EC2101: Microeconomic Analysis I

Lecture 5

Theory of the Consumer

- Consumer Welfare
  - Consumer Surplus
  - Compensating Variation
  - Equivalent Variation
- Network Externalities
- Market Demand

Consumer Welfare

Change in Utility as a Result of a Change in Price

- When the price of a good decreases,
  the consumer is usually better off (higher utility).
- When the price of a good increases,
  the consumer is usually worse off (lower utility).
- How do we quantify the benefit or loss
  due to a change in price?
  - Consumer surplus
  - Compensating variation
  - Equivalent variation

Why is Measuring Consumer Welfare Important?

- Grab and Uber announced a merger in March 2018.
- Did the merger benefit or harm consumers?
  - Benefit: The merger may reduce the cost of production.
  - Harm: The merged firm may set higher prices.
- In September 2018, the Competition and Consumer Commission of Singapore concluded that the merger had led to the substantial eroding of competition in the ride-hailing market.
  - Grab was fined $6.42 million, and Uber $6.58 million.

Consumer Welfare:

Consumer Surplus

Consumer Surplus

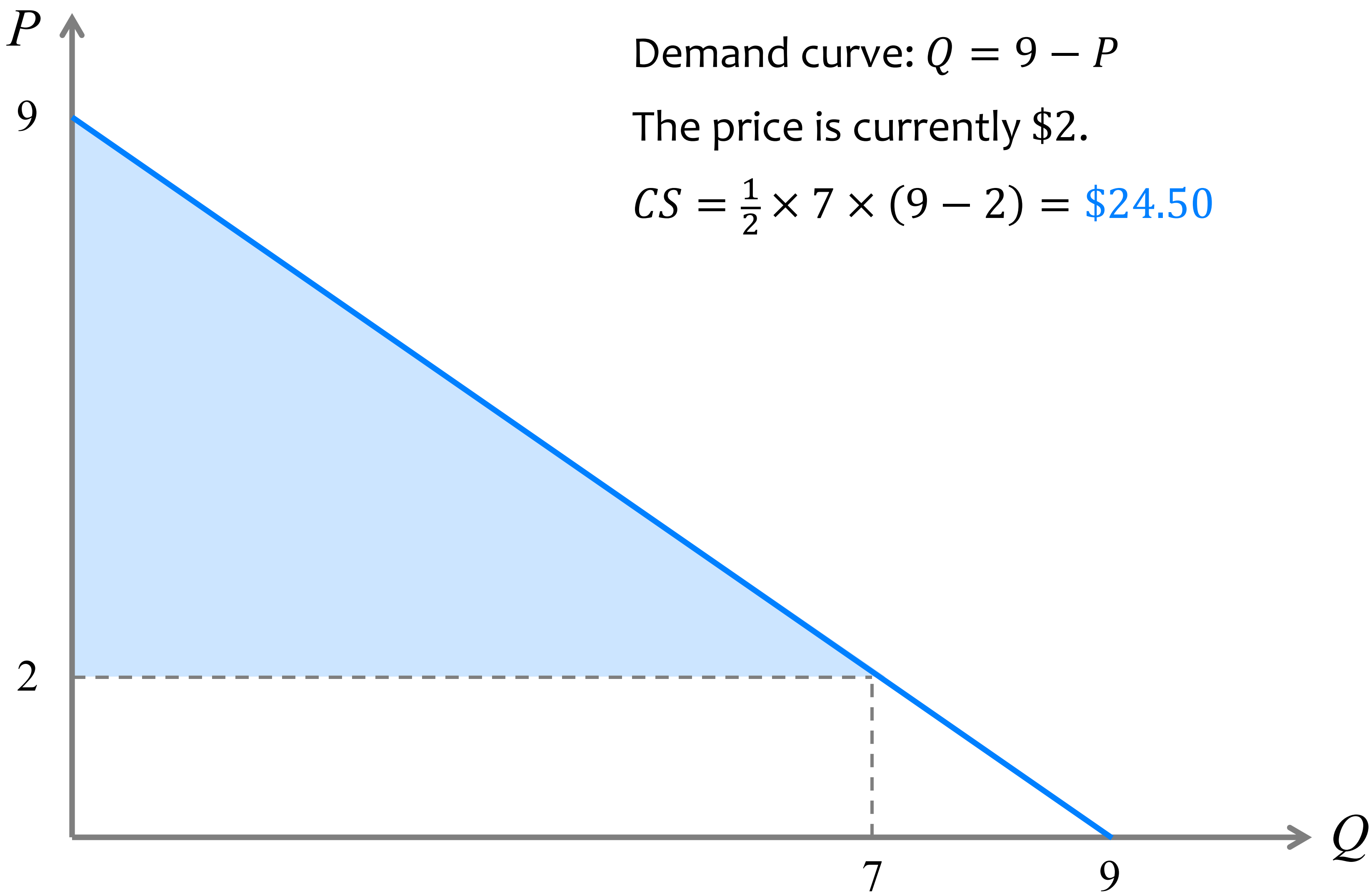
- Consumer Surplus (CS) — individual consumer:
  - The difference between
    the consumer's willingness to pay for a good and
    the cost of purchasing the good.
  - CS = WTP – Price
- Consumer Surplus (CS) — market:
  - The sum of all individual consumers' consumer surplus.
  - Graphically, the area below the demand curve
    and above the price.

Consumer Surplus

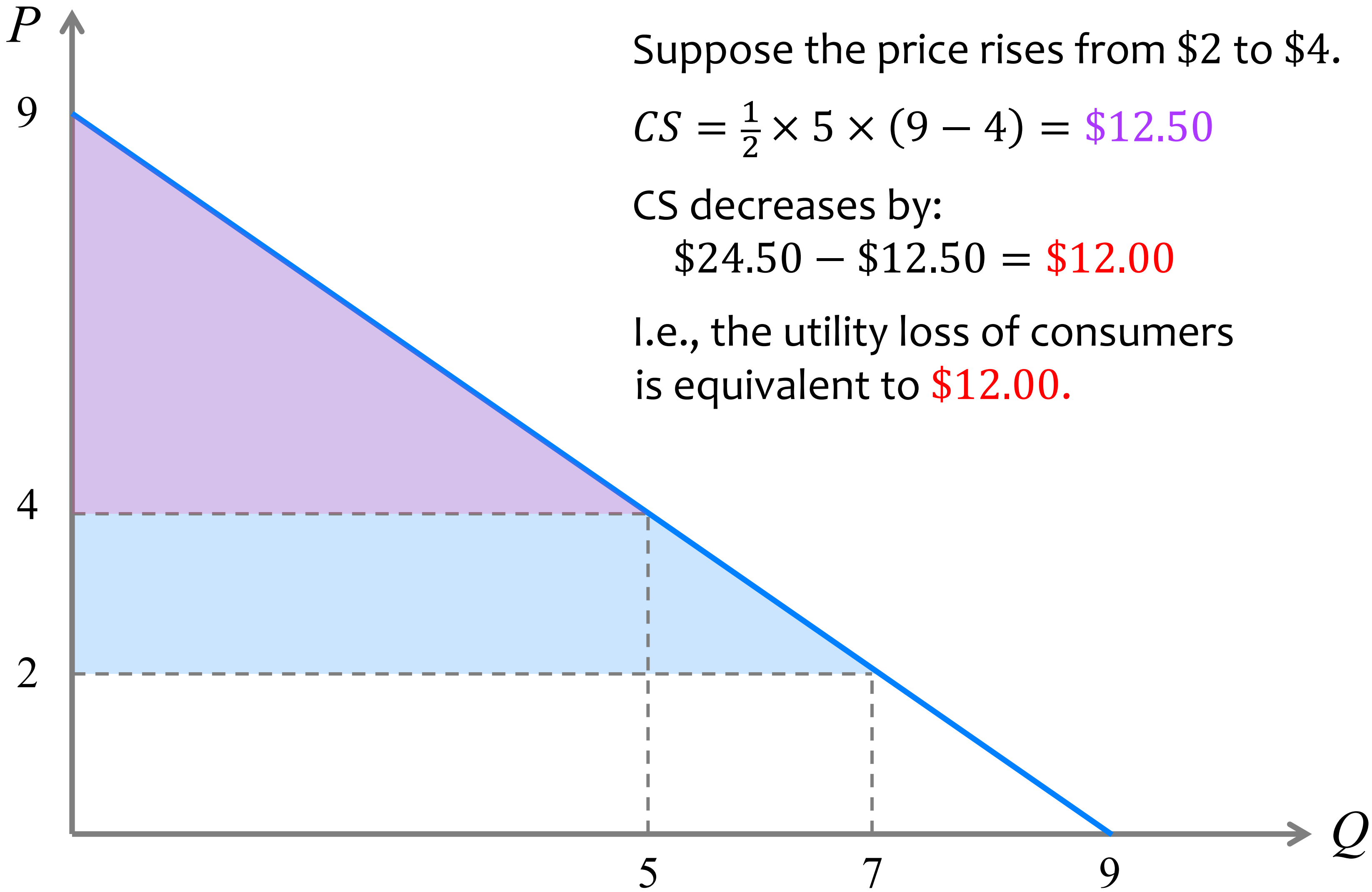
Demand curve: $Q = 9 - P$

The price is currently \$2.

$CS = \frac{1}{2} \times 7 \times (9 - 2) = \$24.50$



Change in Consumer Surplus



Suppose the price rises from \$2 to \$4.

$CS = \frac{1}{2} \times 5 \times (9 - 4) = \$12.50$

CS decreases by:

$\$24.50 - \$12.50 = \$12.00$

I.e., the utility loss of consumers is equivalent to $\$12.00$.

Consumer Welfare:

Compensating Variation

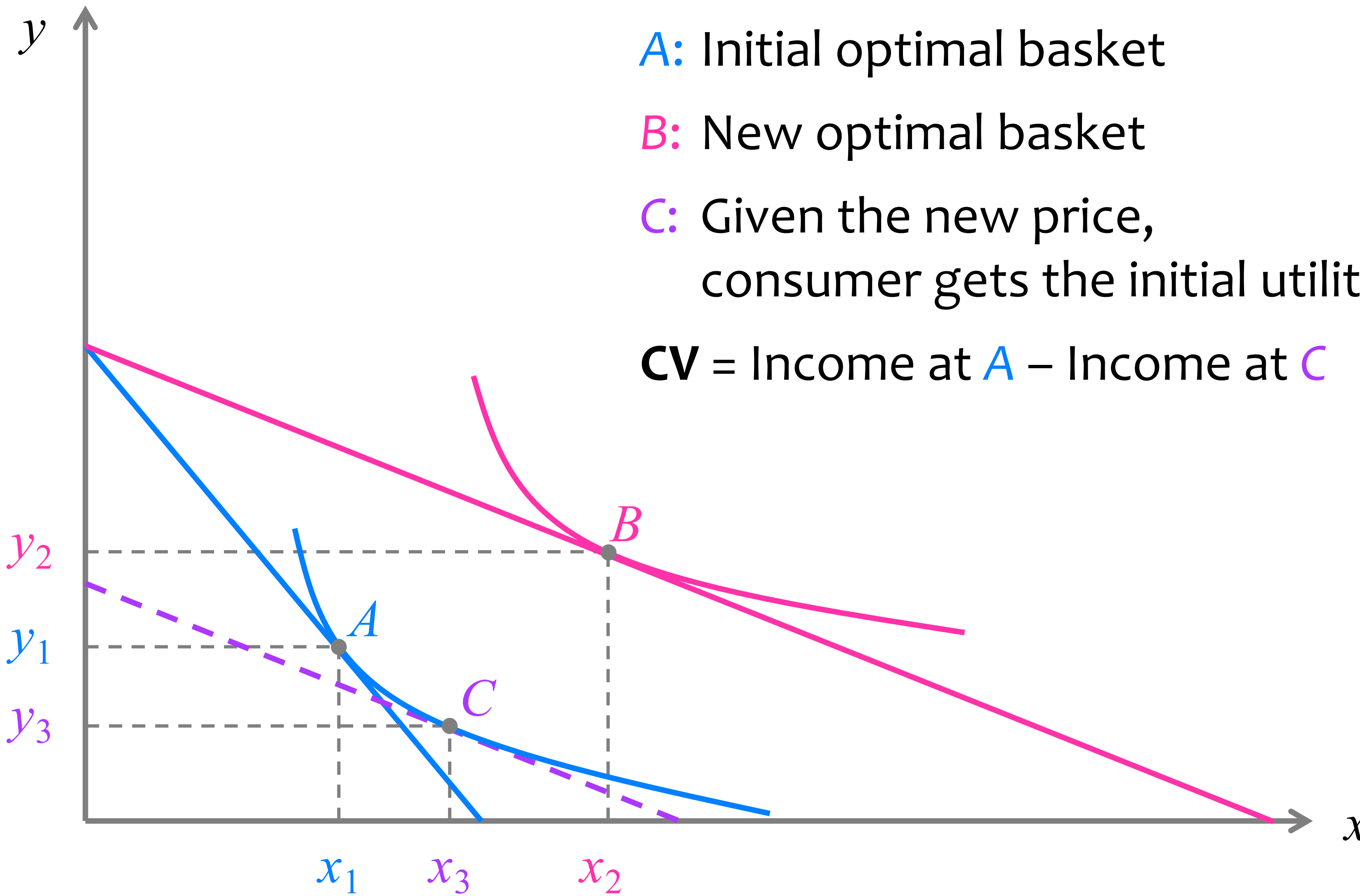
Compensating Variation: Example

- Chris, with an income of $100, buys gelato and coffee.
  - At her initial optimal basket, her utility is 50.
- Suppose the price of gelato falls.
- After the price drop, to get a utility of 50,
  Chris needs to spend only $90.
  - After the price drop, she spends $10 less
    to obtain the pre-price drop utility level.
  - Thus the benefit of the price drop is equivalent to $10.
  - The compensating variation is $\$100 - \$90 = \$10$.

Compensating Variation: Definition

- Compensating Variation (CV):
  - The amount of money (income)
    that the consumer is willing to give up after the price drop
    in order to maintain the pre-price drop utility level.
- Suppose the initial optimal basket is basket *A*.
- Suppose the price of gelato falls.
- Given the new price, the optimal basket that generates the same level of utility as basket *A* is basket *C*.
- CV = Income at basket *A* – Income at basket *C*

Compensating Variation



A: Initial optimal basket

B: New optimal basket

C: Given the new price, consumer gets the initial utility

CV = Income at A – Income at C

Consumer Welfare:

Equivalent Variation

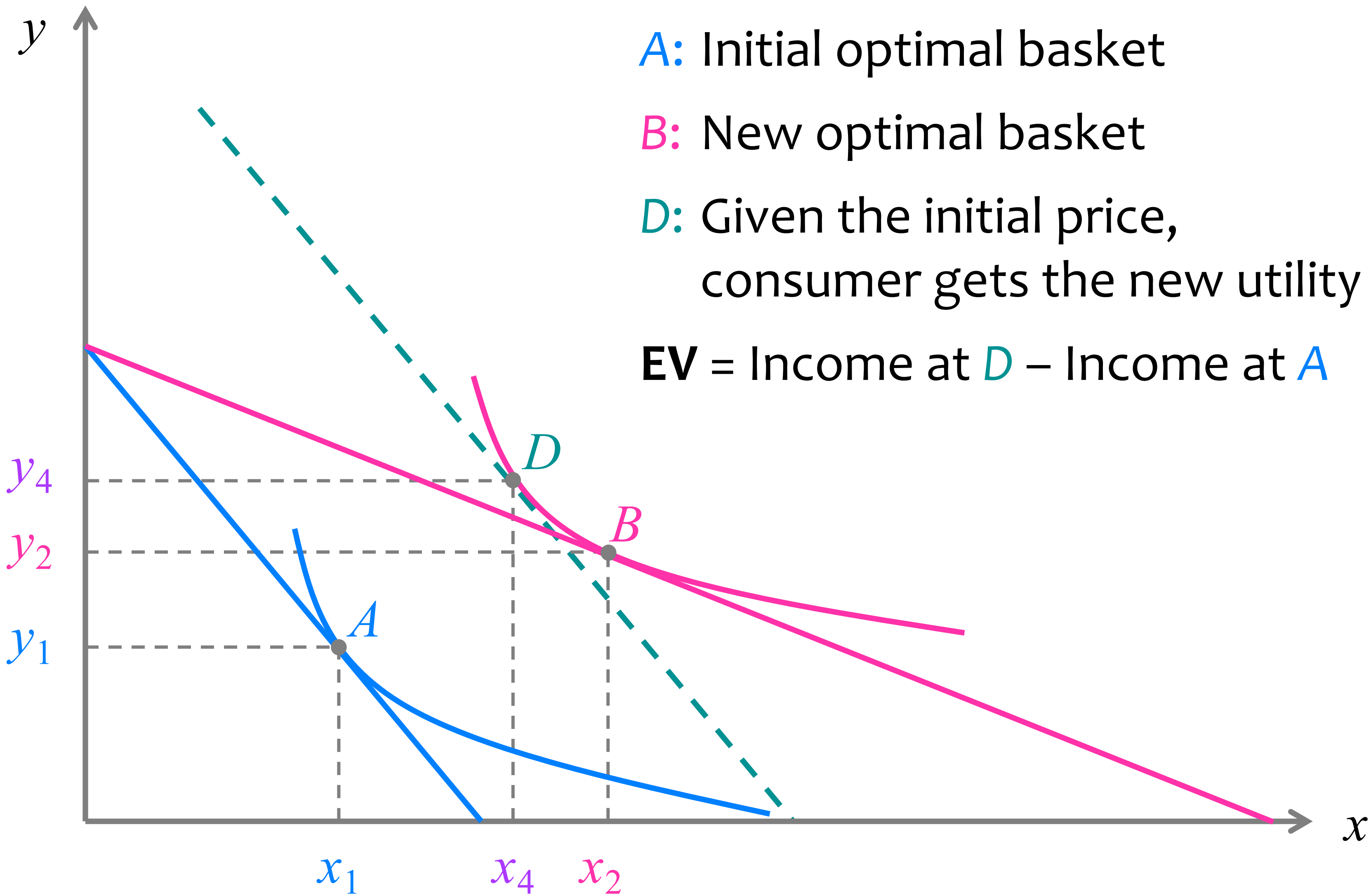
Equivalent Variation: Example

- Chris, with an income of $\$100$, buys gelato and coffee.
  - At her initial optimal basket, her utility is 50.
- Suppose the price of gelato falls.
  - At her new optimal basket, her utility is 60.
- Before the price drop, to get a utility of 60, Chris would need an income of $\$120$.
  - Before the price drop, she would need to spend $\$20$ more to obtain the post-price drop utility level.
  - Thus the benefit of the price drop is equivalent to $\$20$.
  - The equivalent variation is $\$120 - \$100 = \$20$.

Equivalent Variation: Definition

- Equivalent Variation (EV):
  - The amount of money (income)
    that the consumer would need before the price drop
    in order to attain the post-price drop utility level.
- Suppose the initial optimal basket is basket *A*.
- Suppose the price of gelato falls.
  - The new optimal basket is basket *B*.
- Given the initial price, the optimal basket that generates the same level of utility as basket *B* is basket *D*.
- EV = Income at basket *D* – Income at basket *A*

Equivalent Variation



A: Initial optimal basket

B: New optimal basket

D: Given the initial price, consumer gets the new utility

EV = Income at *D* – Income at *A*

Exercise 5.1

Calculating CV and EV

- Suppose Sloane has utility function $U(x, y) = xy$.
- Suppose gelato (x) costs $\$10$ a pint, coffee (y) costs $\$5$ a cup, and Sloane's income is $\$60$.
    - Sloane's optimal basket (basket *A*) is $x_1 = 3, y_1 = 6$.
    - Sloane's utility from basket *A* is $U_A = 18$.

- Suppose the price of gelato (x) falls to $\$6$ a pint.
    - Sloane's new optimal basket (basket *B*) is $x_2 = 5, y_2 = 6$.
    - Sloane's utility from basket *B* is $U_B = 30$.

- Calculate the compensating variation and the equivalent variation of this price change.

Exercise 5.1(a)

Calculating Compensating Variation (CV)

Exercise 5.1(a)

Calculating Compensating Variation (CV)

Exercise 5.1(b)

Calculating Equivalent Variation (EV)

Exercise 5.1(b)

Calculating Equivalent Variation (EV)

Network Externalities

Network Externalities

- Thus far we have assumed that
  each consumer's demand for a good
    is independent of
  everyone else's demand.

- Network externalities occur when
  a consumer's demand for a good
    depends on
  how many other consumers are purchasing the good.

Positive Network Externalities

- Positive network externality:
  - A consumer's demand for a good increases with the number of other consumers who buy the good.
  - The increase in the quantity demanded of a good as more consumers buy the good is the bandwagon effect.

Negative Network Externalities

- Negative network externality:
  - A consumer's demand for a good decreases
    with the number of other consumers who buy the good.
  - The decrease in the quantity demanded of a good
    as more consumers buy the good
    is the snob effect.

Application

Network Externalities

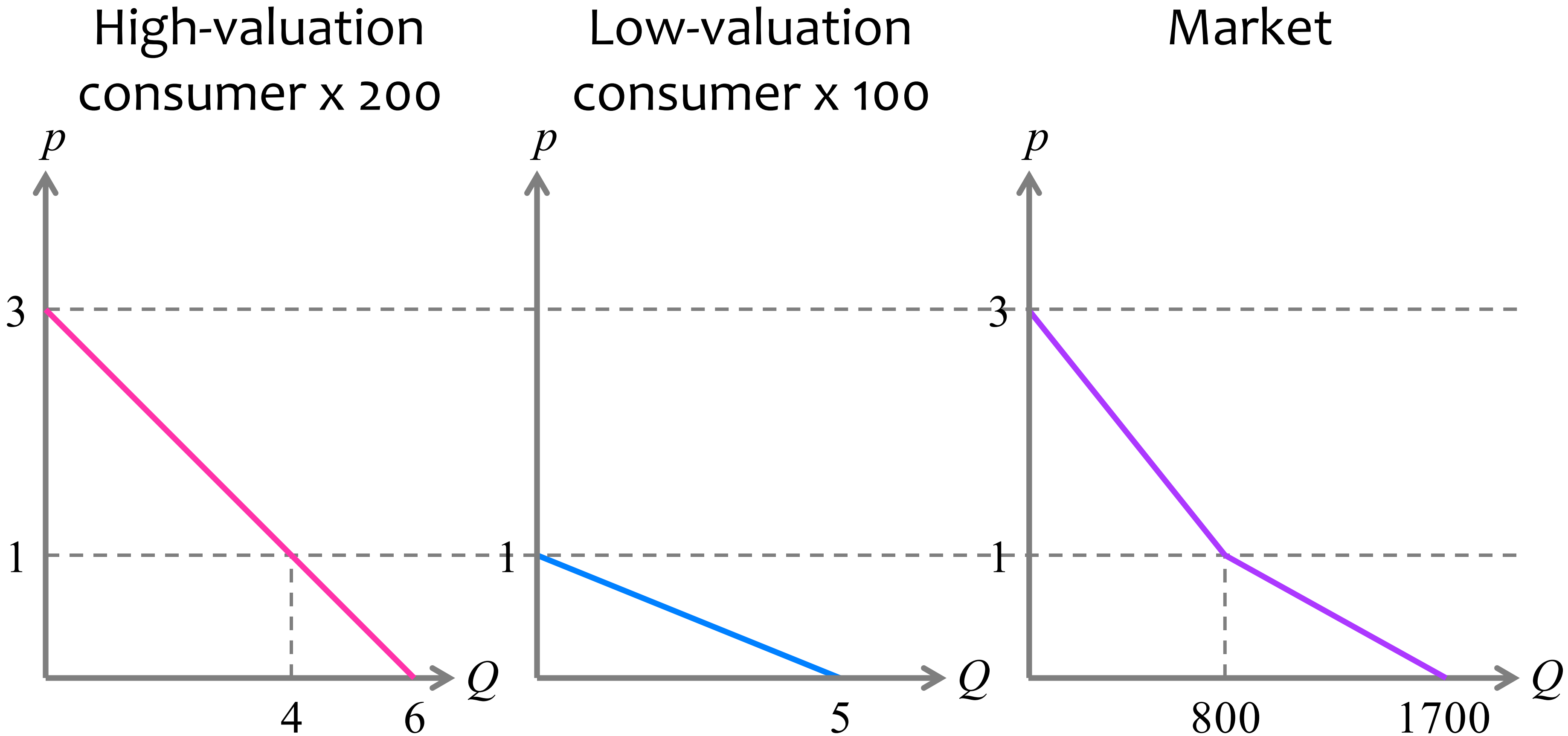
- Think of examples of goods and services with:
  - positive network externalities
  - negative network externalities

Market Demand

Market Demand Curve

- Market/Aggregate Demand Curve:
  - Horizontal summation of all individual demand curves.
- Suppose there are 200 high-valuation consumers.
  - Each high-valuation consumer's demand curve is $Q = 6 - 2p.$
- Suppose there are 100 low-valuation consumers.
  - Each low-valuation consumer's demand curve is $Q = 5 - 5p.$
- What is the market demand curve?

Market Demand Curve



$Q = 6 - 2p$

$p = -\frac{1}{2}Q + 3$

$Q = 5 - 5p$

$p = -\frac{1}{5}Q + 1$

Market Demand Curve

- When $p > 1$:
  - Only high-valuation consumers will buy.
  - Market demand curve: $Q = 200(6 - 2p)$
- When $p \leq 1$:
  - Both high-valuation and low-valuation consumers will buy.
  - Market demand curve: $Q = 200(6 - 2p) + 100(5 - 5p)$
- Market demand curve:

$$Q = \begin{cases} 1{,}700 - 900p & \text{if } p \leq 1 \\ 1{,}200 - 400p & \text{if } p > 1 \end{cases}$$

Summary

Summary: Consumer Choice

Summary: Engel Curve

Optimal Choice

What I buy at a particular income

+

Change in Income

=

Engel Curve

What I buy as a function of income

Summary: Individual Demand Curve

Optimal Choice
What I buy at a particular price

+

Change in Price

=

Individual Demand
What I buy as a function of price

Summary: Market Demand Curve

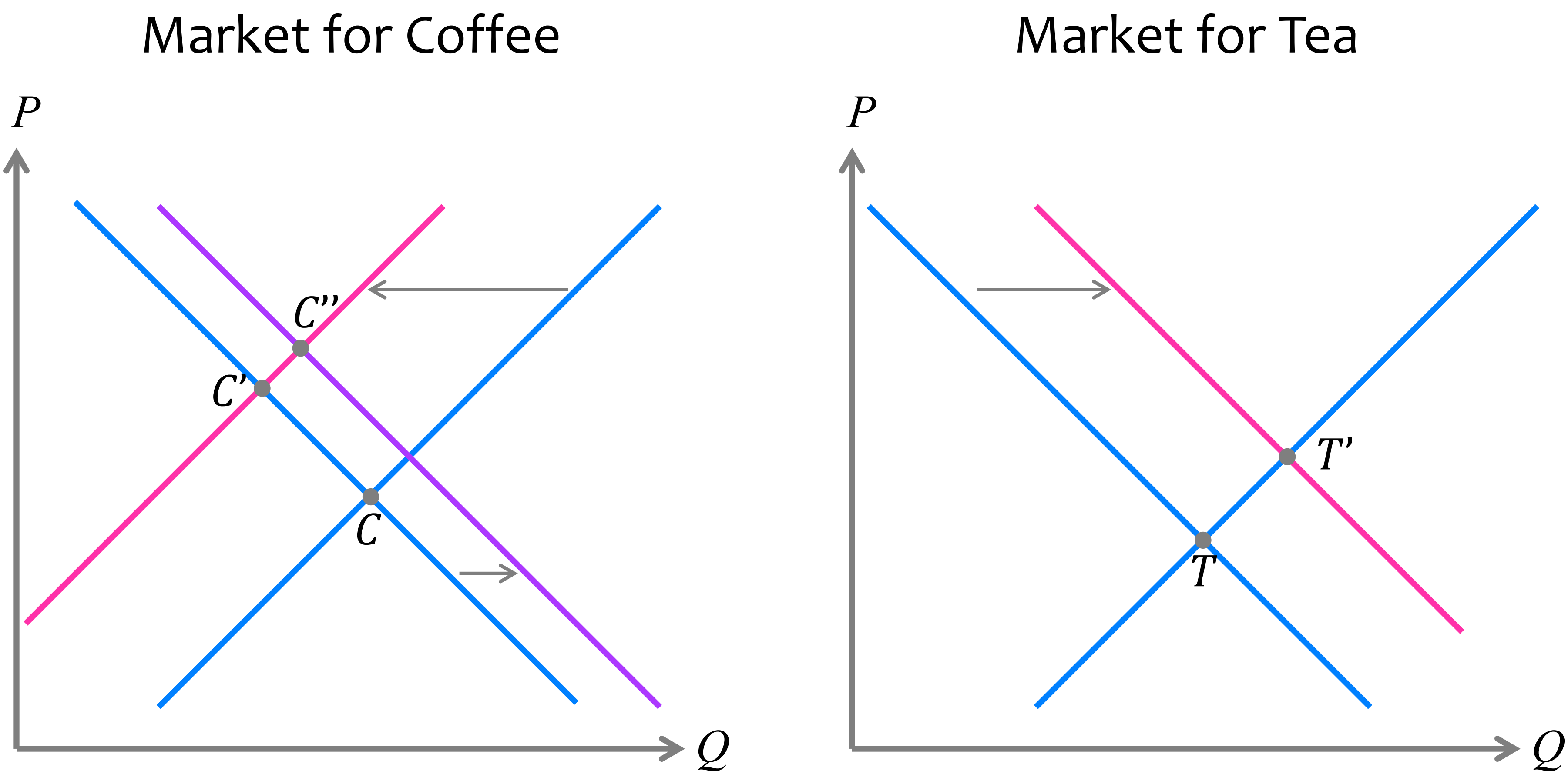
Lecture 5

General Equilibrium Analysis: Exchange Economy

- General Equilibrium
- Exchange Economy
- Edgeworth Box
- Pareto Efficiency

General Equilibrium

Market for Coffee & Market for Tea



Partial Equilibrium vs. General Equilibrium

- Partial Equilibrium Analysis
  - Finding the equilibrium price and quantity
    in a single market,
    holding prices in all other markets fixed.
- General Equilibrium Analysis
  - Finding the equilibrium prices and quantities
    in more than one market simultaneously.

Exchange Economy

Exchange Economy

- There are two consumers in the economy:
  Consumer *A* and Consumer *B*.
- There are two goods in the economy: good 1 and good 2.
- Consumer *A*'s consumption basket is denoted by:
  $$\left(x_1^A, x_2^A\right)$$
- Consumer *B*'s consumption basket is denoted by:
  $$(x_1^B, x_2^B)$$
- An allocation is a pair of consumption baskets:
  $$\left(\left(x_1^A, x_2^A\right), (x_1^B, x_2^B)\right)$$

Endowment Allocation

- Each consumer is endowed with a non-negative amount of each good.
  - The allocation that the consumers start with is the endowment allocation:

$$\left((\omega_1^A, \omega_2^A), (\omega_1^B, \omega_2^B) \right)$$

- Suppose Consumer A's endowment is $(5,4)$ and Consumer B's endowment is $(7,2)$.
  - The total amount of good 1 is $5 + 7 = 12$.
  - The total amount of good 2 is $4 + 2 = 6$.

Exchange Economy

- There is no money or income.
- There is no production.
- The two consumers can trade with each other.
- After trading,
    - Consumer *A* will end up with consumption basket $x^A = \left(x_1^A, x_2^A\right)$.
    - Consumer *B* will end up with consumption basket $x^B = (x_1^B, x_2^B)$.

Feasible Allocation

- An allocation $\left((x_1^A, x_2^A), (x_1^B, x_2^B)\right)$ is feasible if
  - all the quantities are non-negative
  - for each good, total consumption equals total endowment

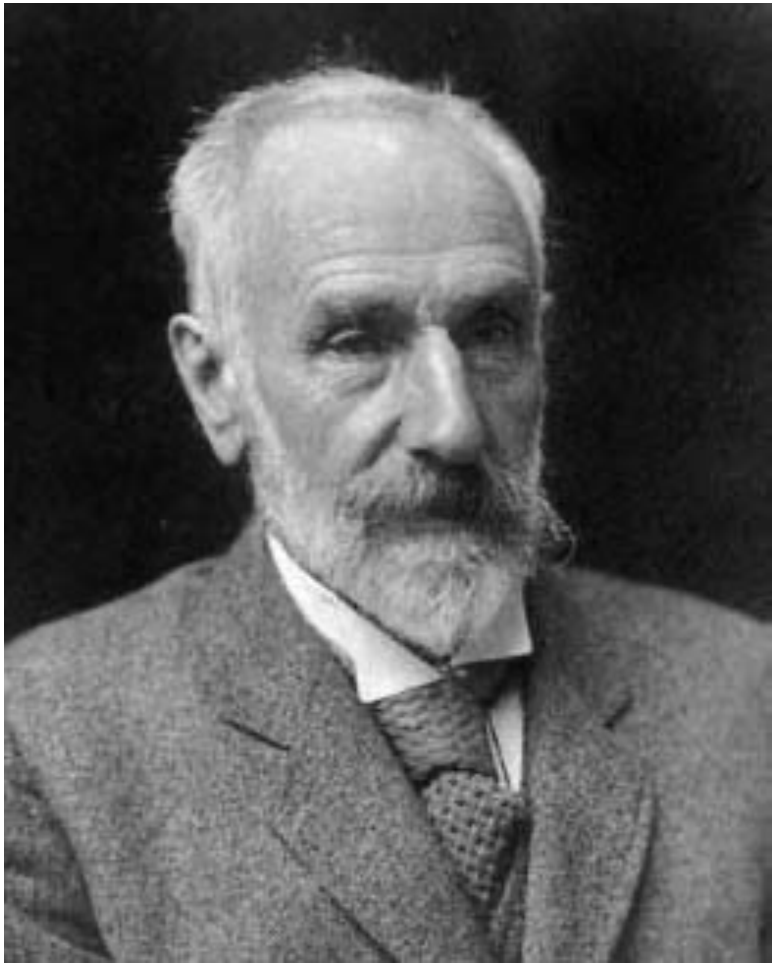
$$x_1^A + x_1^B = \omega_1^A + \omega_1^B$$

$$x_2^A + x_2^B = \omega_2^A + \omega_2^B$$

- Suppose the total amount of good 1 is 12 and the total amount of good 2 is 6. Which allocations are feasible?
  - $\left((6,3), (6,3)\right)$
  - $\left((8,-2), (4,8)\right)$
  - $\left((3,4), (7,4)\right)$
  - $\left((12,6), (0,0)\right)$

Edgeworth Box

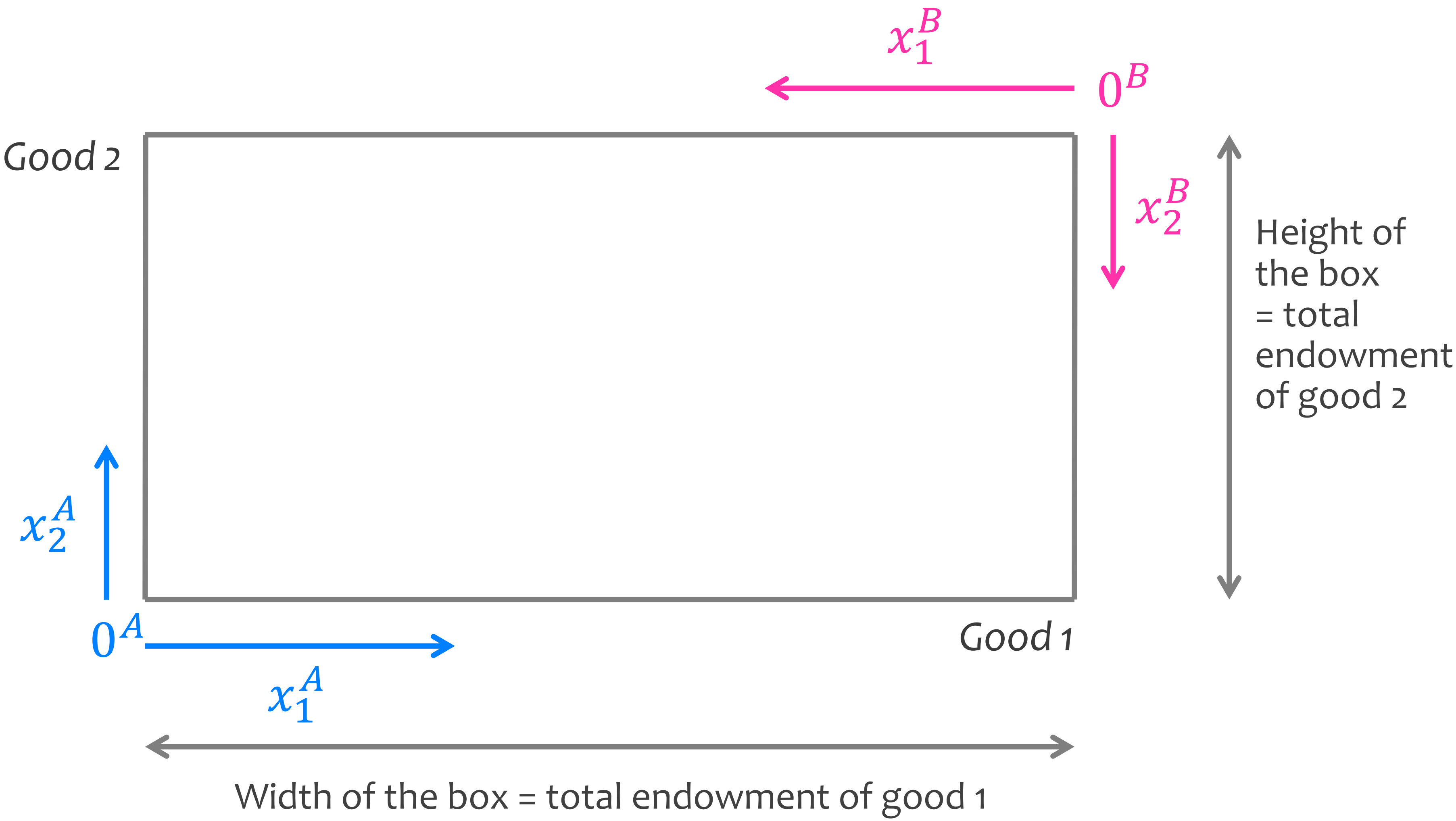
Francis Ysidro Edgeworth



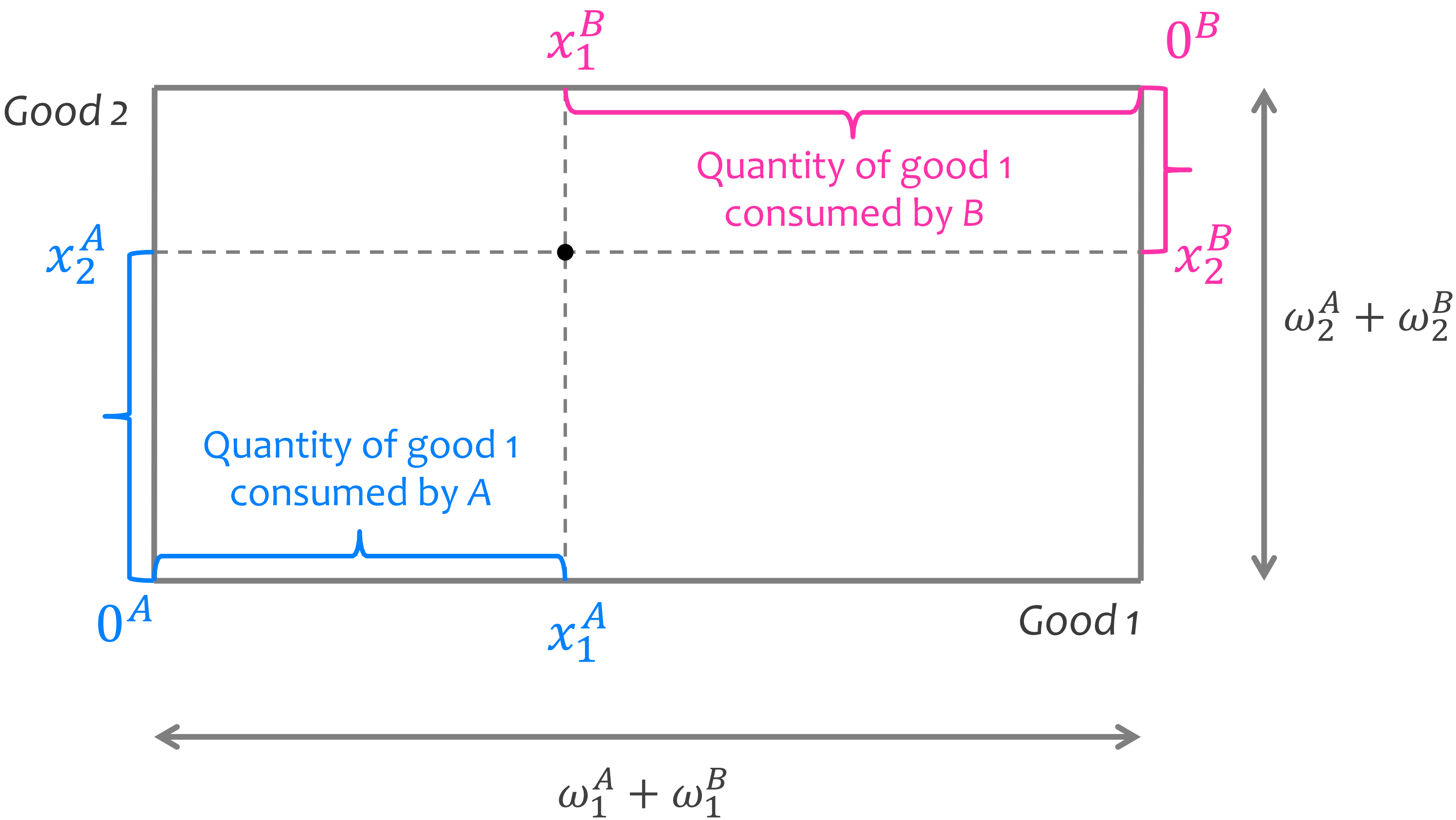
Francis Ysidro Edgeworth
1845–1926

- An Edgeworth box is used to graphically show all feasible allocations of the two goods.
- Every point in the box, including those on the boundaries, represents a feasible allocation.

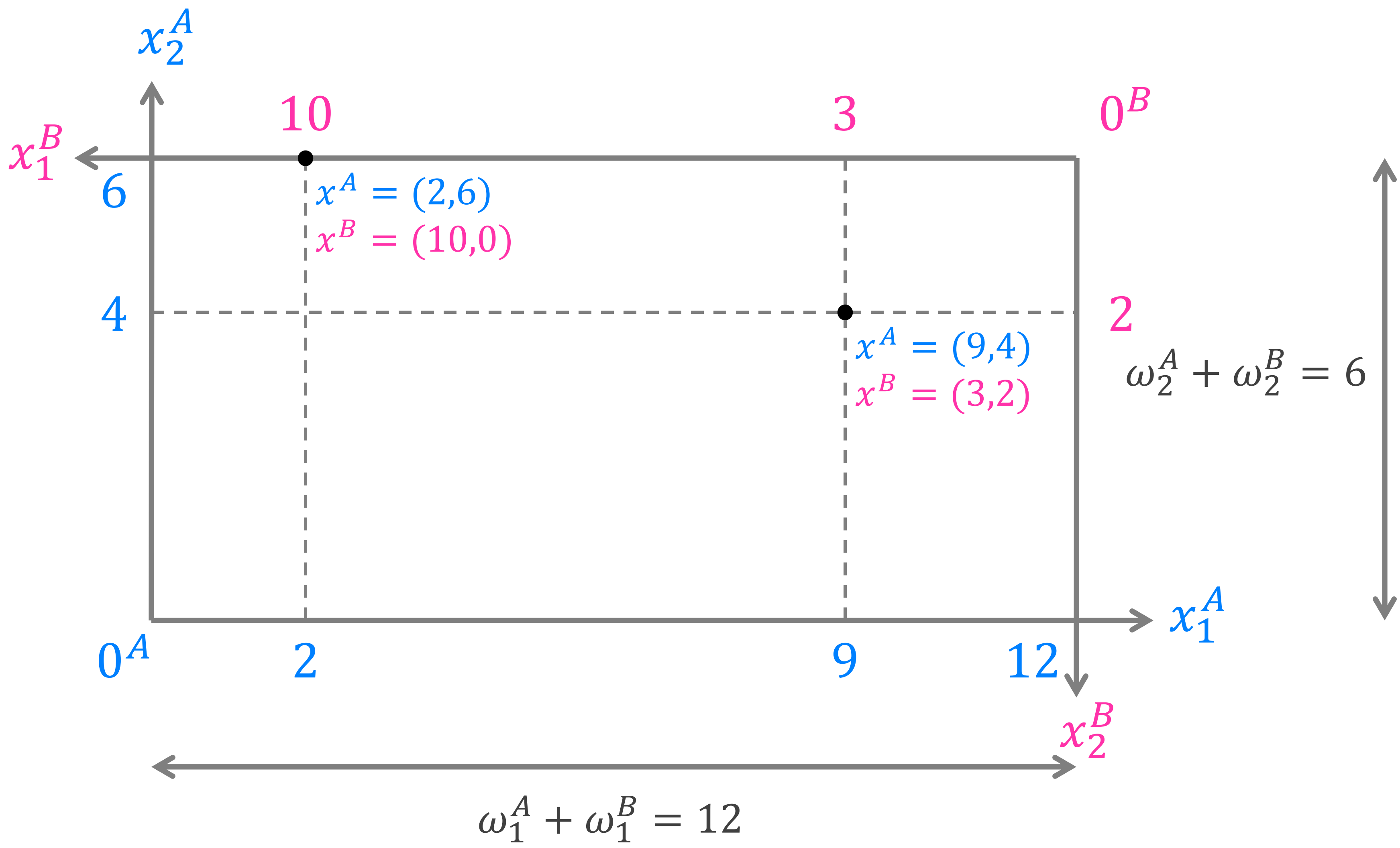
Edgeworth Box



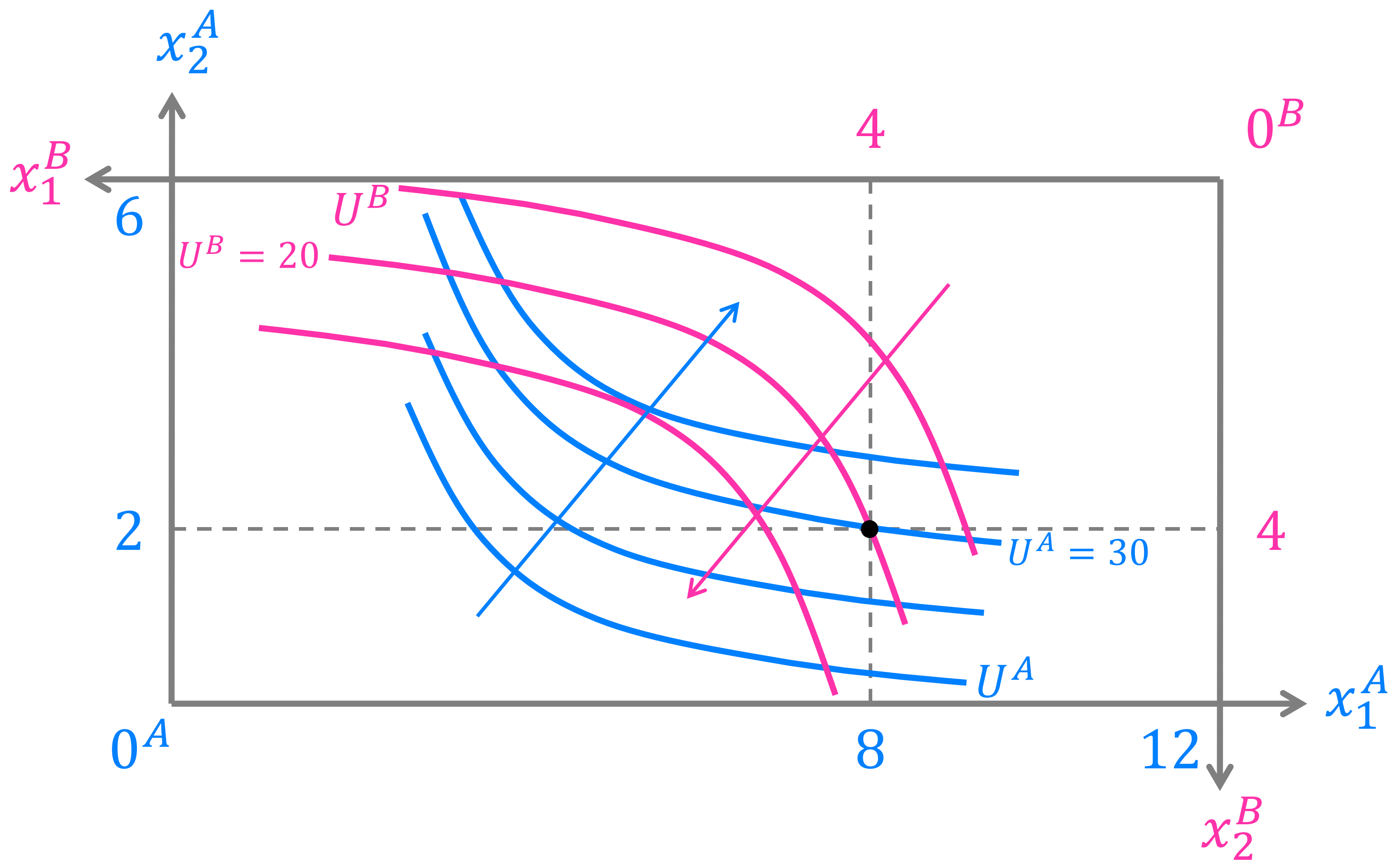
Edgeworth Box: Feasible Allocation



Edgeworth Box: Example

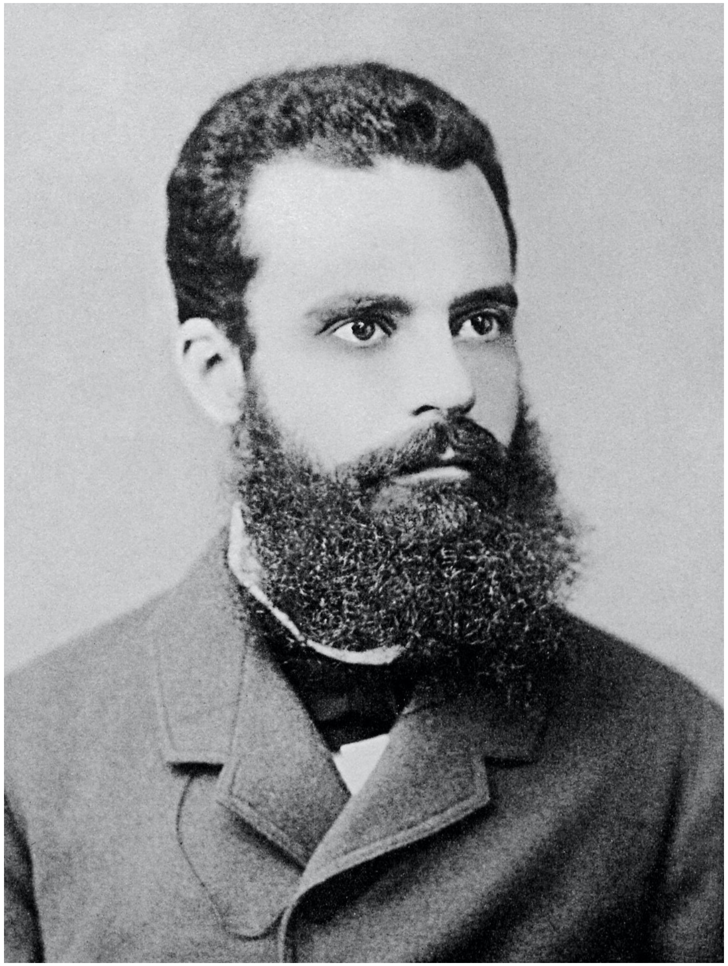


Edgeworth Box: With Preferences



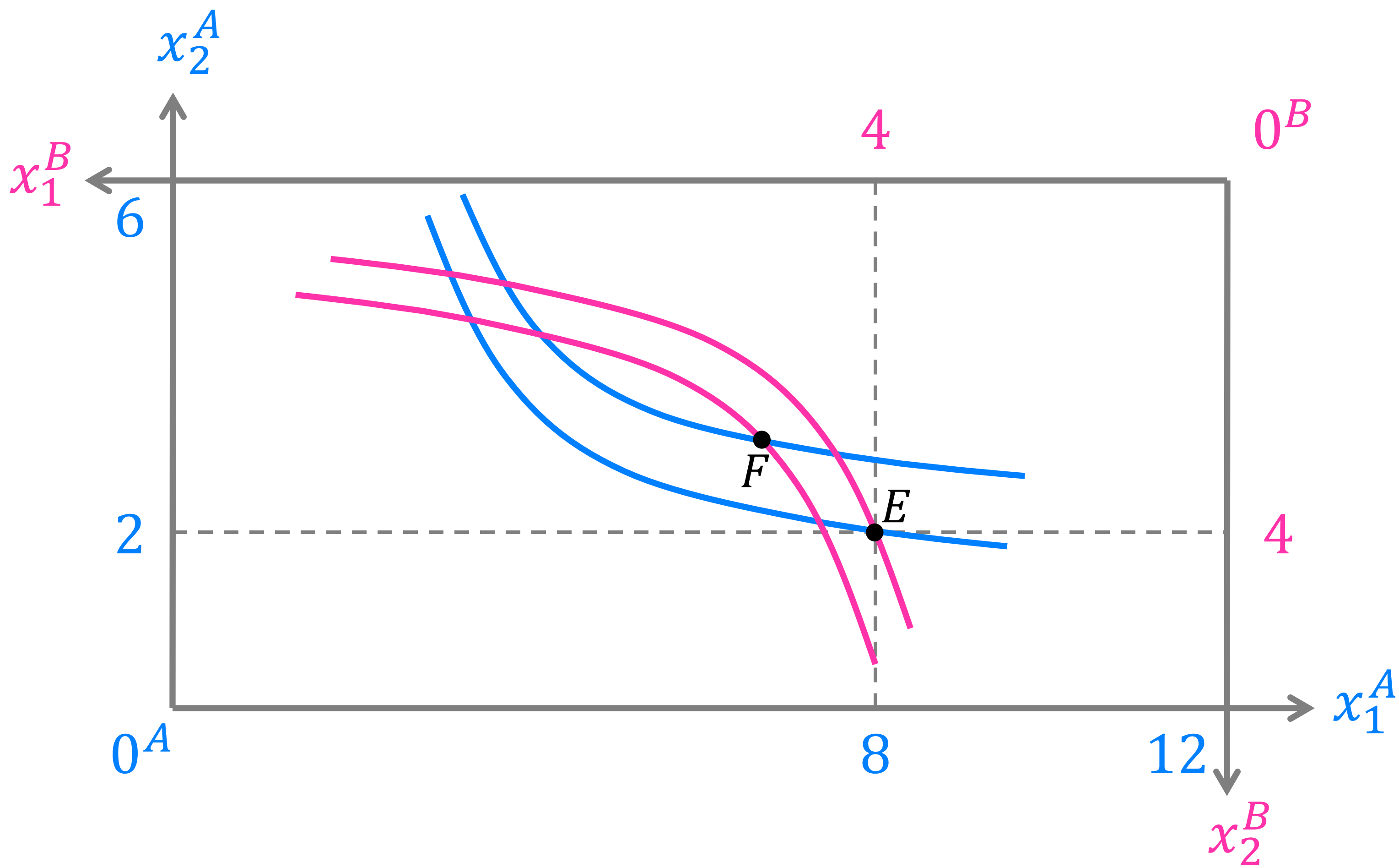
Pareto Efficiency

Vilfredo Pareto


Vilfredo Pareto
1848–1923

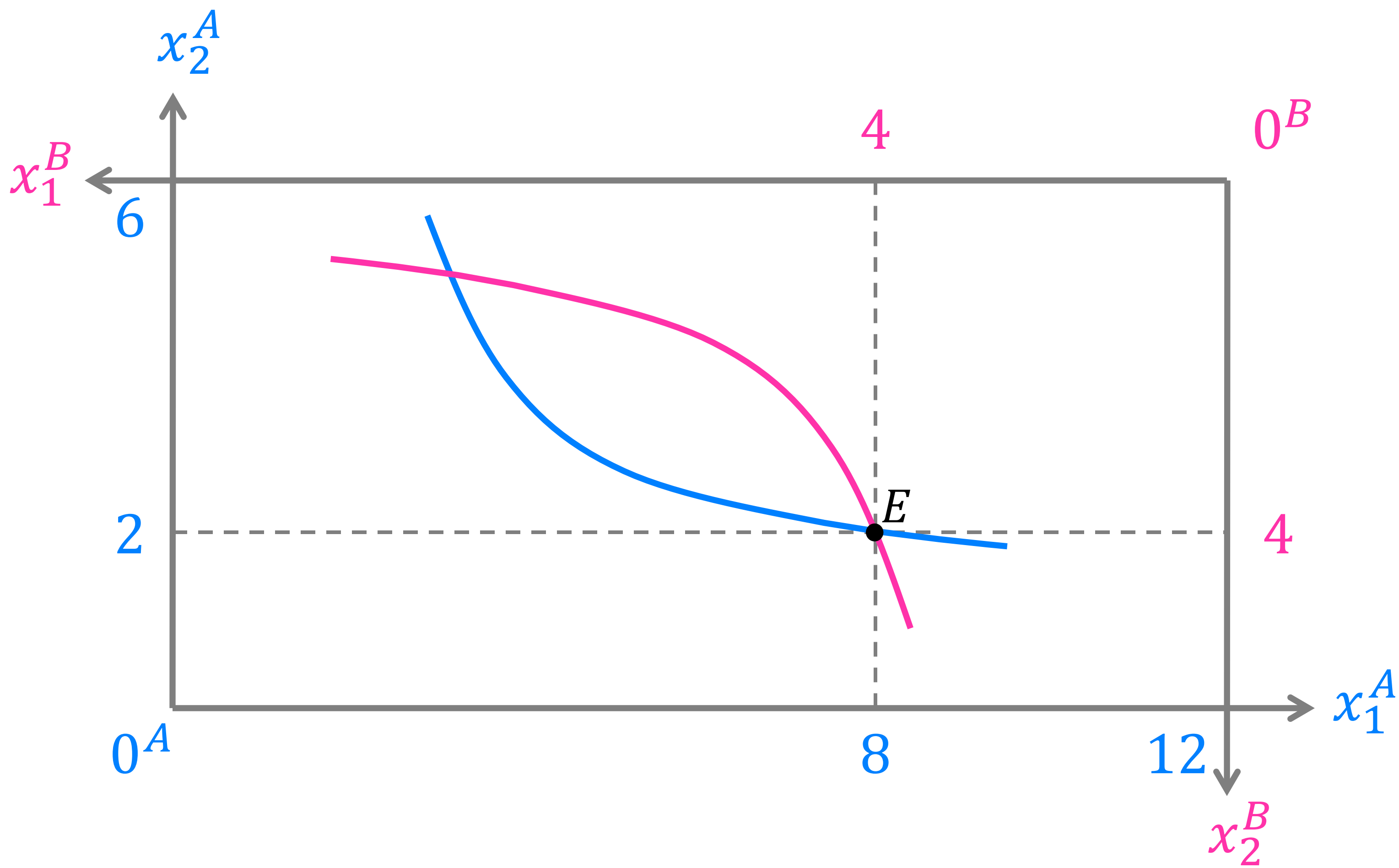
- Economist, statistician, and sociologist.
- Introduced the concept of ordinal utility and Pareto efficiency, laying the foundation of modern welfare economics.
- Emphasized the importance of reconciling economic theories with empirical data, as shown by his work on income distribution.

Is there an allocation where both consumers are better off than at E?

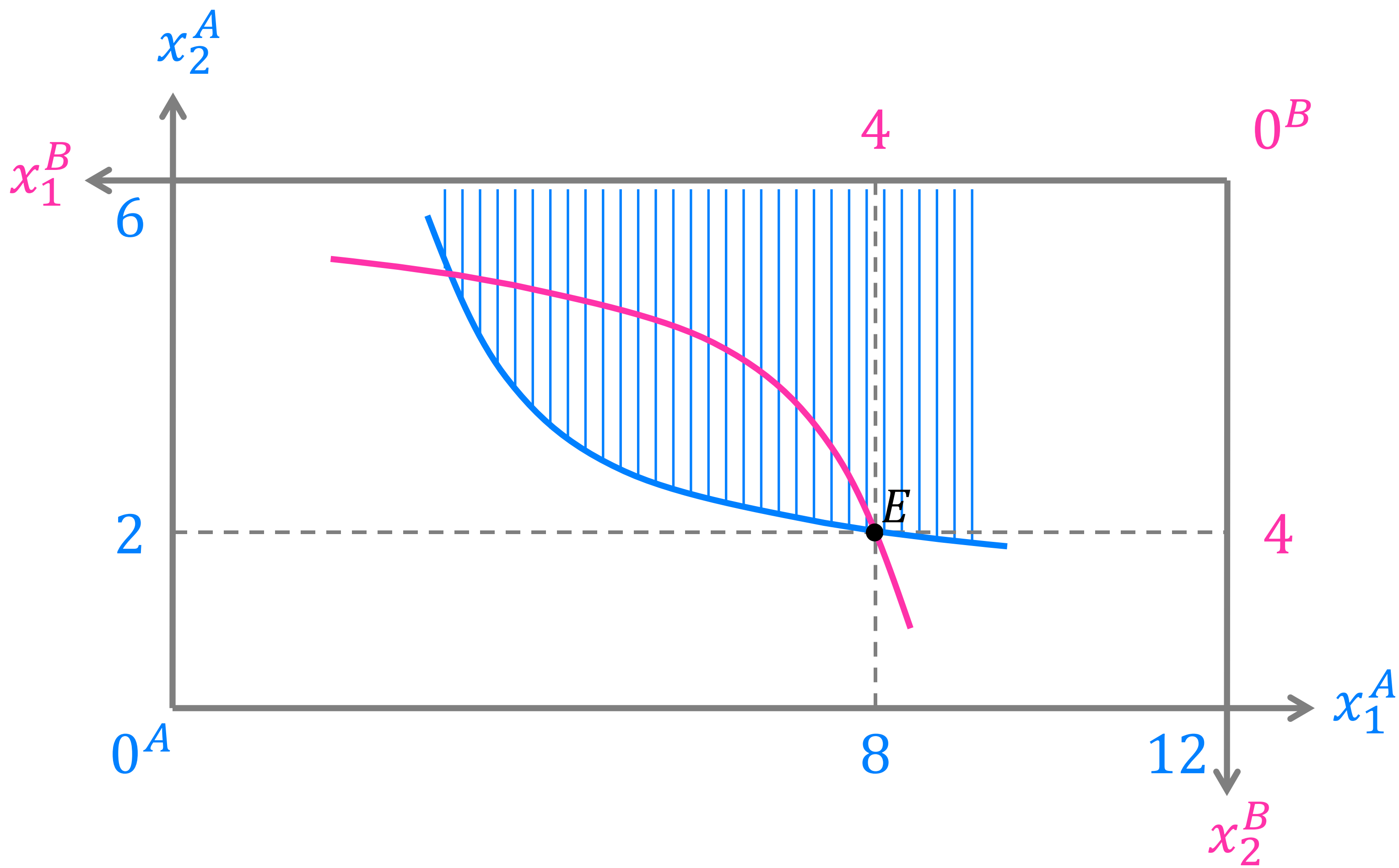


Both consumers have higher utility at point F than at point E.

Is there an allocation where both consumers are at least as well off as at E?

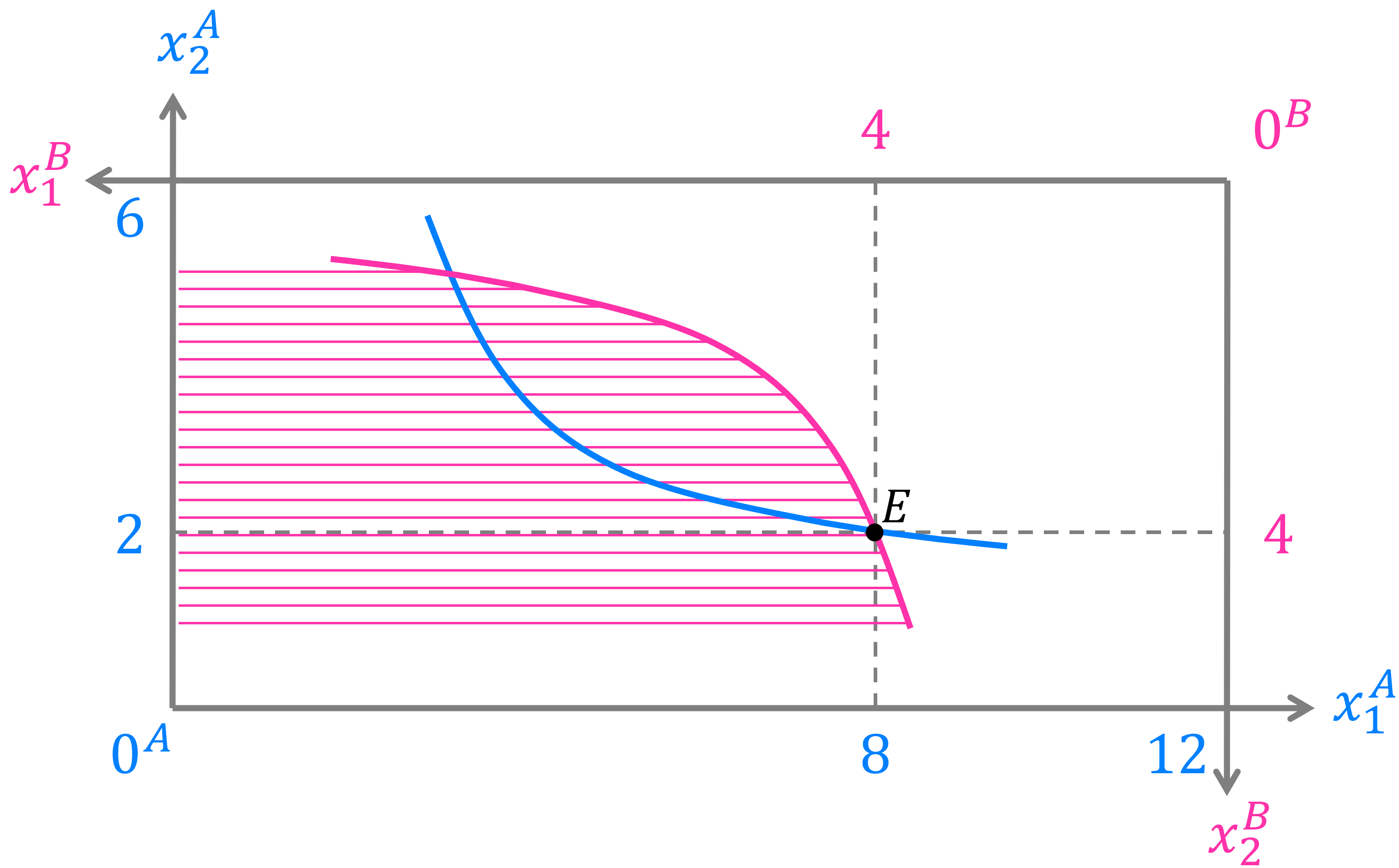


Is there an allocation where both consumers are at least as well off as at *E*?



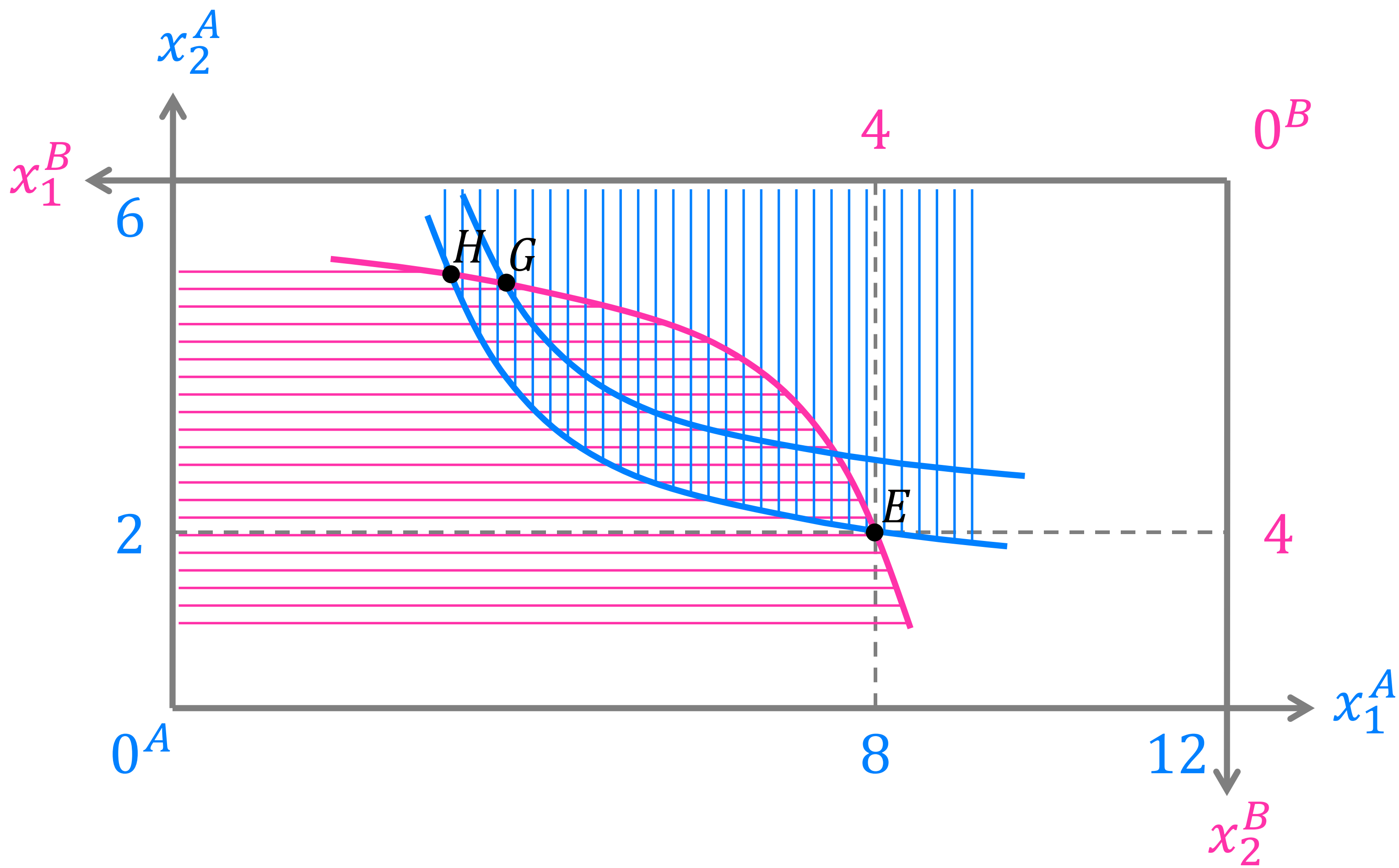
At any allocation in the blue shaded region, consumer *A*’s utility is at least as high as at point *E*.

Is there an allocation where both consumers are at least as well off as at *E*?



At any allocation in the pink shaded region, consumer *B*'s utility is at least as high as at point *E*.

Is there an allocation where both consumers are at least as well off as at *E*?



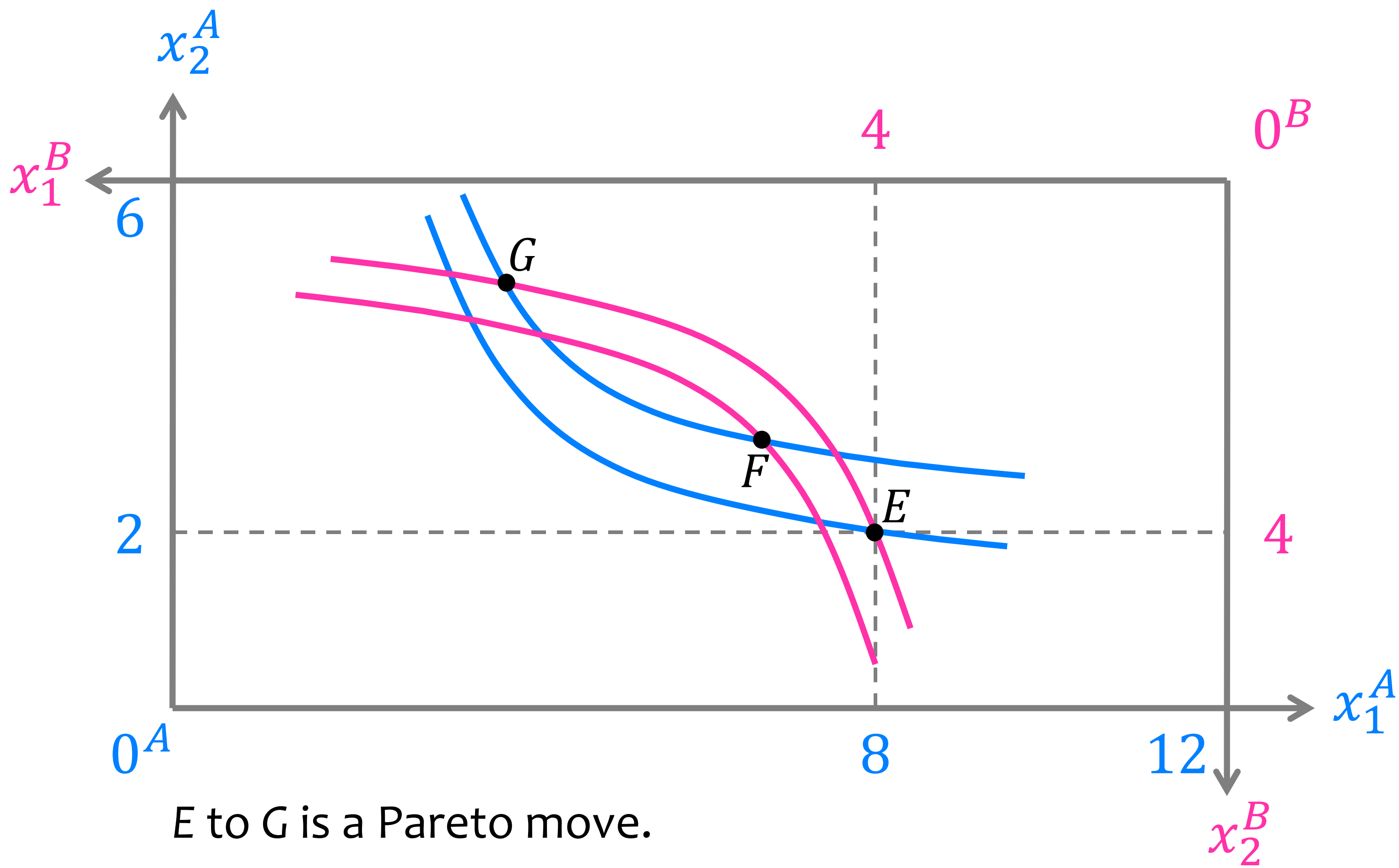
At any allocation in the blue and pink shaded region, each consumer's utility is at least as high as at point *E*.

Pareto Move / Pareto Improvement

- Suppose ***P*** and ***Q*** are two feasible allocations.
  P Pareto dominates ***Q*** if:
  - All consumers like ***P*** at least as well as ***Q***, i.e., $\boldsymbol{P} \succcurlyeq \boldsymbol{Q}$.
  - At least one consumer likes ***P*** better than ***Q***, i.e., $\boldsymbol{P} \succ \boldsymbol{Q}$.

- If ***P*** Pareto dominates ***Q***,
  then moving from ***Q*** to ***P***
  is a Pareto move or a Pareto improvement.

Which are Pareto moves?

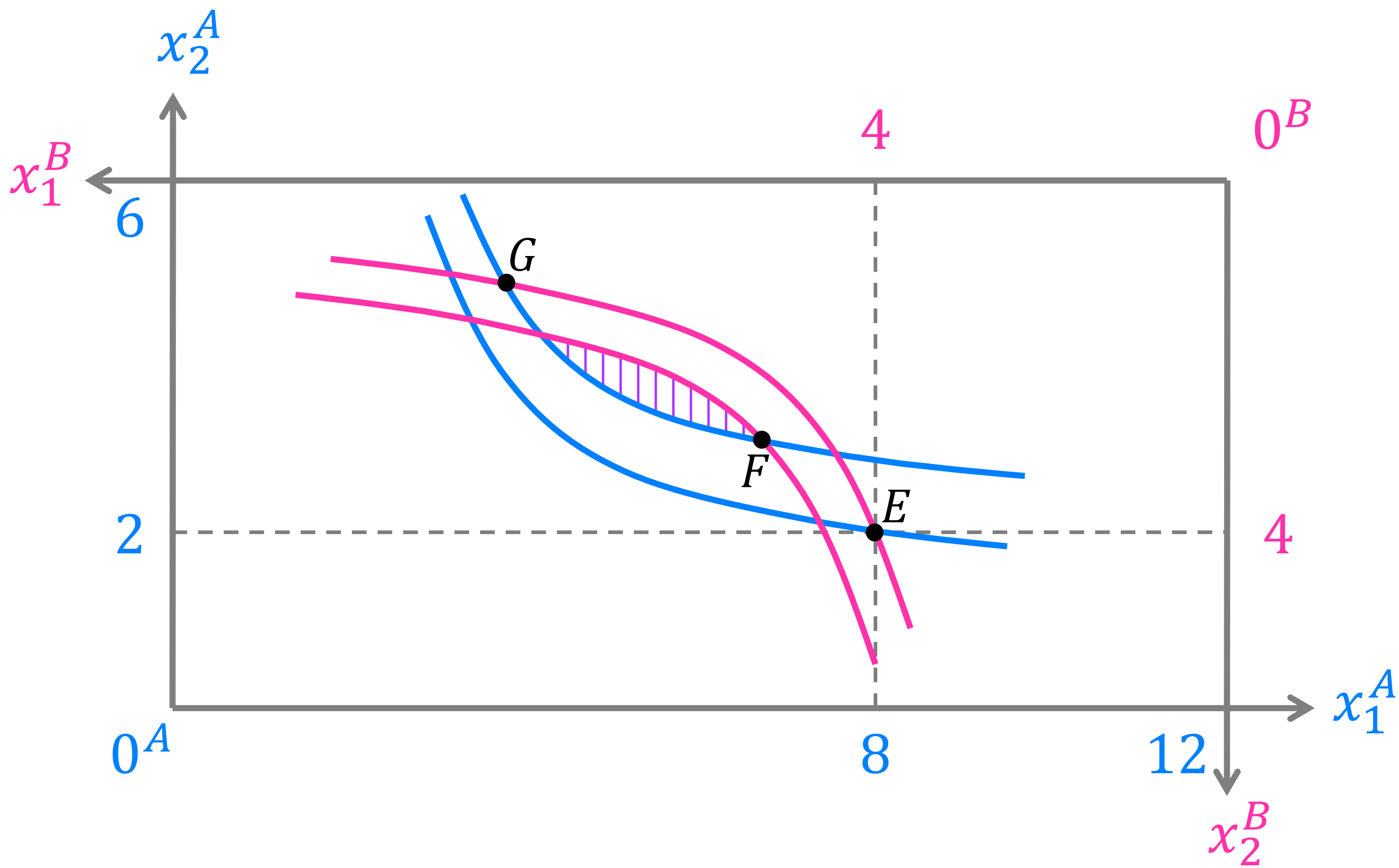


E to *G* is a Pareto move.

G to *F* is a Pareto move.

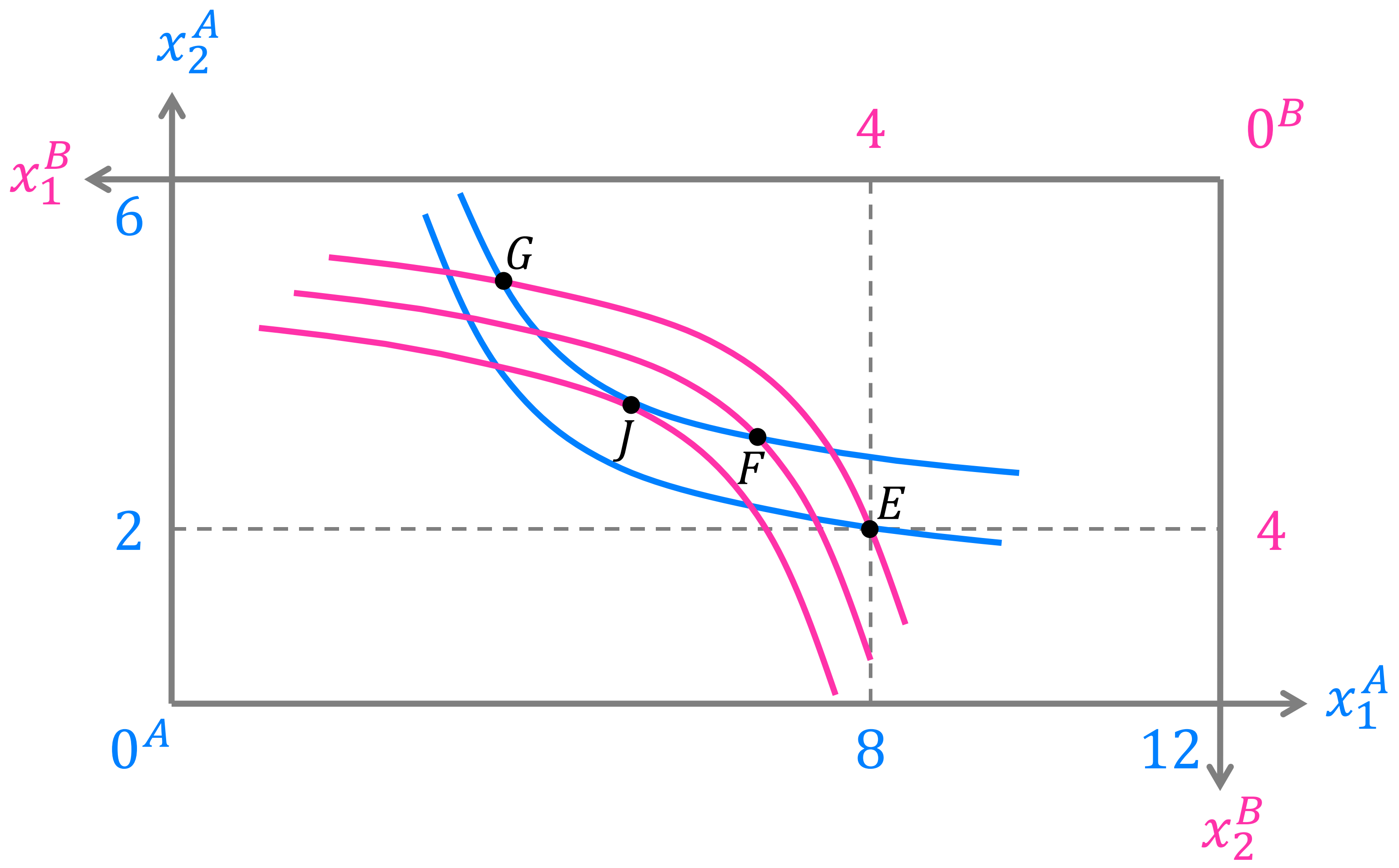
E to *F* is a Pareto move.

At F, can we make a Pareto move?

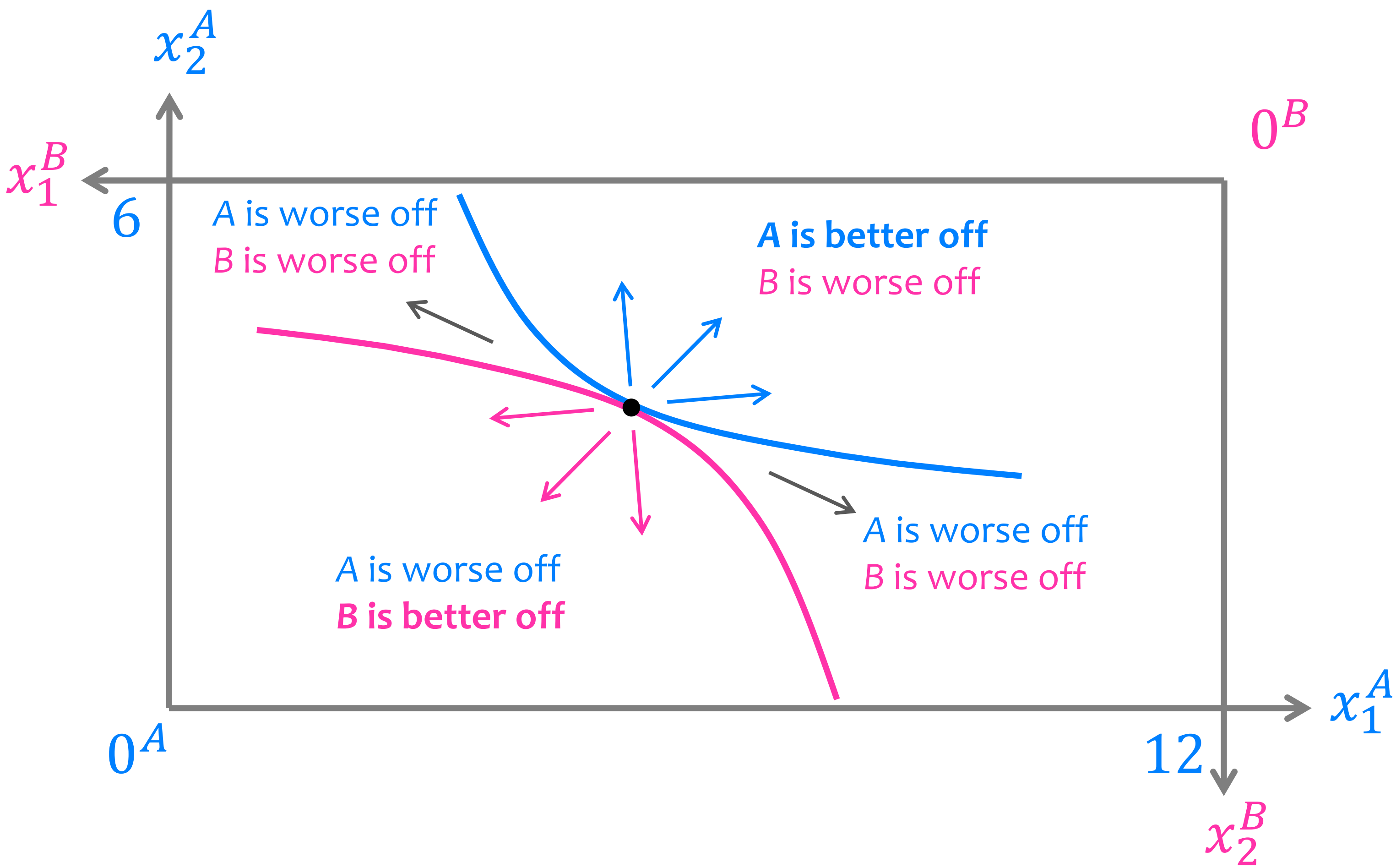


Any allocation in the shaded region
is a Pareto move from F.

At J, can we make a Pareto move?



A closer look at J



At J, we cannot make one consumer better off without making the other consumer worse off.

Pareto Efficiency / Pareto Optimality

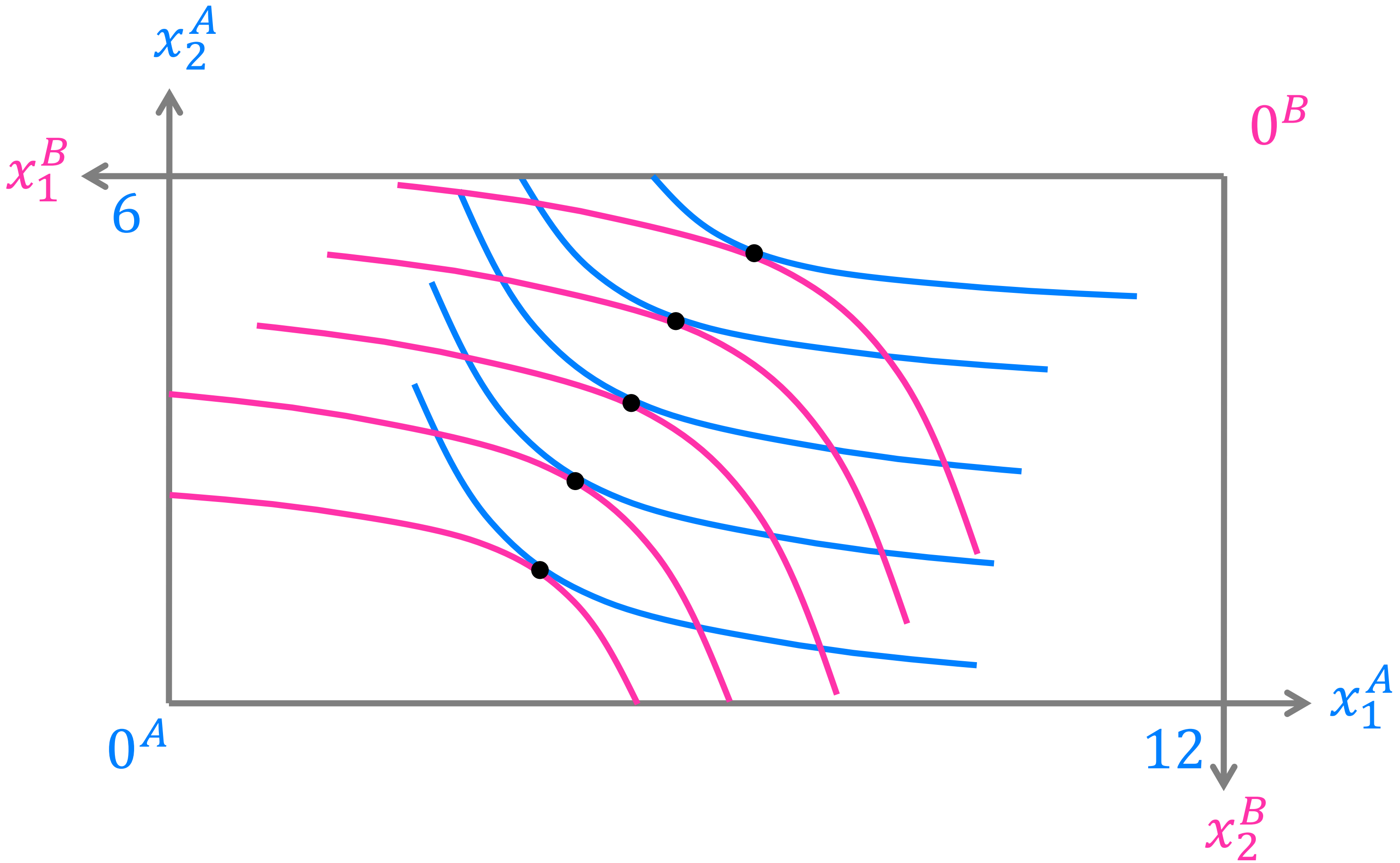
- A feasible allocation ***P*** is Pareto efficient or Pareto optimal if there does not exist an alternative feasible allocation ***Q*** such that:
  - ***Q*** gives all consumers at least as much utility as ***P***.
  - ***Q*** gives at least one consumer more utility than ***P***.

Pareto Efficiency / Pareto Optimality

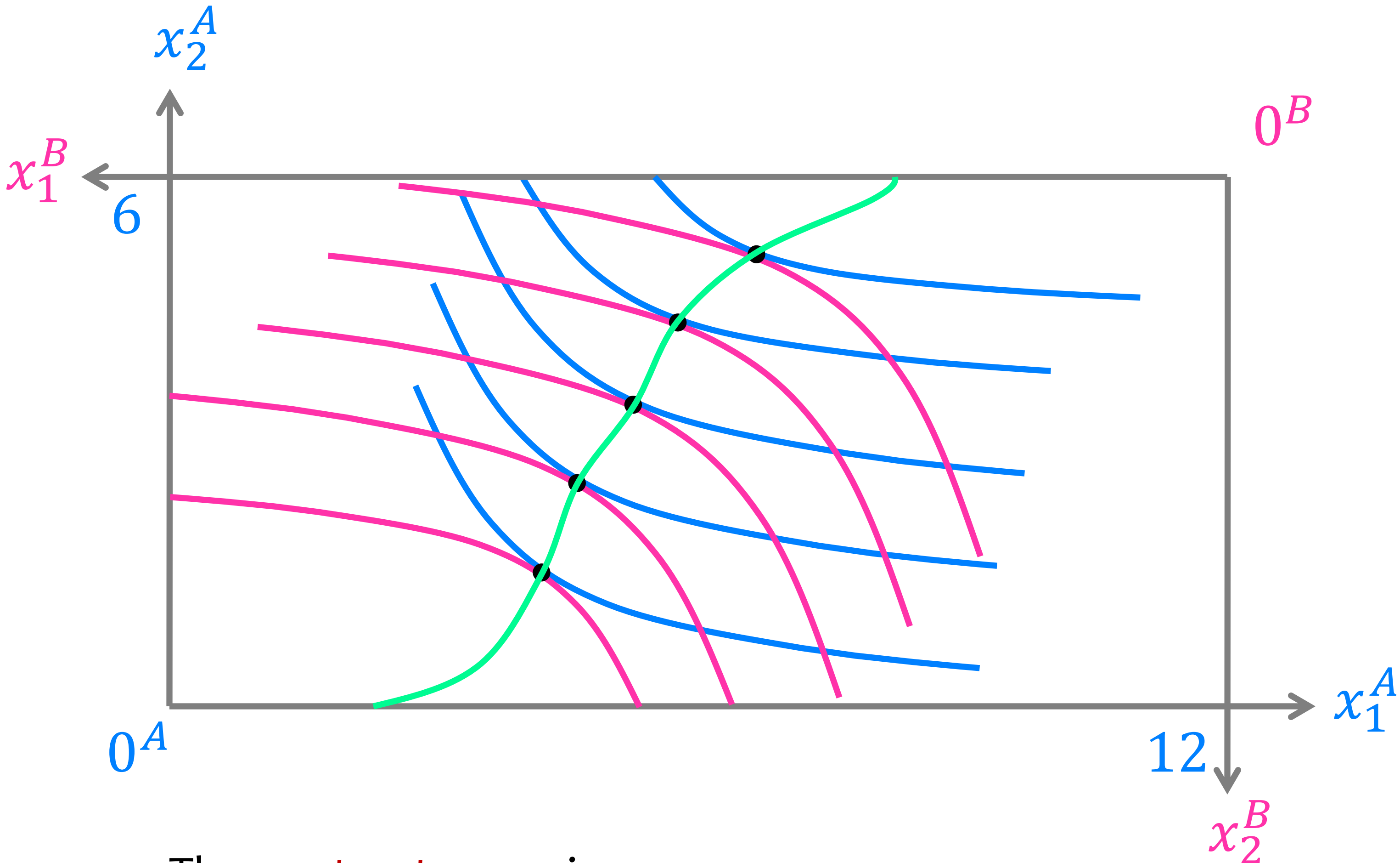
- Suppose each consumer has indifference curves that are smooth with diminishing *MRS*.
- Suppose we have interior solutions.

- The tangency points of any two indifference curves are Pareto efficient.
  - The points where indifference curves intersect (i.e., non-tangency points) are not Pareto efficient.

There are many Pareto-efficient allocations



Contract Curve



The contract curve is
the set of all Pareto-efficient allocations.

Deriving the Contract Curve Mathematically

- Tangency condition:

$$MRS_{1,2}^{A} = MRS_{1,2}^{B} \qquad \text{(i)}$$

  - E.g., if $U^i = x_1^i x_2^i$ for $i = A, B$, then $MRS_{1,2}^i = \frac{x_2^i}{x_1^i}$.

- The allocation must be feasible:

$$x_1^A + x_1^B = \omega_1^A + \omega_1^B \qquad \text{(ii)}$$

$$x_2^A + x_2^B = \omega_2^A + \omega_2^B \qquad \text{(iii)}$$

- Substituting (ii) and (iii) into (i),
  we can express the contract curve in terms of x_1^A and x_2^A or
  in terms of x_1^B and x_2^B.

Exercise 5.2

Contract Curve

- Suppose $MRS_{1,2}^{A} = \frac{x_2^A}{x_1^A}$, $MRS_{1,2}^{B} = \frac{x_2^B}{x_1^B}$, and there are 10 units of good 1 and 10 units of good 2 in the economy. Find the contract curve, $x_2^A(x_1^A)$.

Exercise 5.2

Contract Curve

Exercise 5.3

Pareto Improvement and Pareto Efficiency

Are the following statements True or False?

(a) If an allocation is Pareto efficient,
there are no Pareto improvements to be had.

(b) If an allocation is not Pareto efficient,
there are Pareto improvements to be had.

Exercise 5.4

Feasibility and Pareto Efficiency

- Recall: An allocation is feasible if:

$$x_1^A + x_1^B = \omega_1^A + \omega_1^B$$

$$x_2^A + x_2^B = \omega_2^A + \omega_2^B$$

- Alternative definition: An allocation is feasible if:

$$x_1^A + x_1^B \leq \omega_1^A + \omega_1^B$$

$$x_2^A + x_2^B \leq \omega_2^A + \omega_2^B$$

  - For each good, the total amount consumed
    does not exceed the total amount available in the economy.

Exercise 5.4

Feasibility and Pareto Efficiency

- Suppose there is a total of 8 units of good 1 and 4 units of good 2 in an economy.

- Suppose the consumers' preferences for each good satisfy monotonicity.

- Is the allocation $\big((1,1),(1,1)\big)$ Pareto efficient?
  - Note that by the alternative definition, this allocation is feasible.

Exercise 5.5

Pareto Improvement

- Refer to the Edgeworth box on the next slide. Indicate whether the following statements are True or False.
  - *P* is a Pareto improvement over *Q*.
  - *Q* is a Pareto improvement over *R*.
  - *Q* is a Pareto improvement over *T*.
  - *R* is a Pareto improvement over *S*.
  - *S* is a Pareto improvement over *T*.
  - *T* is a Pareto improvement over *R*.

Exercise 5.5

Pareto Improvement