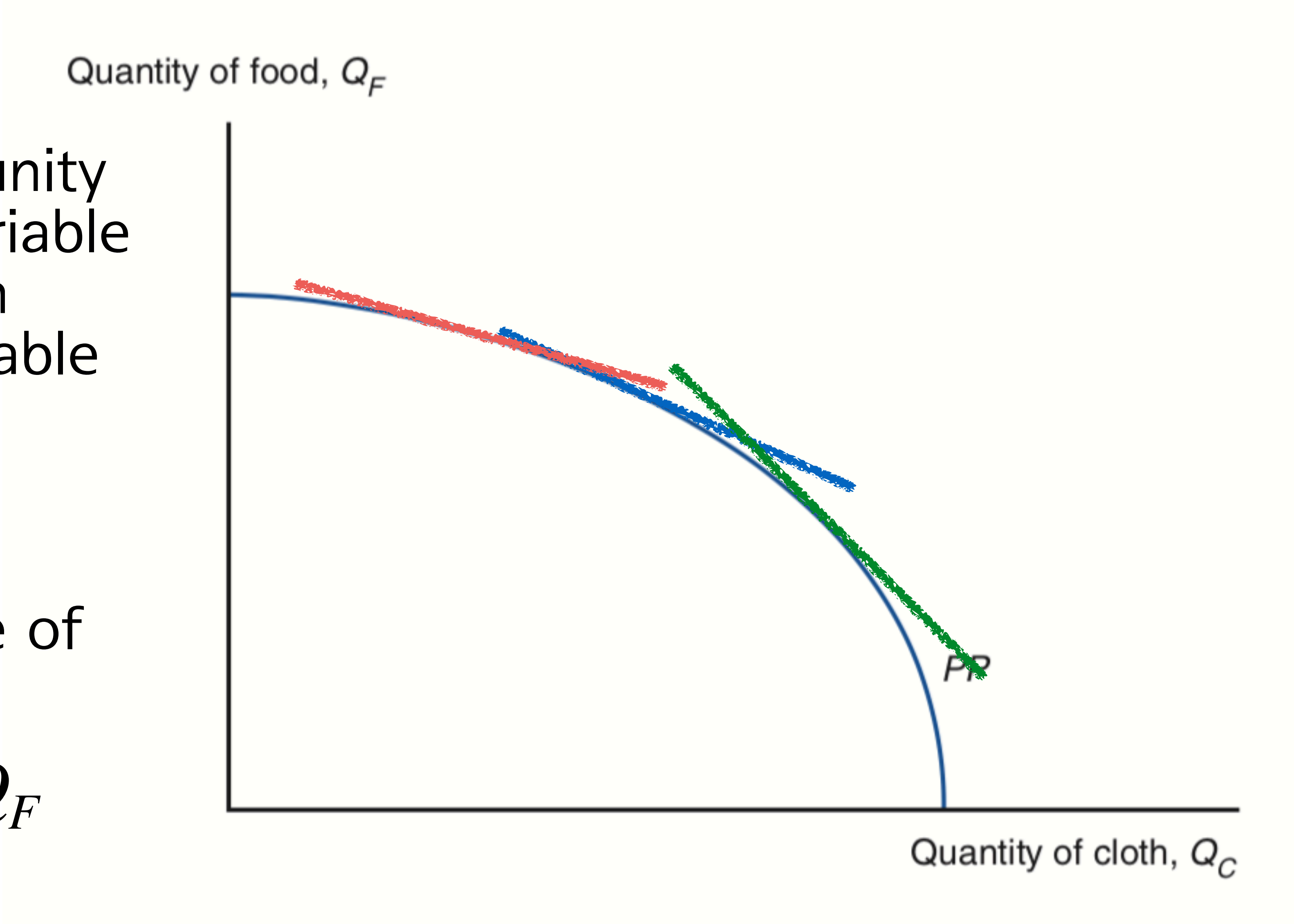
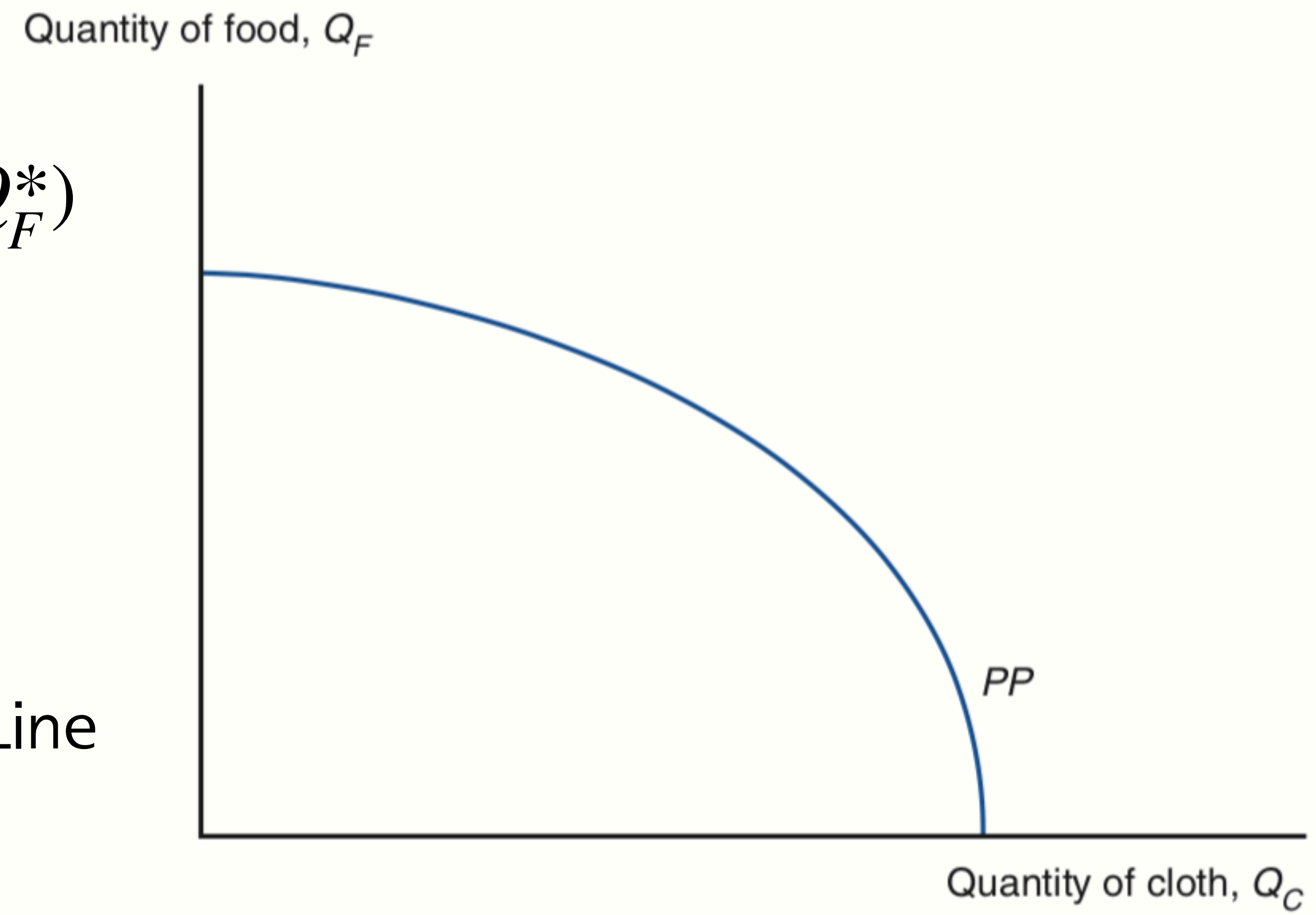


Opportunity cost of cloth: increasing

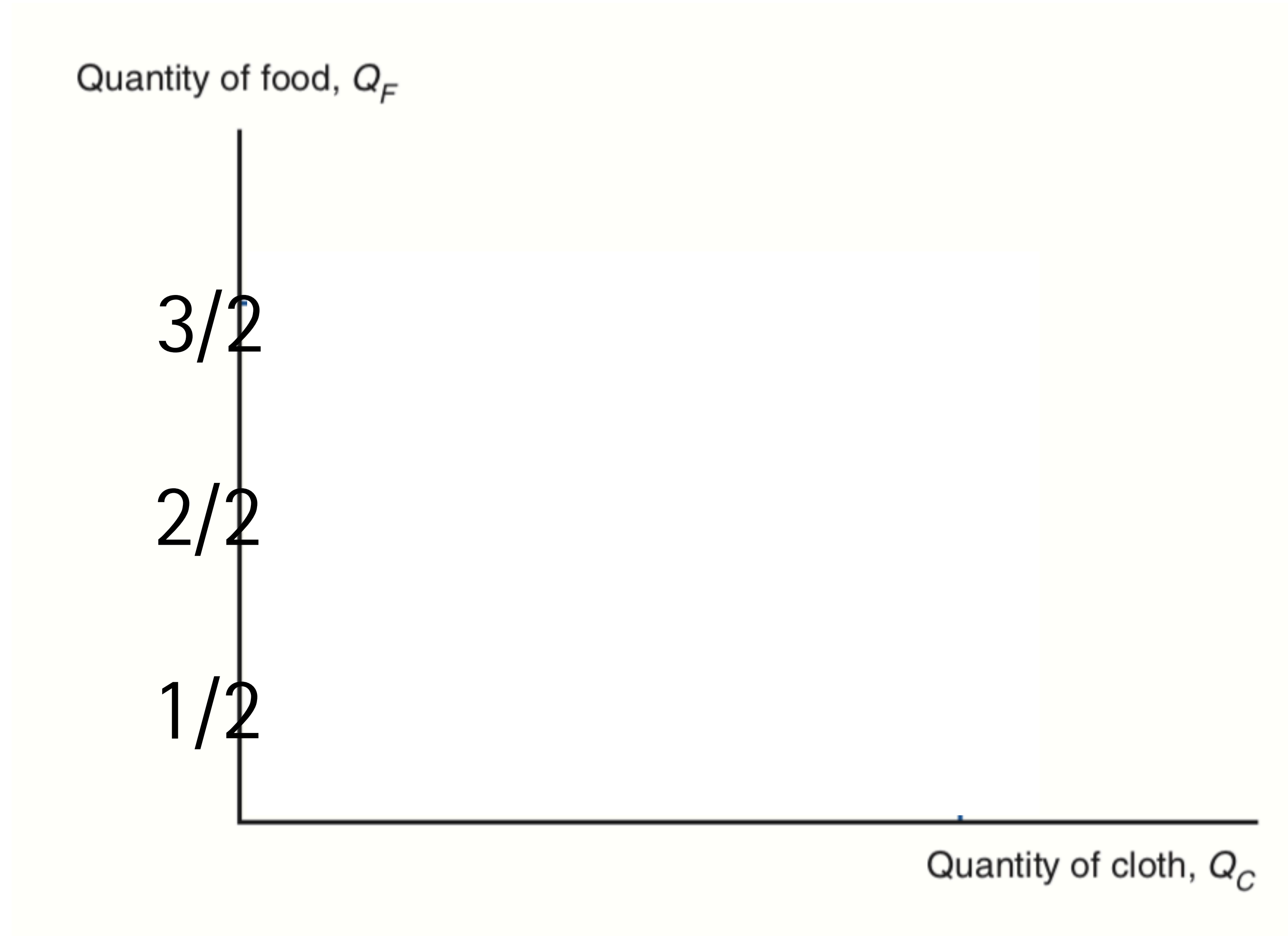
PPF with Factor Substitution

- $V = \bar{P}_C Q_C + \bar{P}_F Q_F$
- We should find (Q_C^*, Q_F^*) which maximize value given $(\bar{P}_C, \bar{P}_F)$
- To find (Q_C^*, Q_F^*), we should isovalue line (curve)
- isovalue line (curve): Line of same value



Isovalue Line

- $V = \bar{P}_C Q_C + \bar{P}_F Q_F$
- for given V,
    - $Q_F = -\dfrac{\bar{P}_C}{\bar{P}_F} Q_C + \dfrac{\bar{V}}{\bar{P}_F}$
    - Line with slope $-P_C/P_F$ and vertical intercept $\bar{V}$
- Example
    - $P_C = 1, P_F = 2,$



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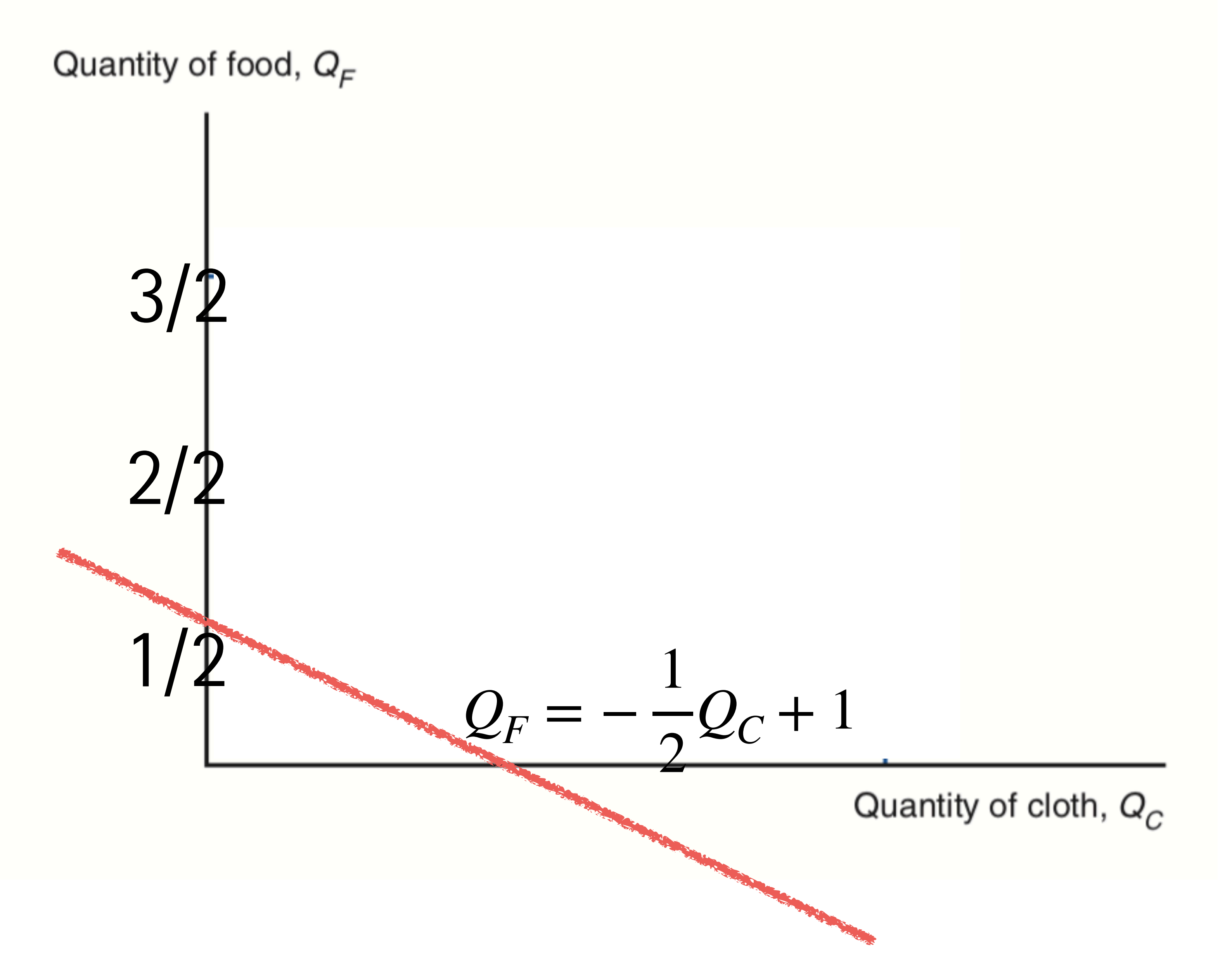

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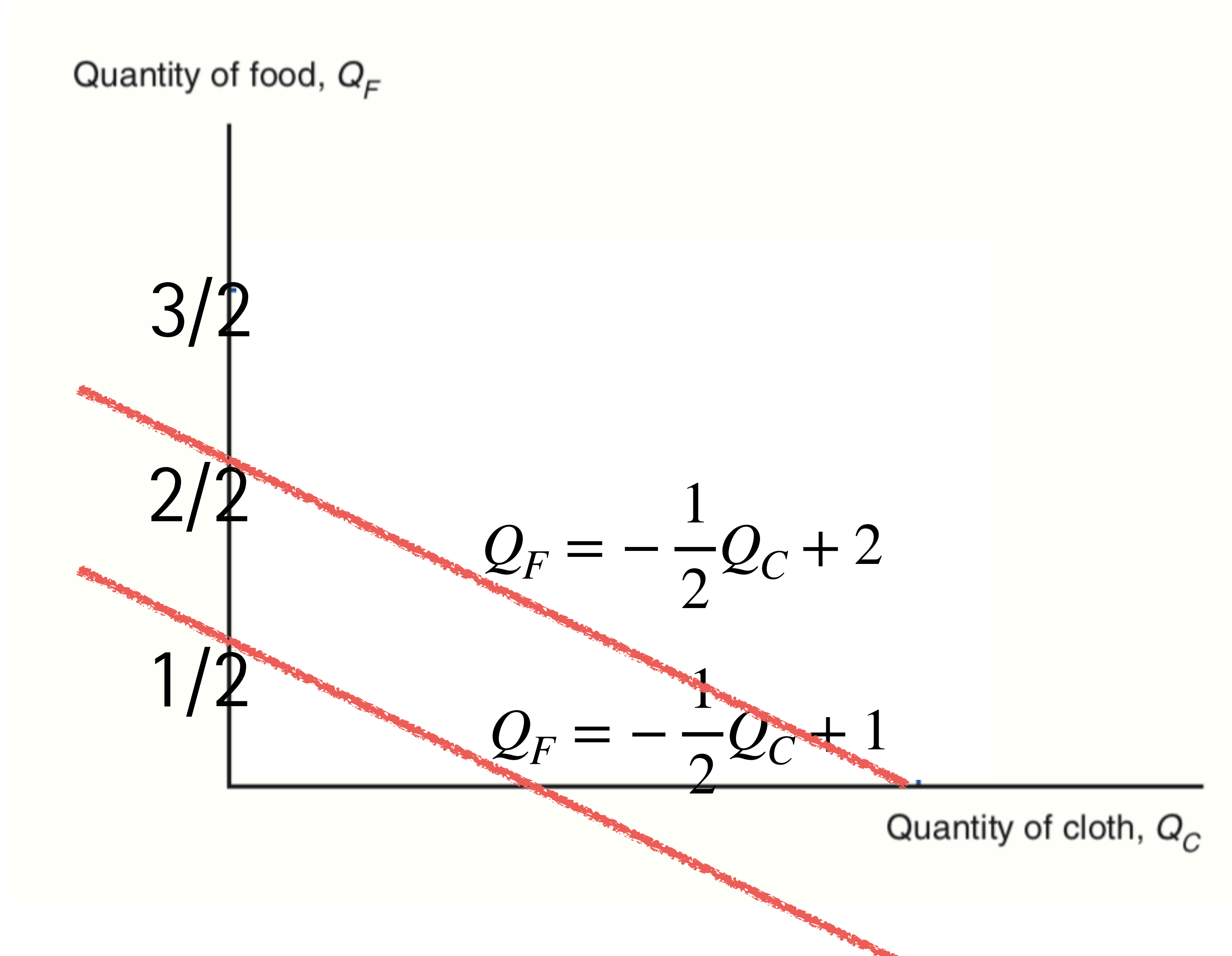

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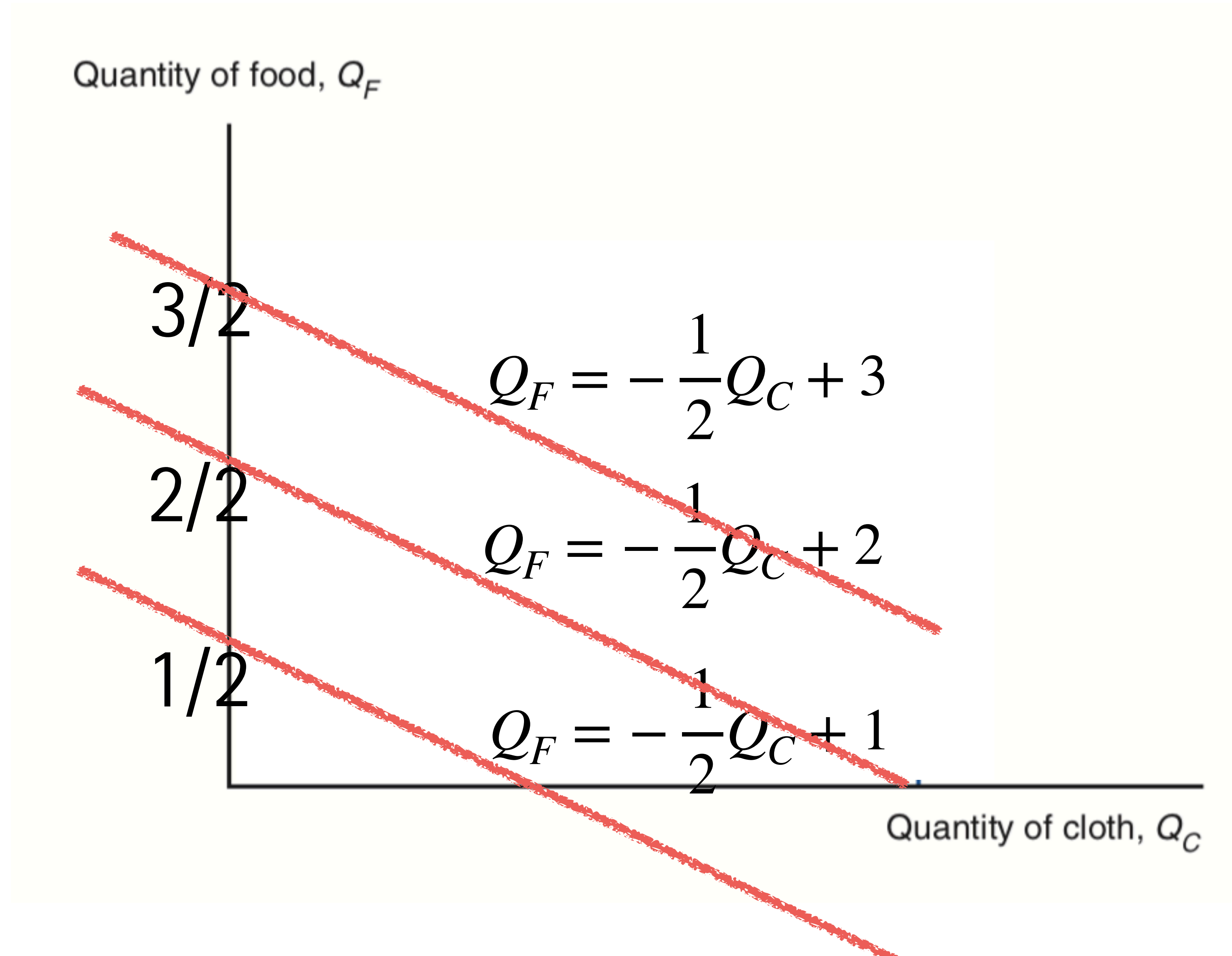

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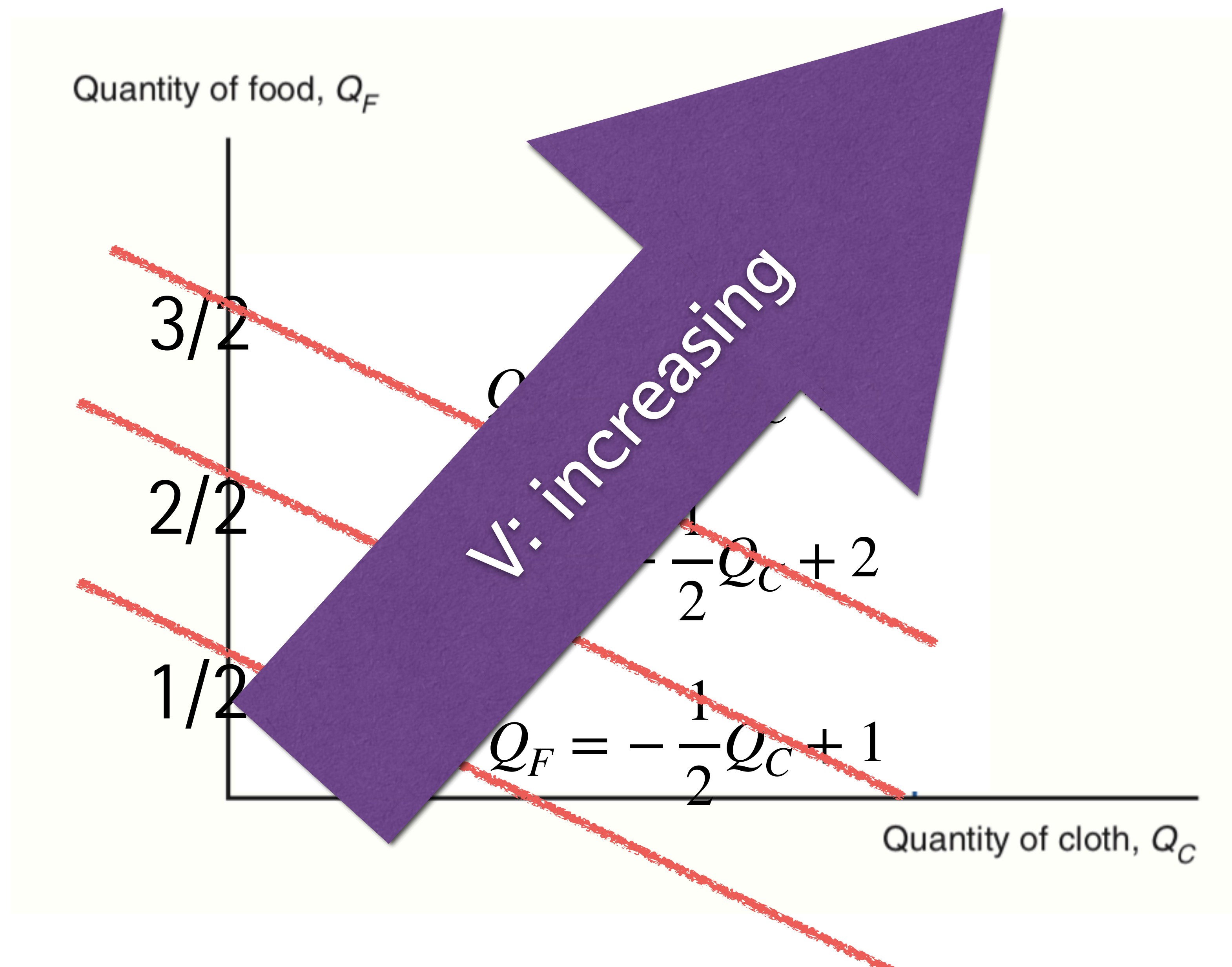
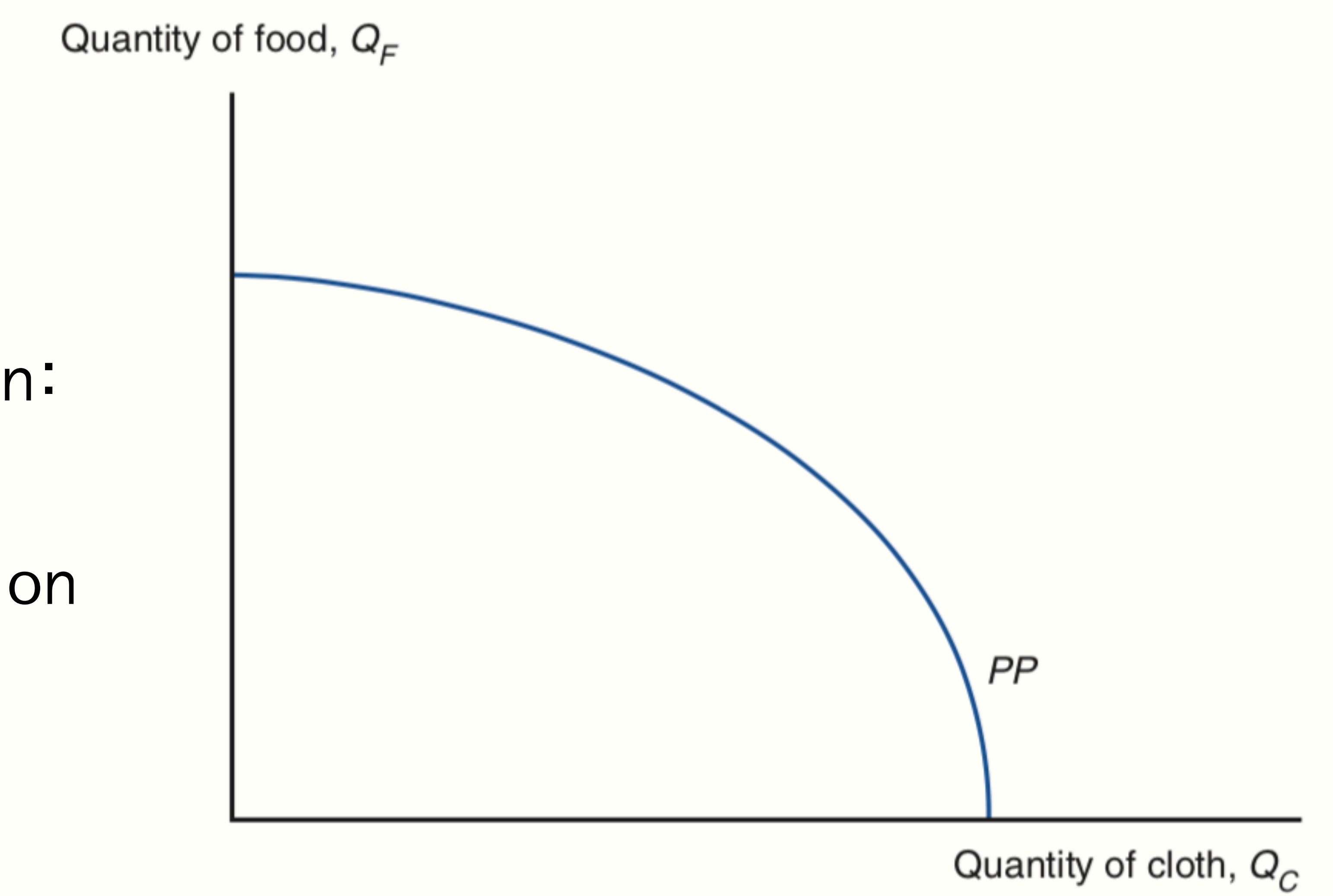
- $V = \bar{P}_C Q_C + \bar{P}_F Q_F$
- for given V,
  - $Q_F = -\dfrac{\bar{P}_C}{\bar{P}_F} Q_C + \dfrac{\bar{V}}{\bar{P}_F}$
  - Line with slope $-P_C/P_F$ and vertical intercept $\bar{V}$
- Example
  - $P_C = 1, P_F = 2,$



Finding Production Maximizing Total Value

- Value:
  - A<B<C
- Available Production:
  - A, B
- (Q_C^*, Q_F^*) is always on the tangent point



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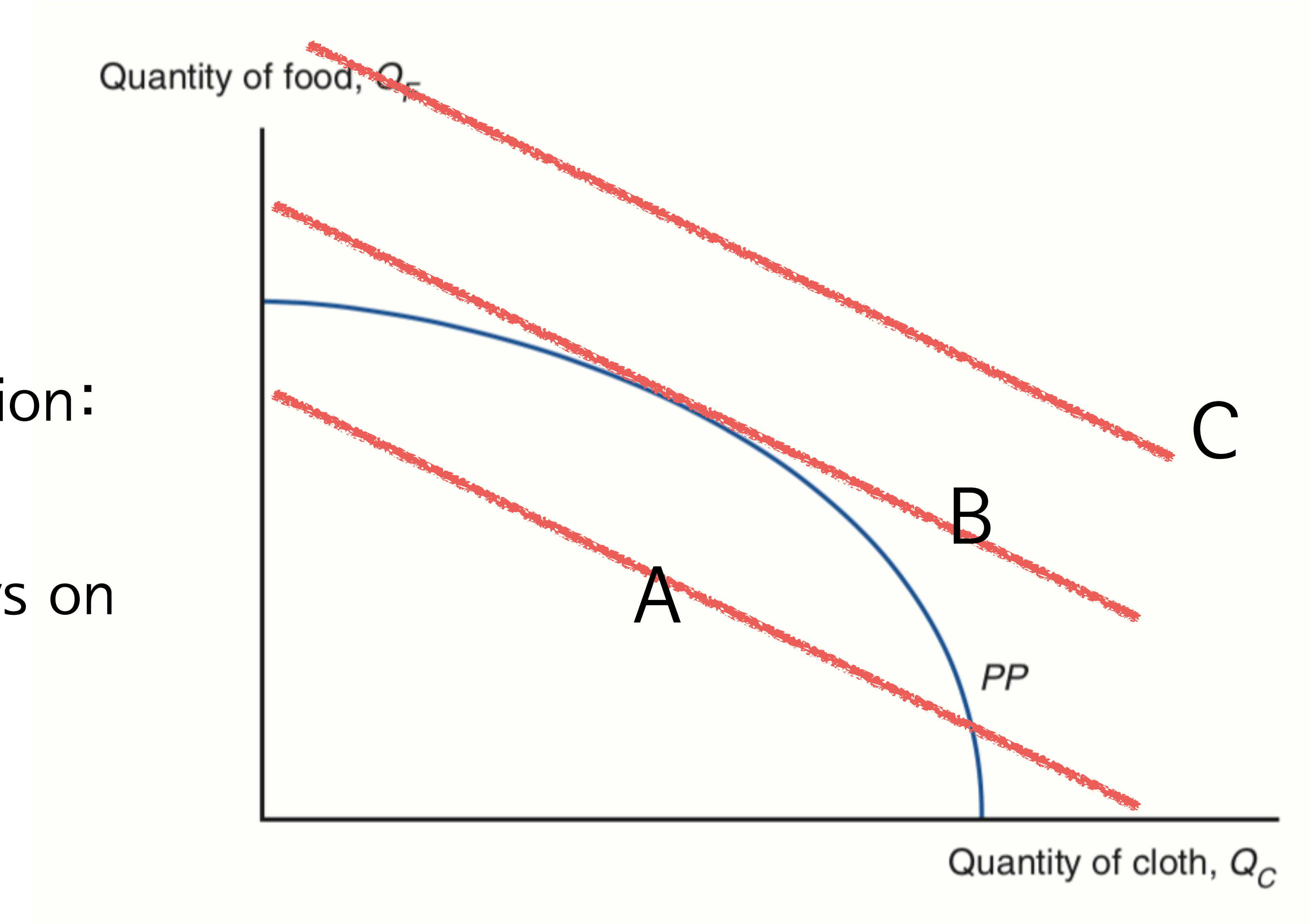

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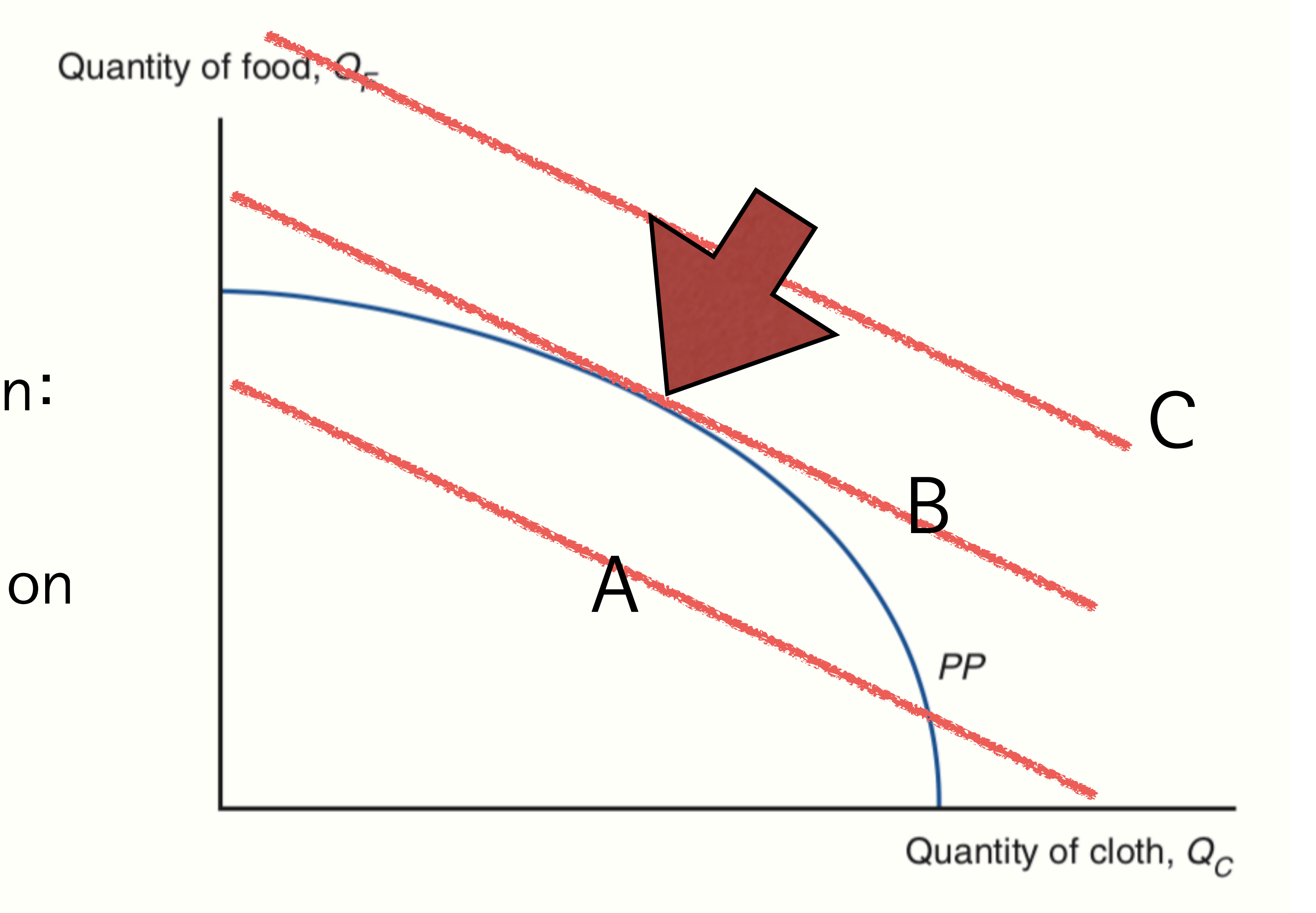


Choosing the Mix of Inputs

- In this two factors model, producers can choose the input to make their final product
- To find the optimal inputs, we should know factor prices
  - price of labor: w (wage)
  - price of capital: r (rental)

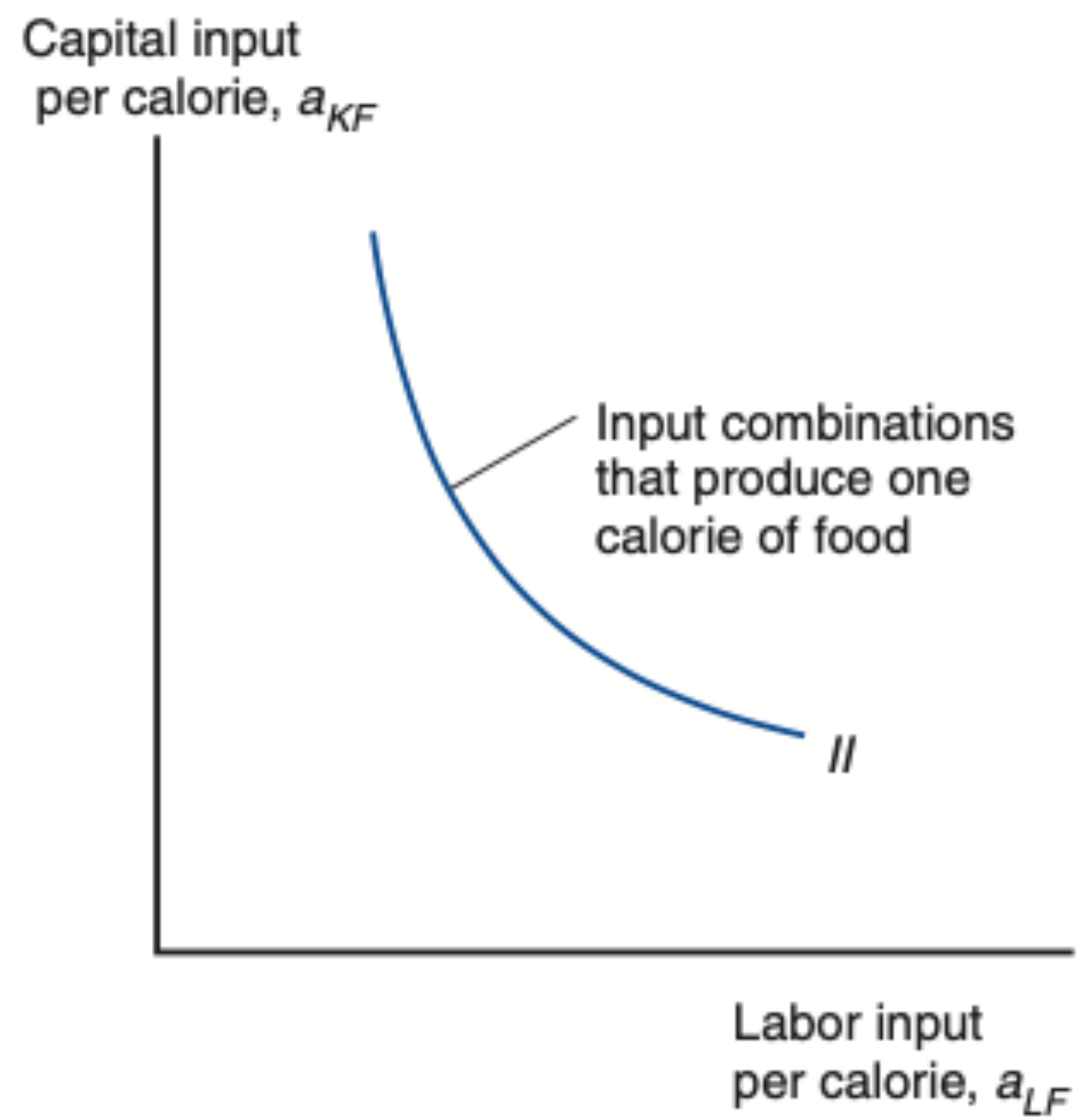
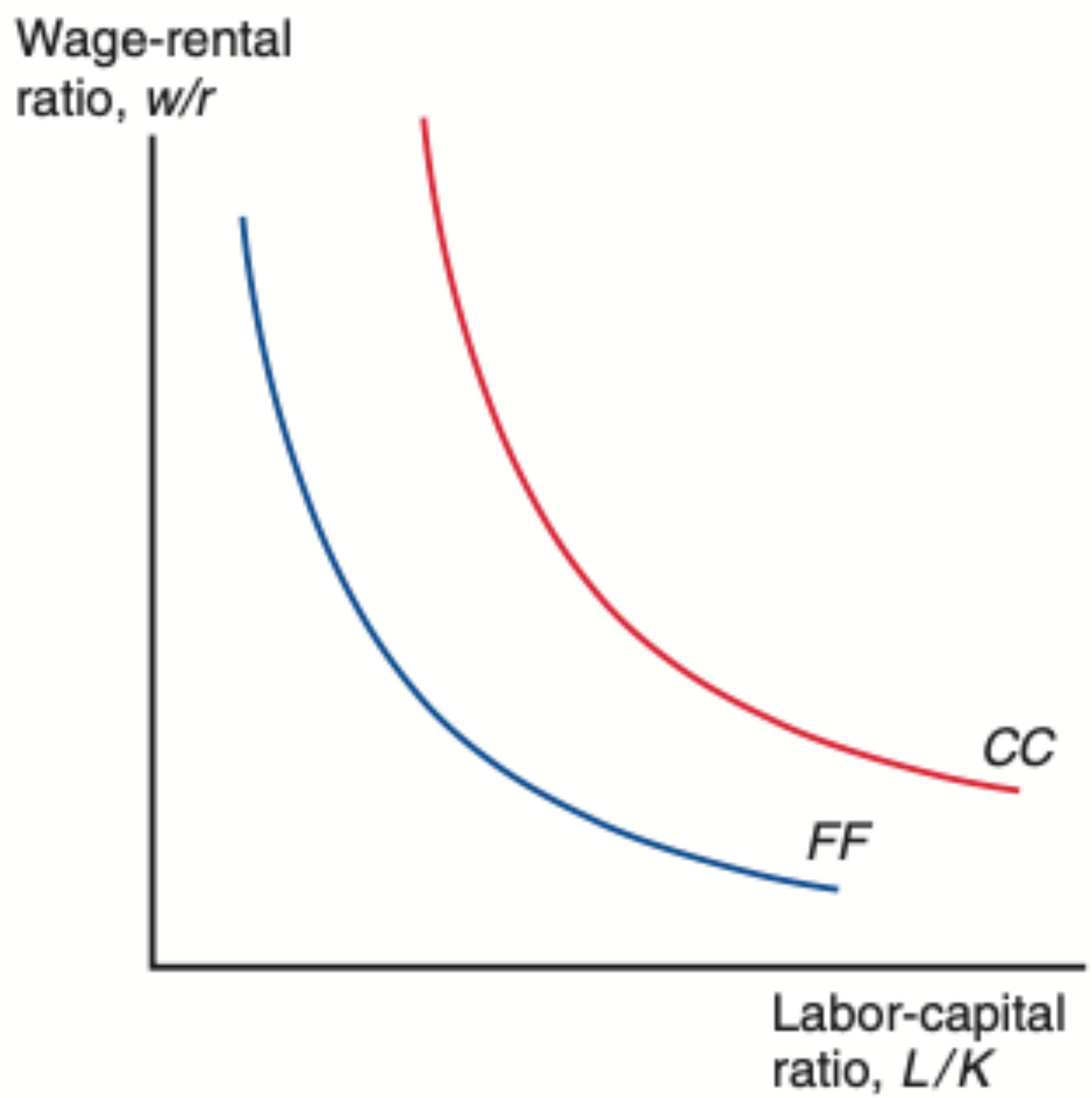


Fig5-4. Input Possibilities in Food Production

Relative Factor Demand Curve

- Labor-capital ratio from the wage-rental ratio
  - FF: Food sector
  - CC: Cloth sector
- If the wage-rental ratio is A:
  - Food sector's L/K is B
  - Cloth sector's L/K is C
- High L/K means labor-intensive
- Low L/K means capital-intensive



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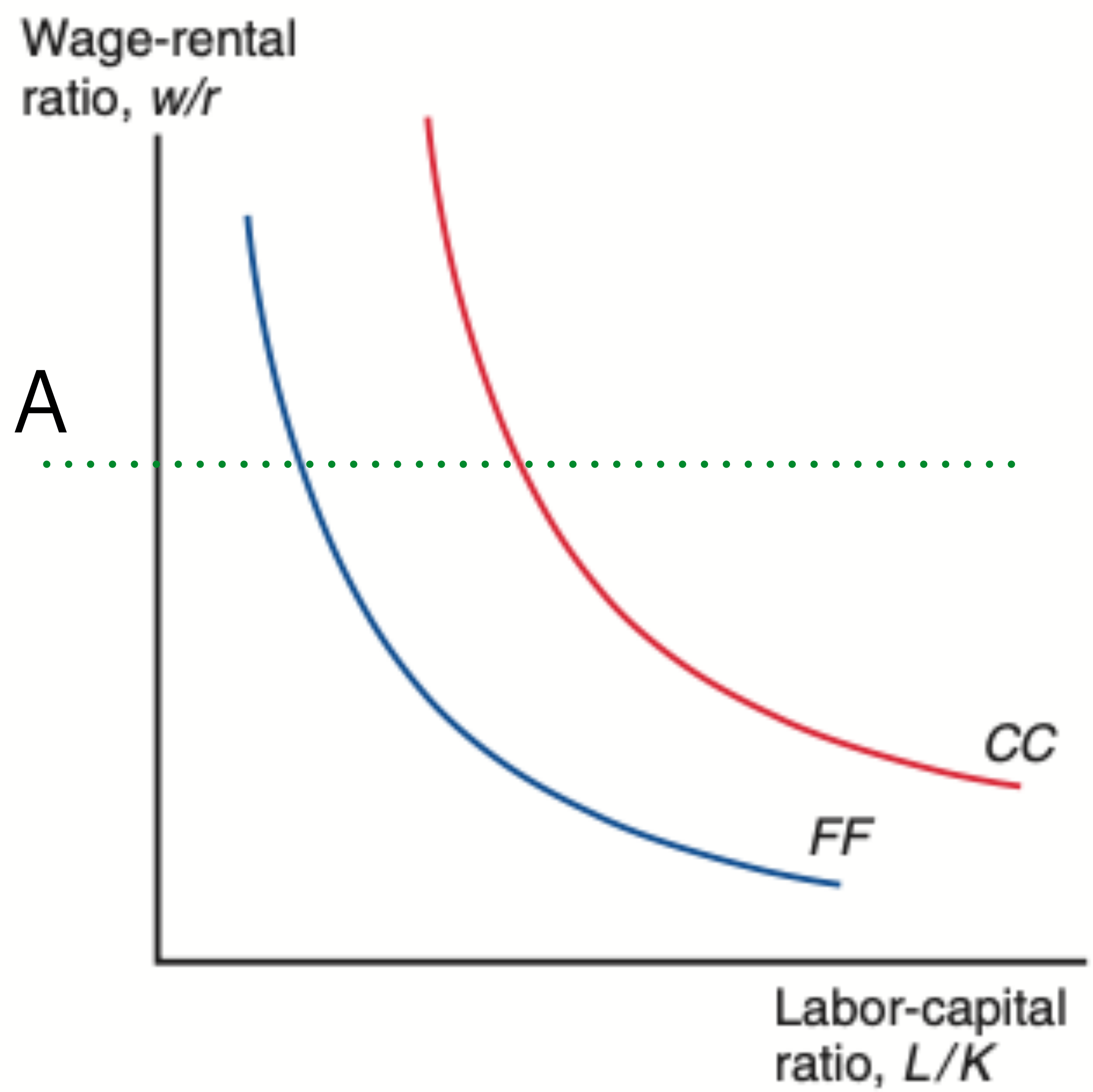

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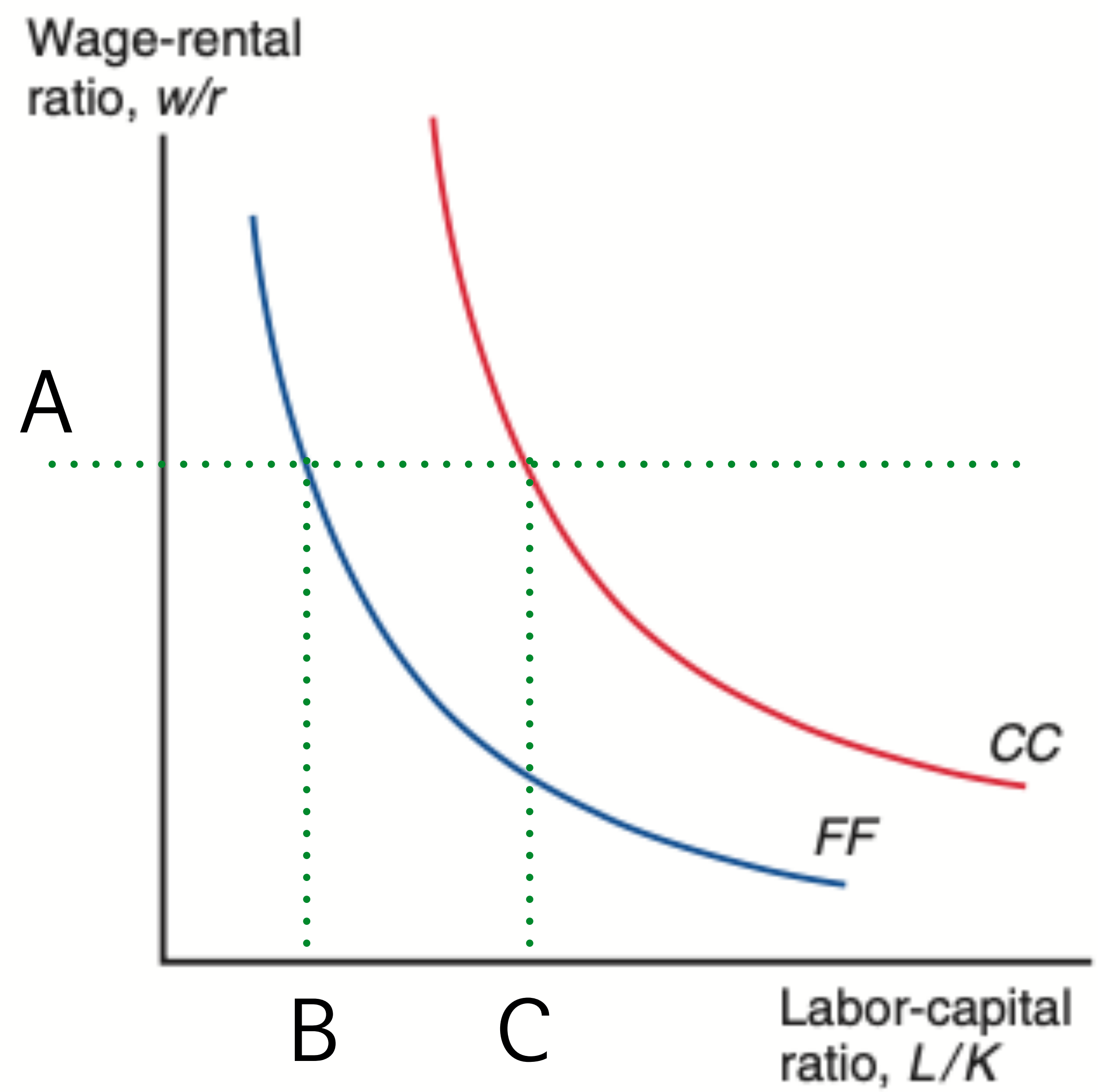


Labor-intensive production

High L, Low K

Capital-intensive production

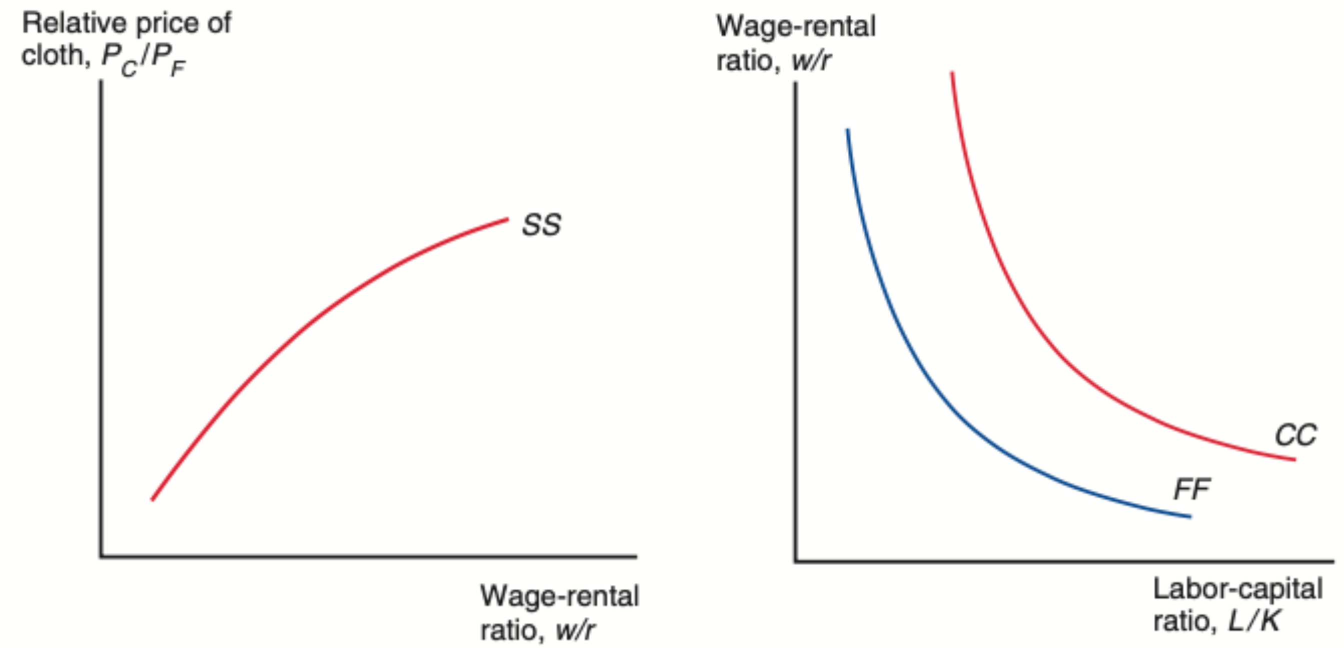
Low L, High K

Factor Prices and Goods Prices

- Price of final product P_C, P_F depend on factor prices w, r.
- Cloth sector is labor-intense $\Rightarrow w$ have relatively more effect on P_C
- Food sector is capital-intense $\Rightarrow r$ have relatively more effect on P_F
- Therefore, $w/r \uparrow \Leftrightarrow P_C/P_F \uparrow$

Factor (Input) Prices and Good (Output) Prices

- We can combine two graphs by matching w/r axis



Factor (Input) Prices and Good (Output) Prices

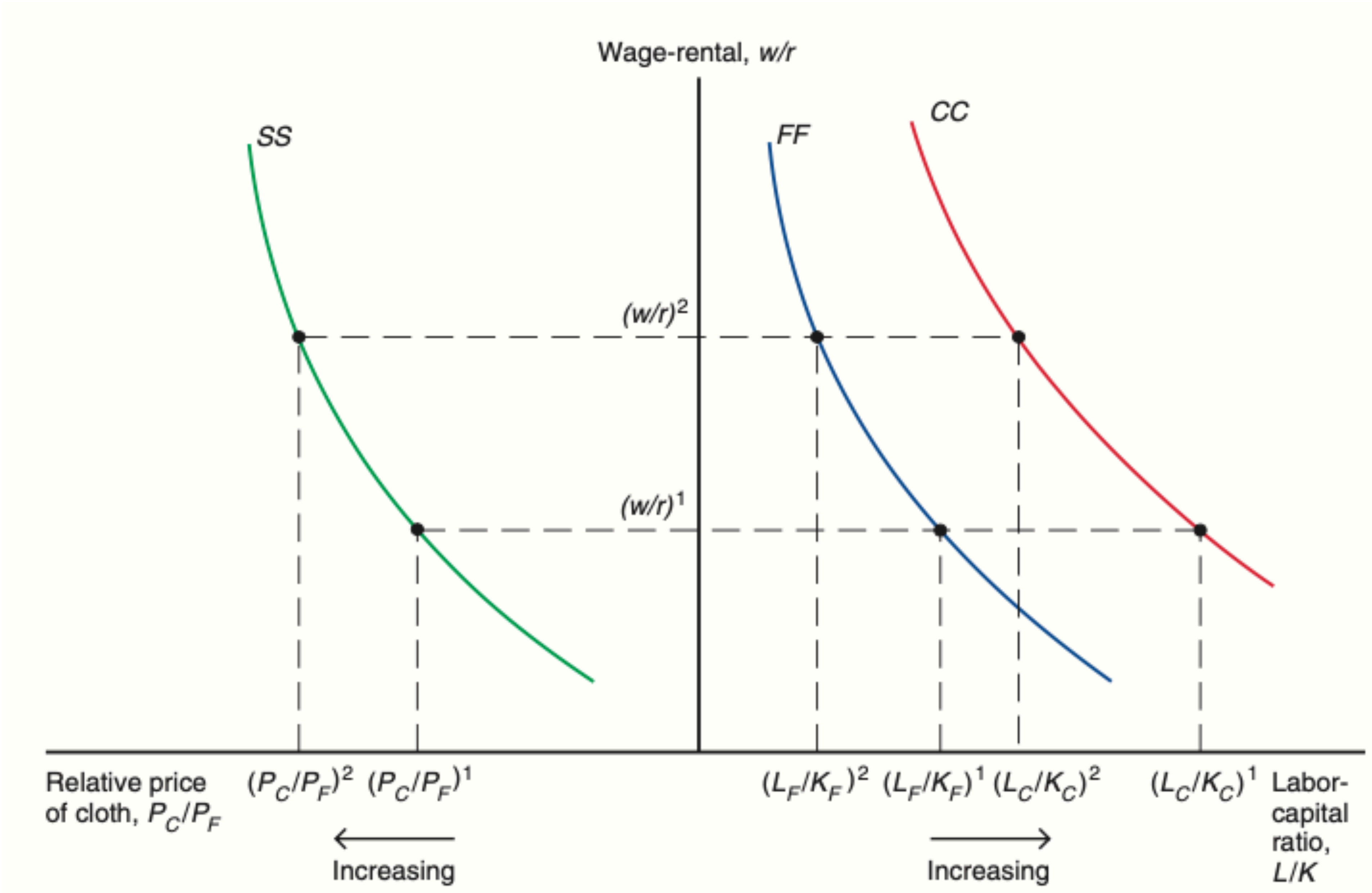
- We can combine two graphs by matching w/r axis

Factor (Input) Prices and Good (Output) Prices

- We can combine two graphs by matching w/r axis

Factor Prices ⇒ Input Choices

- $P_C/P_F \uparrow$
  $\Rightarrow w/r \uparrow$
  $\Rightarrow L_F/K_F \downarrow$, $L_C/L_F \downarrow$
- Real wage $\uparrow$, Real rental $\downarrow$.
- It means change in income distribution
- L/K will not change if P_C/P_F does not change



Factor Prices ⇒ Input Choices

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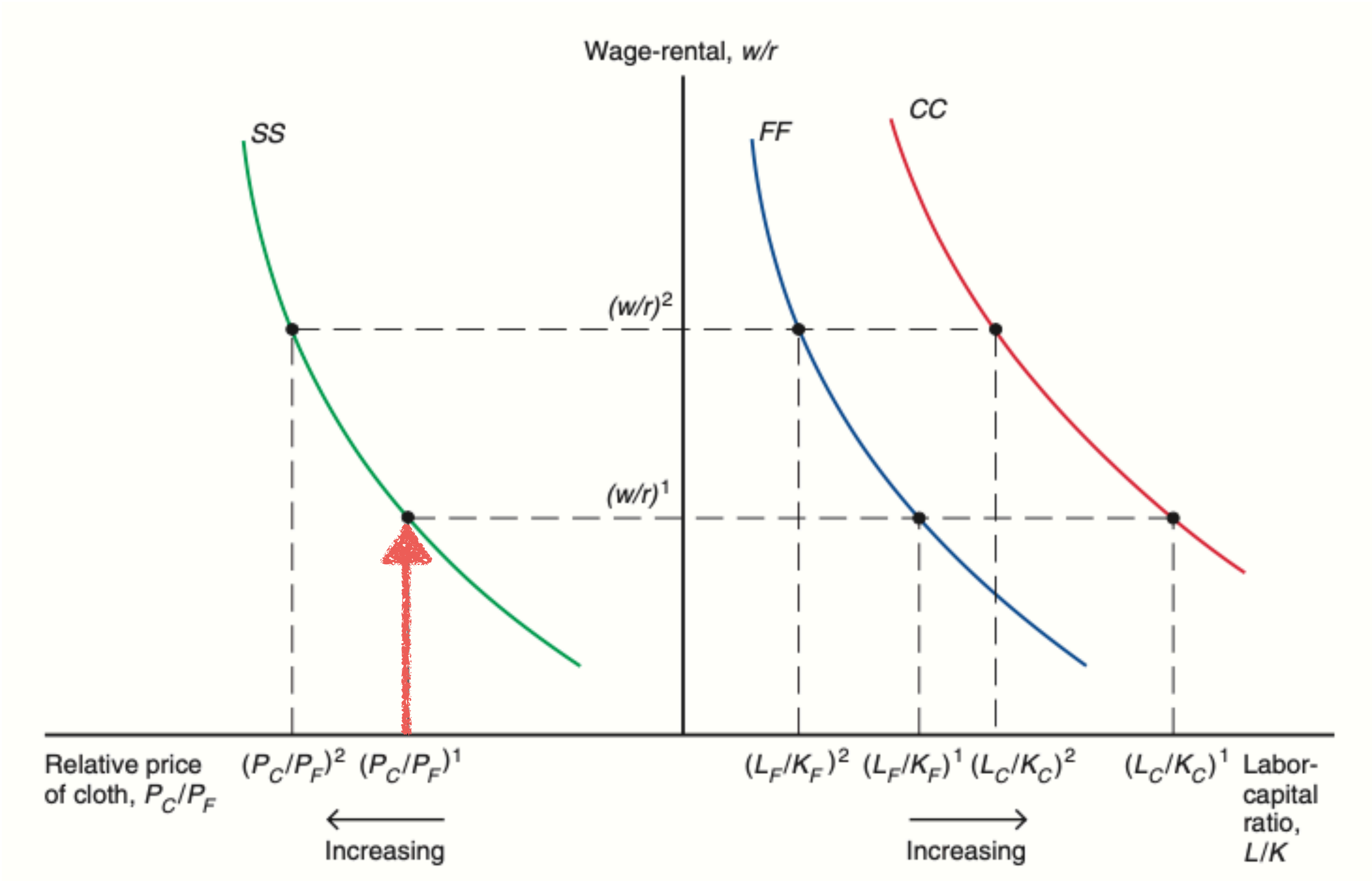

Factor Prices
⇒ Input Choices

- $P_C/P_F \uparrow$
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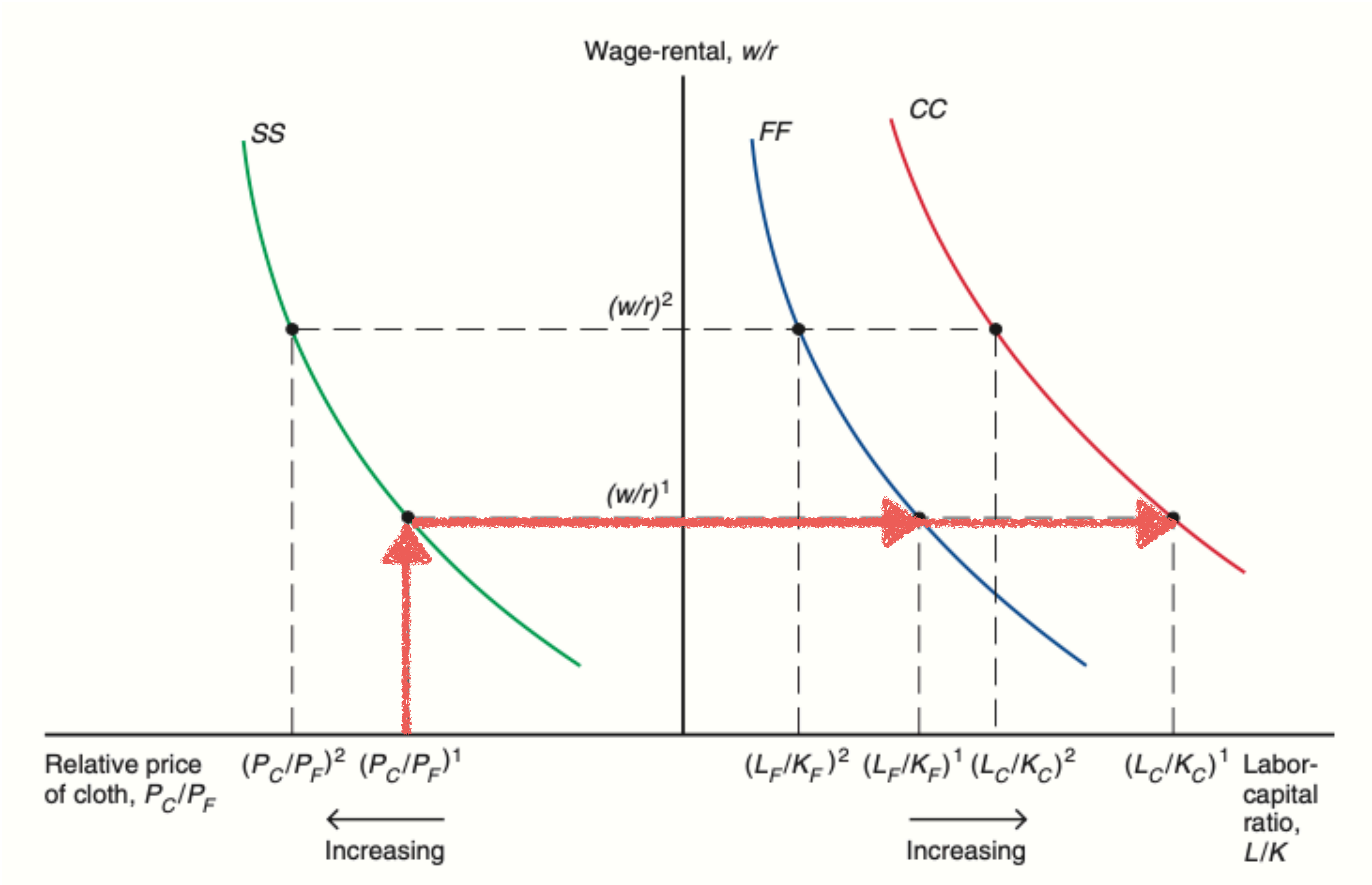

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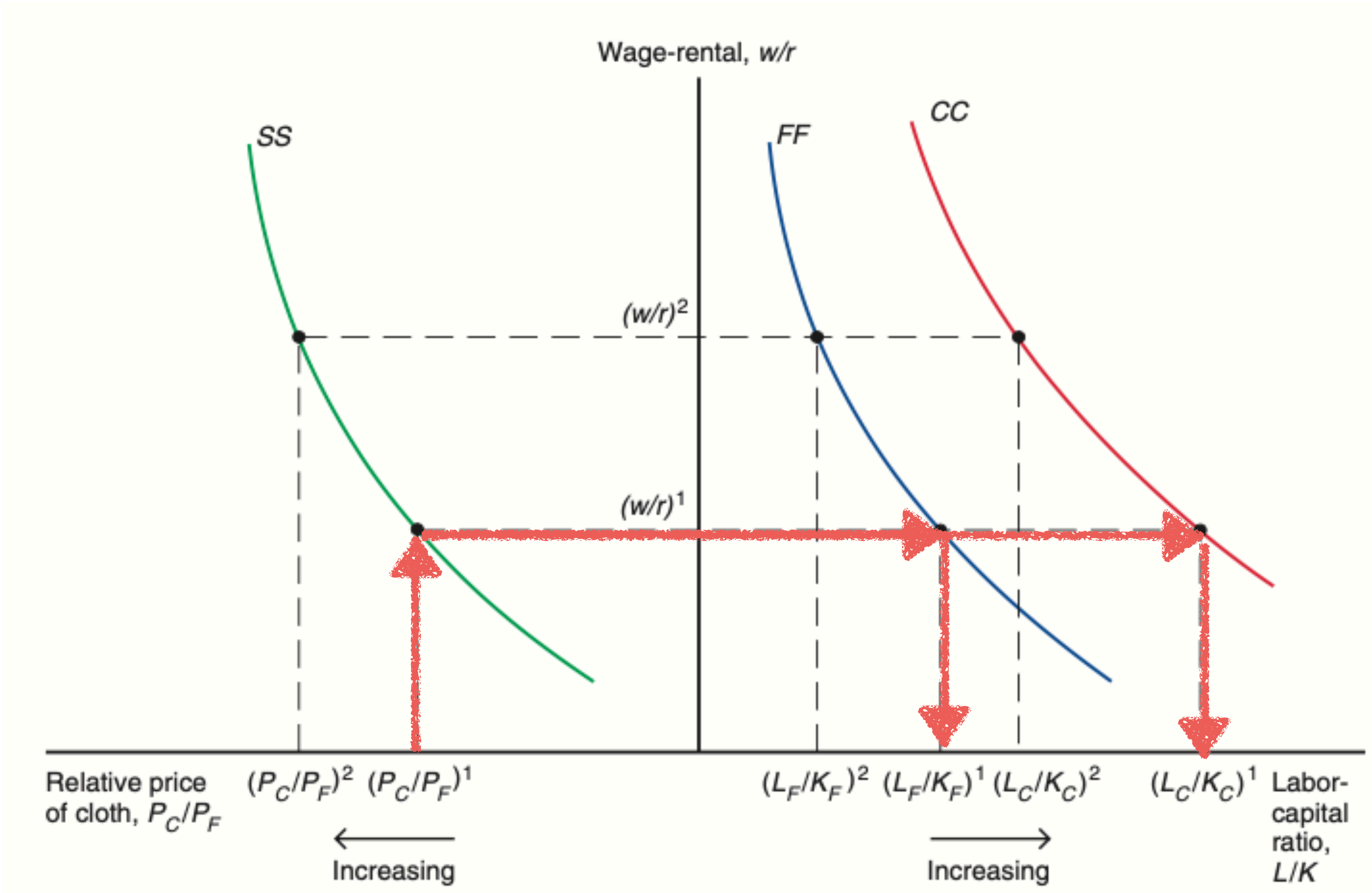
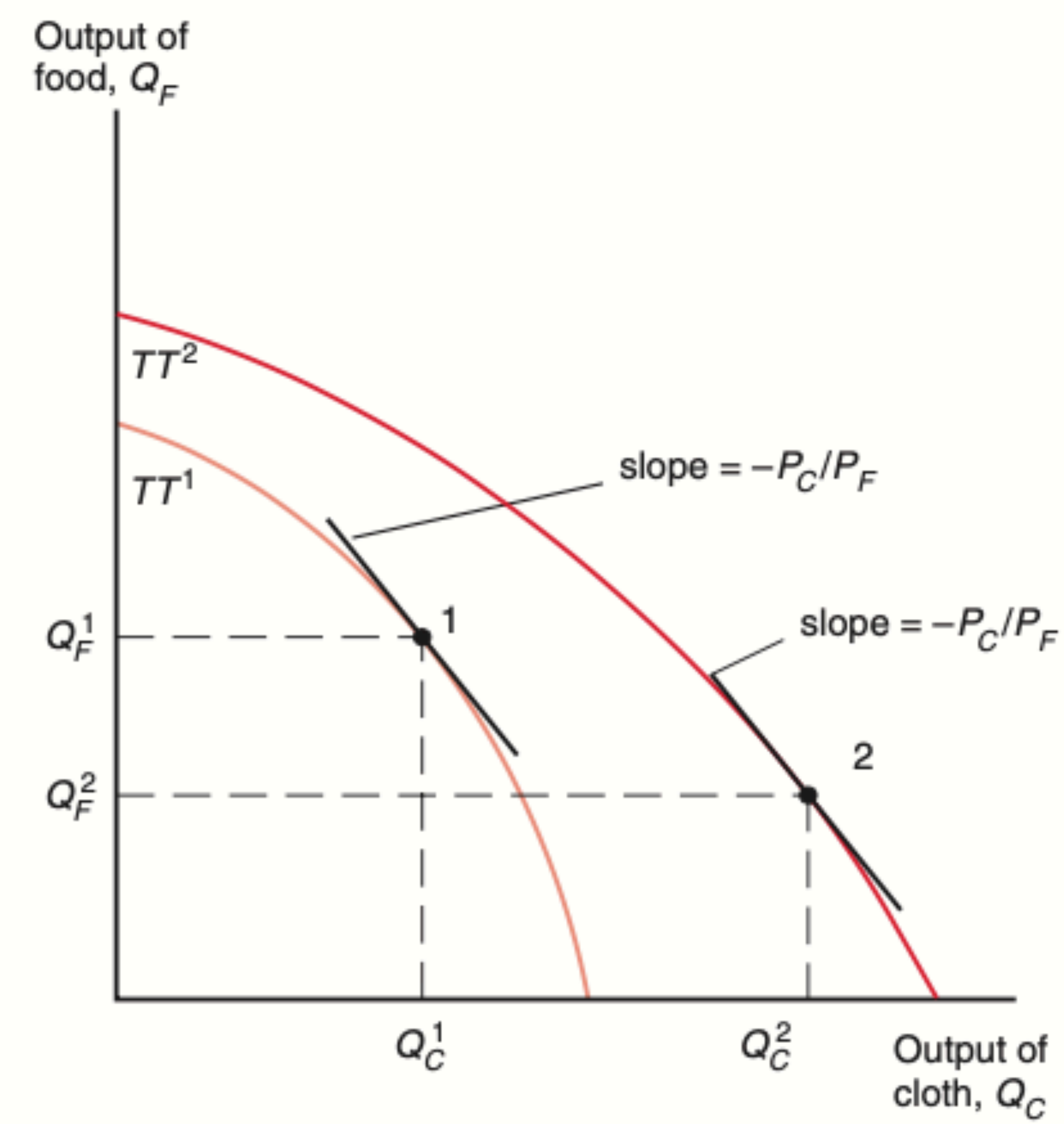


Resources and Output

- Question:
  How changes in resources (the total supply of a factor) affect the allocation of factors across sectors and the associated changes in output?
- Think about the case in which total L increase
  - PPF will change because now the country can hire more labor

Resources and Production Possibilities (PP)

- L ↑ ⇒ PP increase more on Q_C:
  - Reason: Cloth is a labor-intense sector
  - Optimal output: more cloth
- Biased expansion of production possibilities
- Conclusion: An economy will tend to be relatively effective at producing goods that are intensive in the factors with which the country is relatively well endowed



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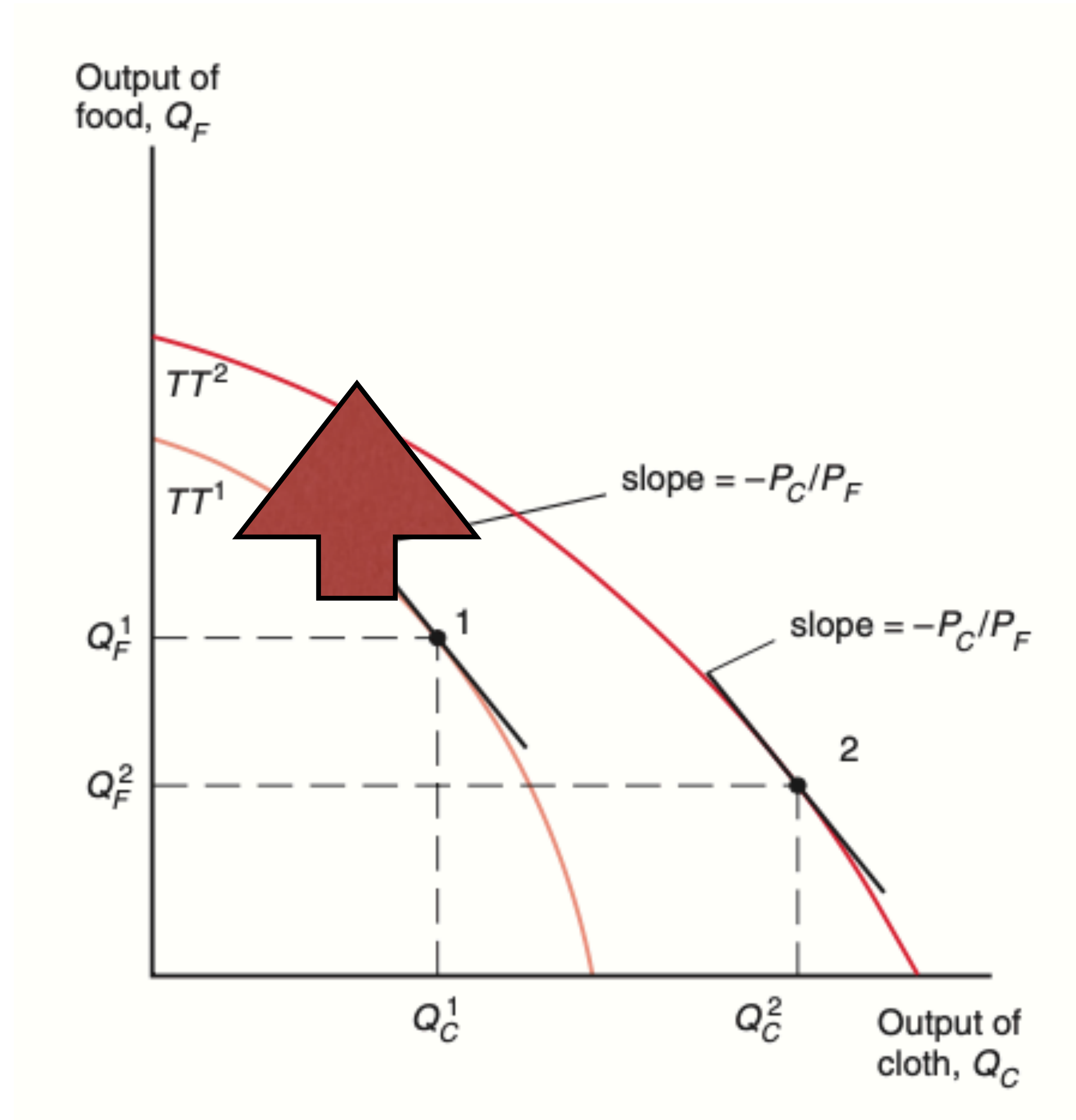

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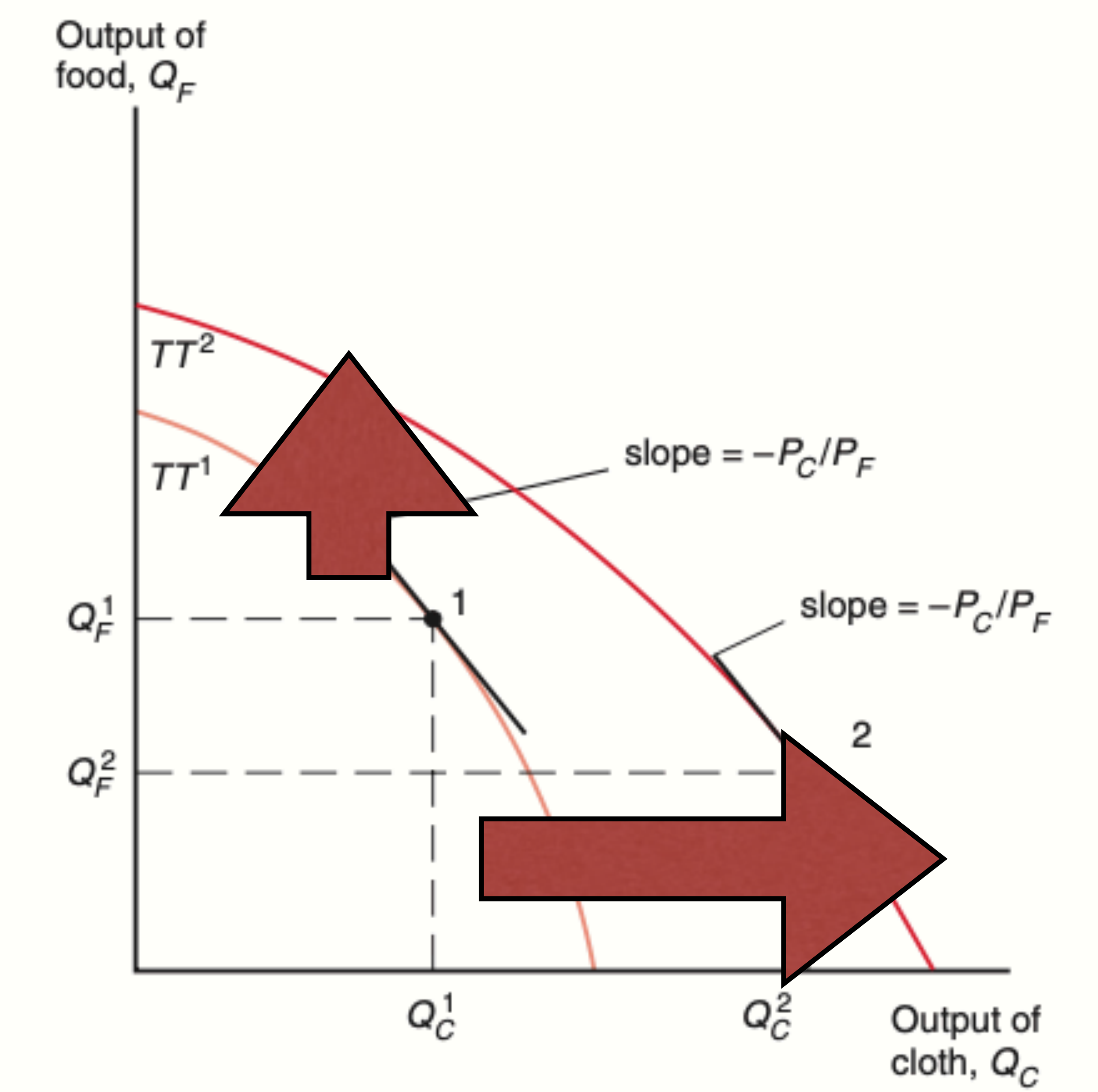


Example

Case	Result
Country having much labors	
Country having much capitals	

Effects of International Trade between Tow-Factor Economies

Settings

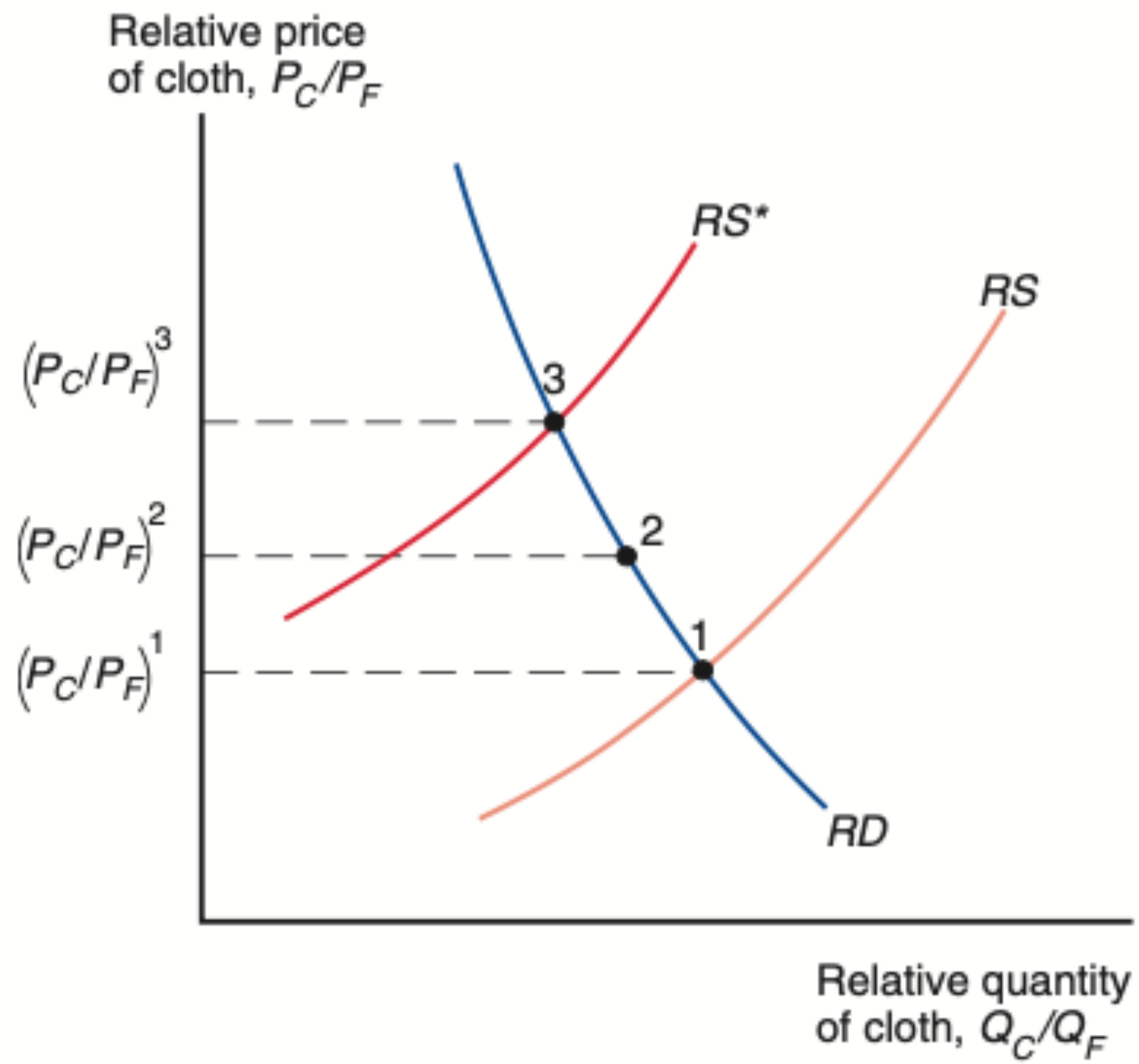
- Two countries: Home and Foreign
  - H and F is very similar except for factor endowment:
- Two factors: Labor and Capital
- Two outputs: Cloth and Food

Relative Prices and the Pattern of Trade

- $L > K \Rightarrow$ Labor-abundant
- $L < K \Rightarrow$ Capital-abundant
- Note: These are relative term
- Example:
  - K in China > K in Korea
  - But Korea is capital-abundant relative to China

Trade and the Convergence of Relative Prices

- After trade:
  - Home: export cloth (-) and import food (+)
    - $\Rightarrow Q_c/Q_F \downarrow$, $P_C/P_F \uparrow$
    - point 1 → point 2
  - Foreign: export food and import cloth
    - point 3 → point 2



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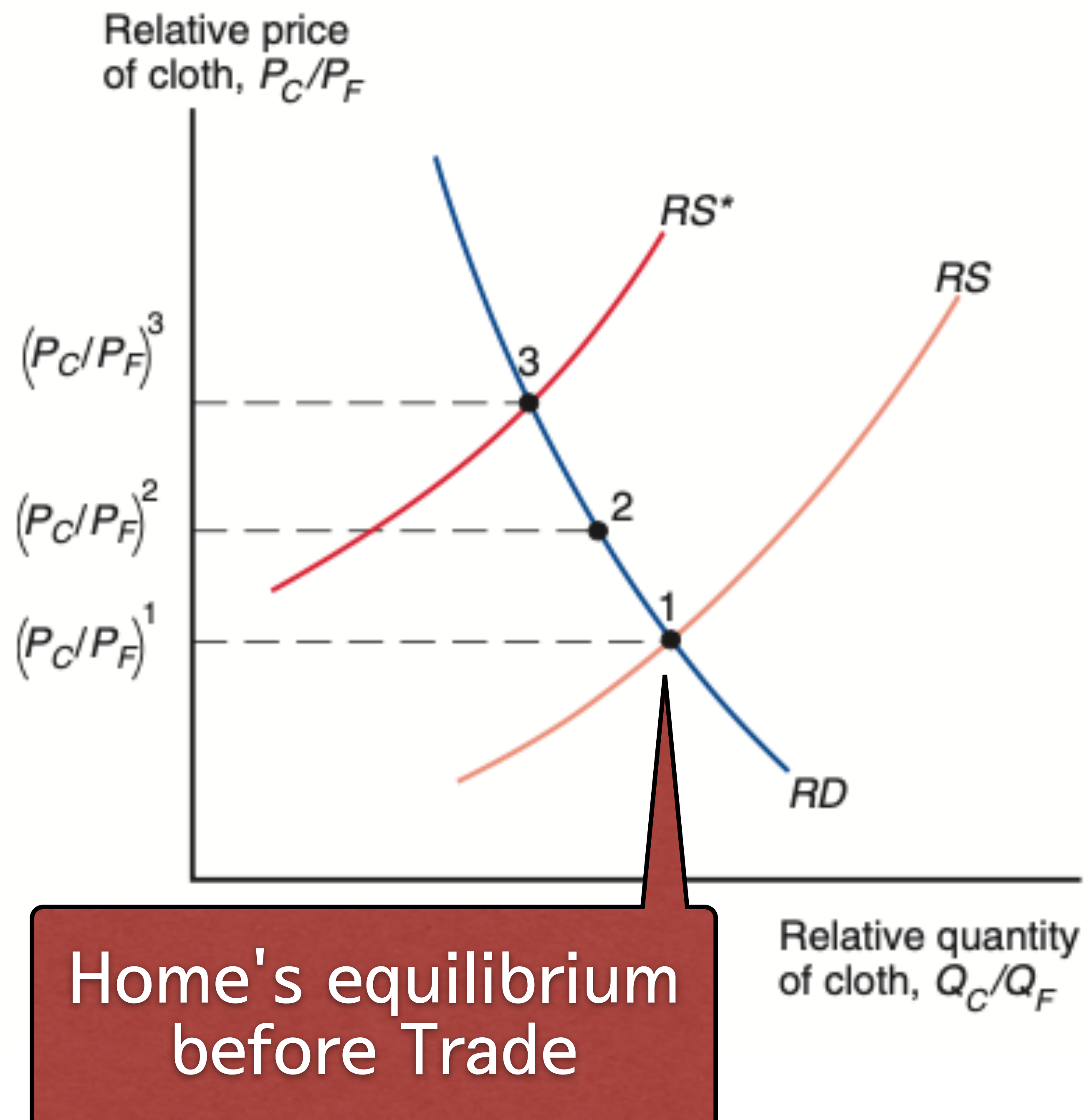

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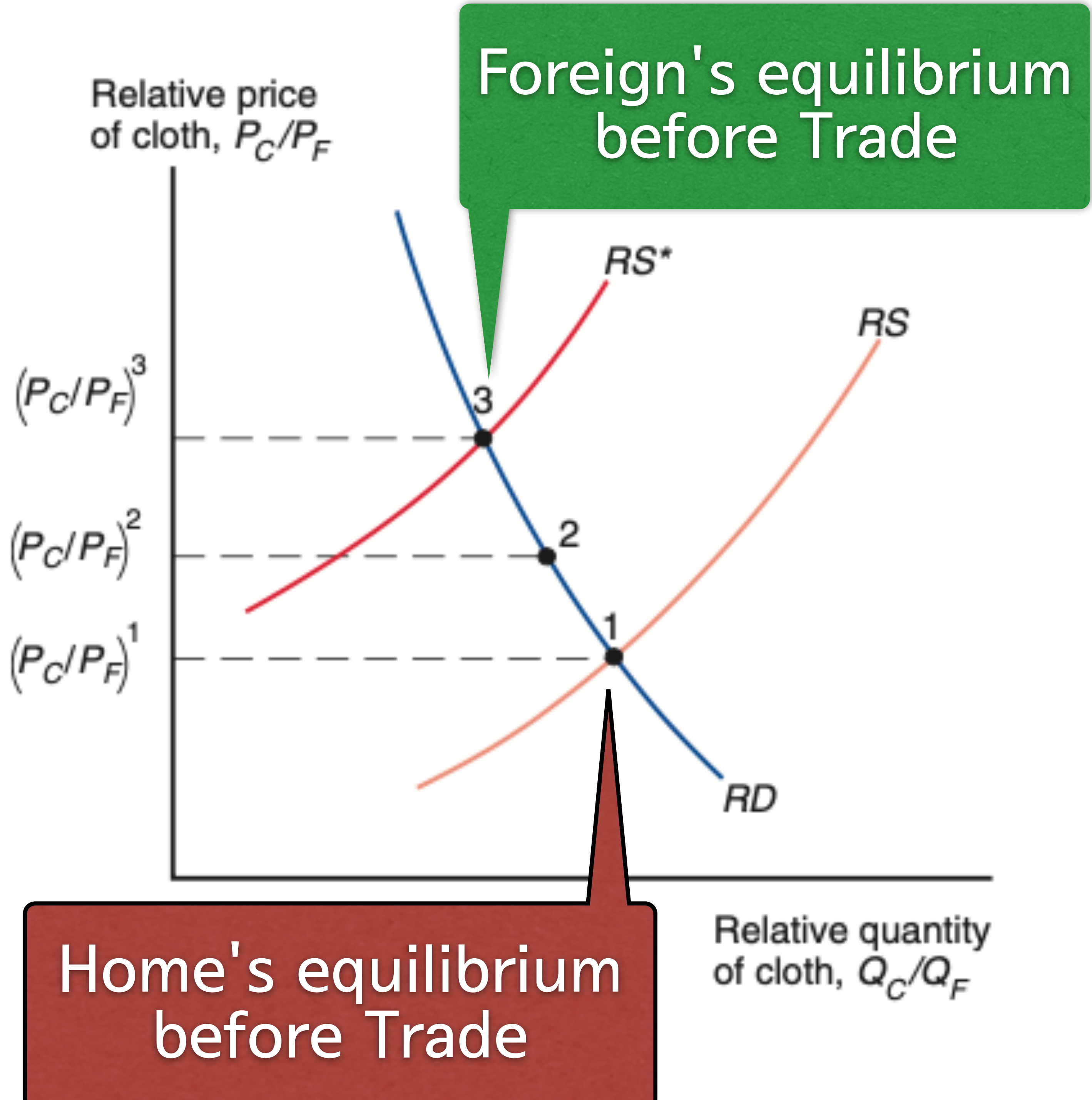

Hecksher-Ohlin Theorem

- Two-good, two-factor, two-country version:
  - The country that is abundant in a factor exports the good whose production is intensive in that factor
- Generalized version:
  - Countries tend to export goods whose production is intensive in factors with which the countries are abundantly endowed

Trade and the Distribution of Income

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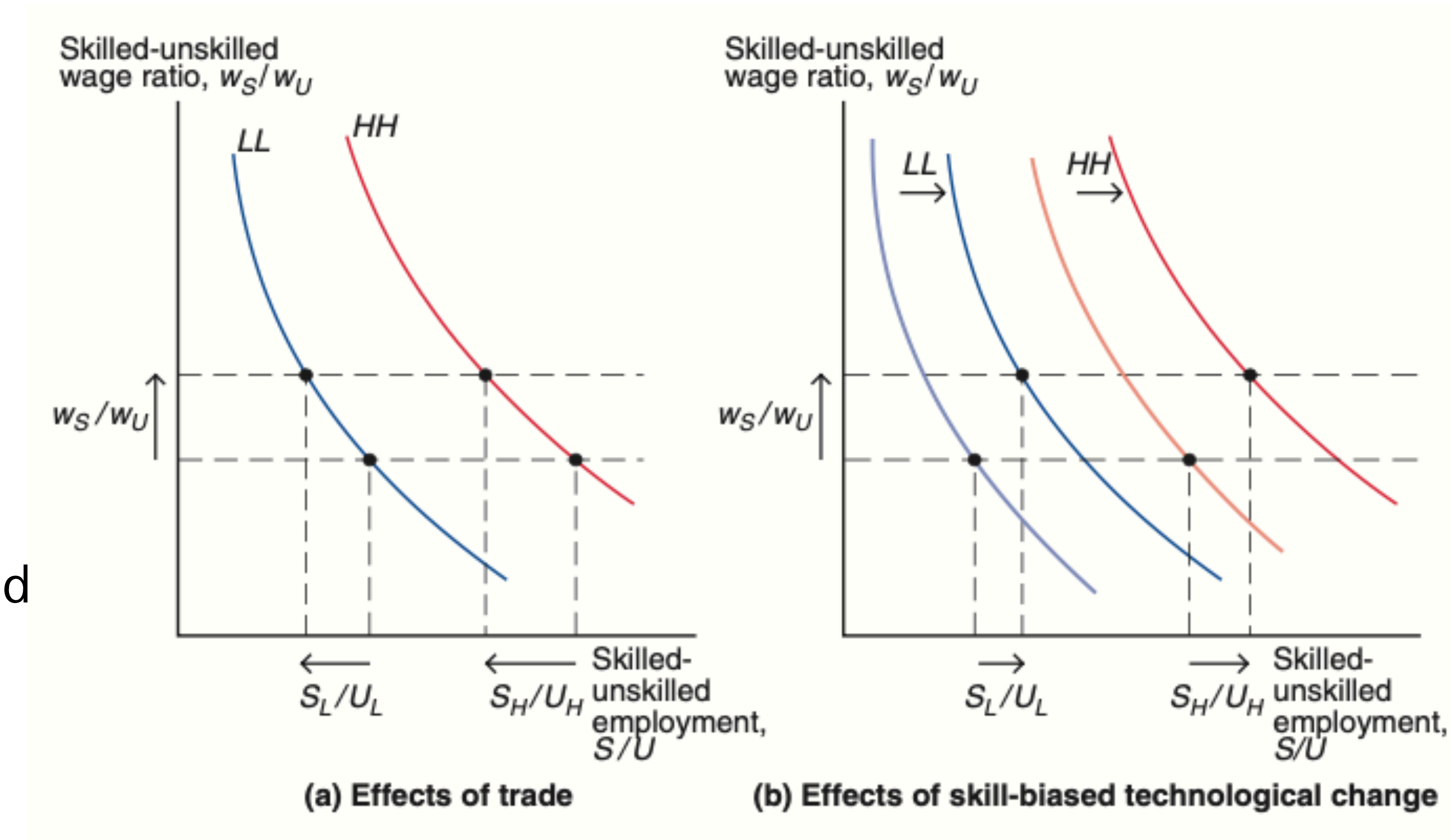
Income Distribution Effects of International Trade

- Owners of a country's abundant factors gain from trade, but owners of a country's scarce factors lose

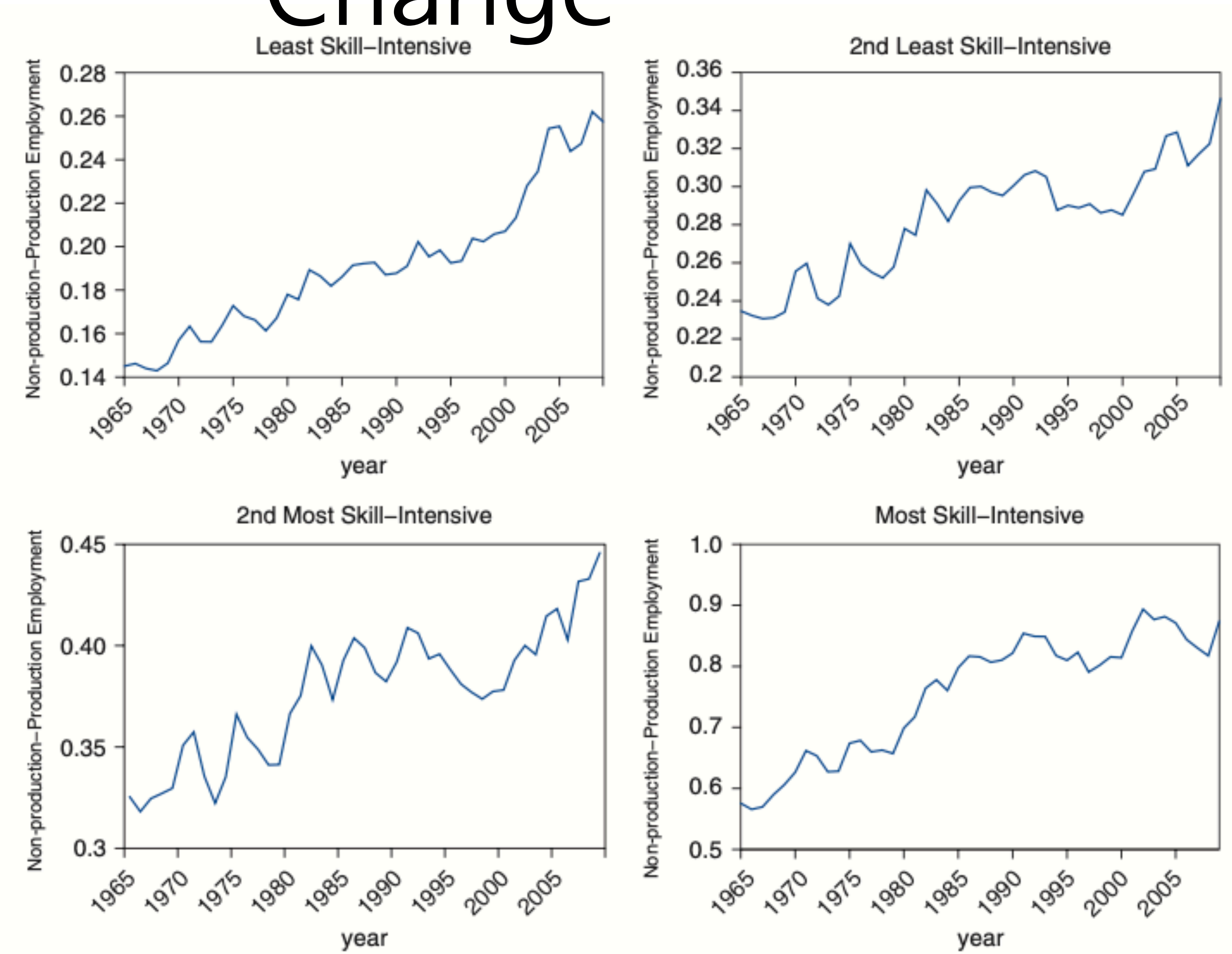
Skill-Biased Technological Change and Income Inequality

- L: Low tech sector
- H: High tech sector
- S: Skilled
- U: Unskilled
- When ws/wu ↑, S/U ↓ (Trade)
- When ws/wu ↑, S/U ↑ (Skill-biased tech. change)
  - Tech change increase inequality



Empirical Evidence Supports Skill-biased Technological Change

- Non-production workers require more education ⇒ skilled employment



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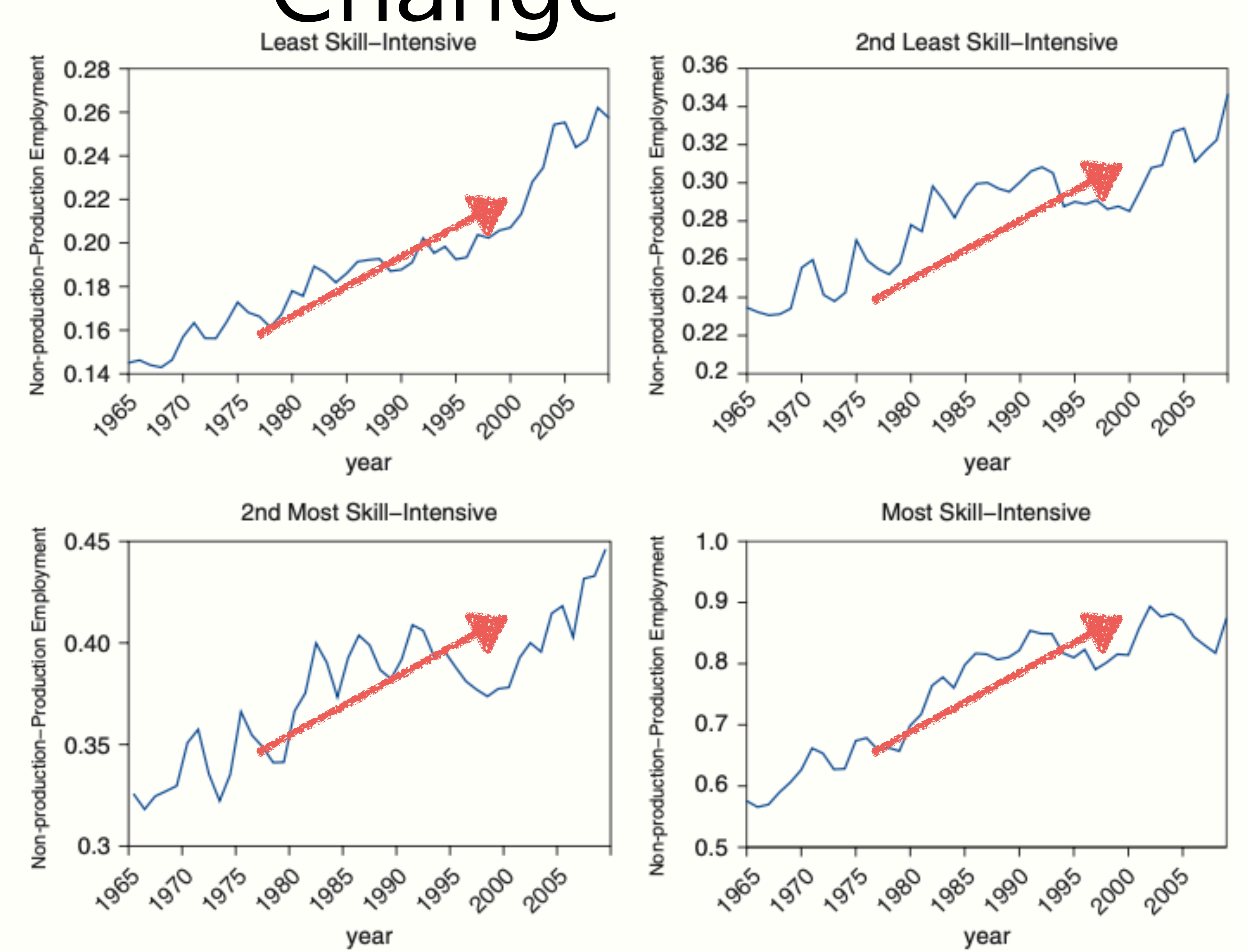

Trade and Income Inequality

- Accelerating process of technological change
  - Export companies upgrade more skill-intensive production technologies ⇒ wage in high tech sector ↑
- Foreign outsourcing
  - Outsourcing occurs in low-tech sector ⇒ wage in low tech sector ↓
- Feenstra & Hanson (1999): Outsourcing from US to Mexico can explain 21-27% of increase in wage premium between non-production (skilled) and production (unskilled) workers.

Factor-Price Equalization

- This two-factor economy model predicts the "equalization of factor prices".
- In an indirect way, the two countries are in effect trading factors of production:
  - Labor-intensive product have more labor embodied
  - When Foreign export cloth, they export labor indirectly to Home.
- This can explain the equaliztion of the two countries' factor prices, but in the real world, factor prices are NOT equalized

In the real world, factor prices are NOT equalized

TABLE 5-1 Comparative International Wage Rates (United States = 100)

Country	Hourly Compensation of Manufacturing Workers, 2015 (United States = 100)
United States	100
Germany	112
Japan	63
Spain	63
South Korea	60
Brazil	31
Mexico	16
China*	11.3
India**	4.5

*Data for 2013

**Data for 2012

Source: The Conference Board, International Labor Comparisons.

Reasons of the False Prediction

- Assumptions of the model is not realistic:
  - Technologies are the same
    - Not same.
  - Costless trade equialize the price of goods
    - Costly. (transportation costs, tariffs, etc)
  - Both countries produce both goods
    - There are specialization of production

Next Topics

- The Empirical Evidence on the H-O model
- The Standard Trade Model
    - Krugman Ch6

Thank you!

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