Università Bocconi

Microeconomics

Prof. Elisa Borghi &
Prof. Maristella Botticini

Lecture T2

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Markets: demand, supply, prices

- In market economies, goods and services are allocated through the **market mechanism**.
- The two sides of a market are
  - **demand**
  - **supply**
- When markets work, prices measure the scarcity of the goods and services that are exchanged. Hence, prices convey critical information to buyers and sellers who make their decisions based on prices (and other variables).

Chapters 2 and 3
Budget constraint and preferences

Overarching goal

Where the demand function comes from?

Building blocks

- ✓ How people make **choices**: economic principles
- ✓ Scarcity, the **budget constraint**, **opportunity cost**
- ✓ Describe mathematically people's **preferences / tastes**
- ✓ **Constrained optimal choice**: how people maximize their well-being subject to scarcity and trade-offs

How does Jannik Sinner choose?

Rational choice theory assumes that individuals choose in a «rational way», that is, they maximize their well-being subject to scarcity and trade-offs. How?

1. First, they identify the set of feasible alternatives

2. Next, they choose «the best» alternative among those feasible

What determines what and how much I demand?

Preferences, tastes	**Budget constraint** – prices of goods & services – income
determine	determines
what I **WANT** to purchase	what I **CAN** purchase

Examples

- I and …

- I and XX's paintings …..
- Bocconi cafeteria: 10-euro menus

Serpico *Indiana Jones*

Tarzan *Sandokan*

Which one I choose?

Here comes our best friend (mathematics!!!)

Consumption bundles of goods

- In the real world, individuals choose / demand / consume bundles of commodities.
- Mathematically, a consumption bundle, $\boldsymbol{x}$, is a vector where x_i indicates the units of good i an individual chooses / consumes

$$\boldsymbol{x = (x_1, x_2, x_3, \ldots, x_n)}$$

- To use graphs, we **assume** that individuals choose / demand /consume just two commodities

$$\boldsymbol{x_1} \text{ and } \boldsymbol{x_2}$$

Important: what we learn using two goods can be extended to n goods.

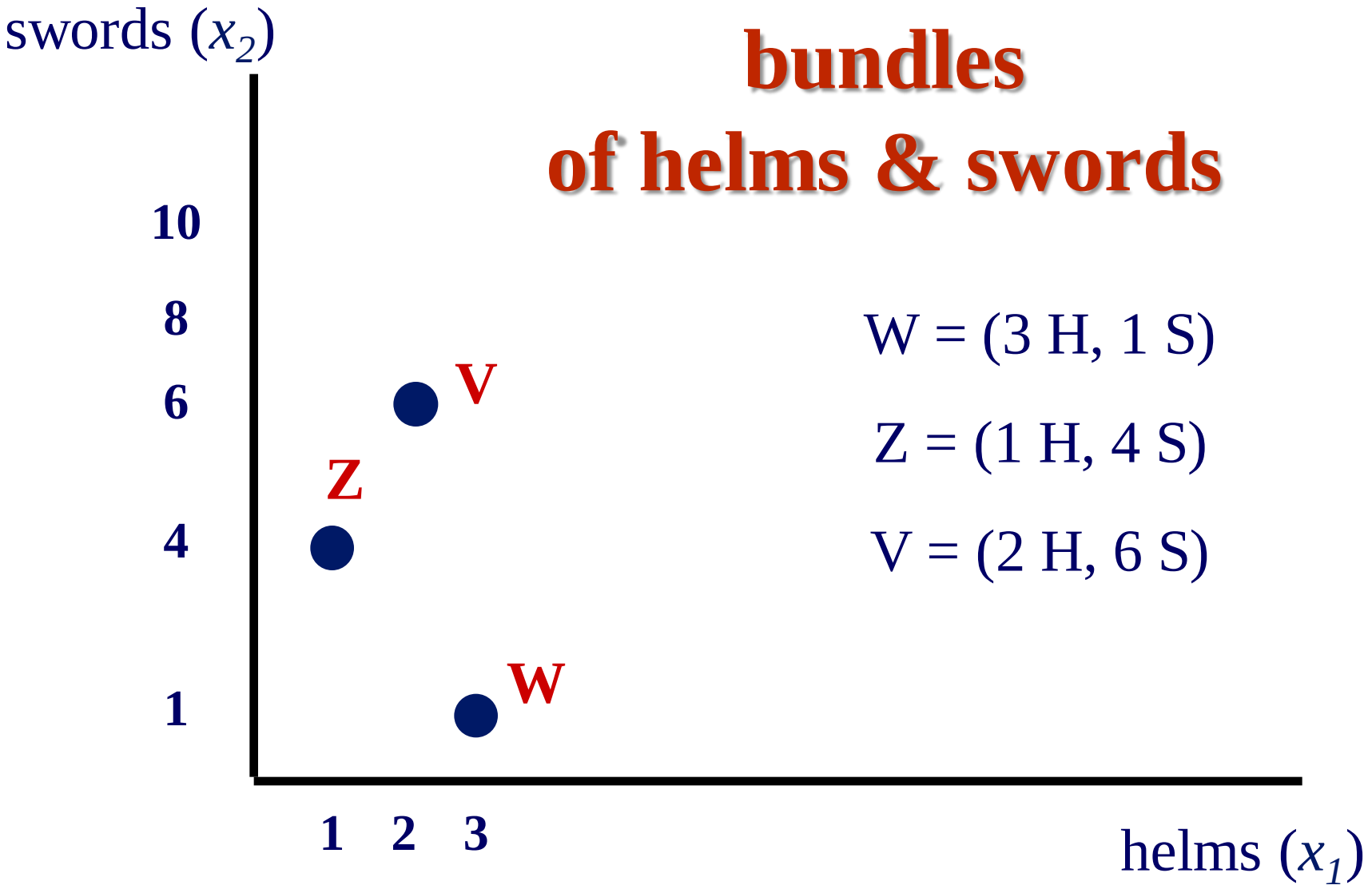
Alexander the Great

… he buys

helms from armorer Stratonikos (x_1)

swords from armorer Thyrsos (x_2)

bundles of helms & swords



W = (3 H, 1 S)

Z = (1 H, 4 S)

V = (2 H, 6 S)

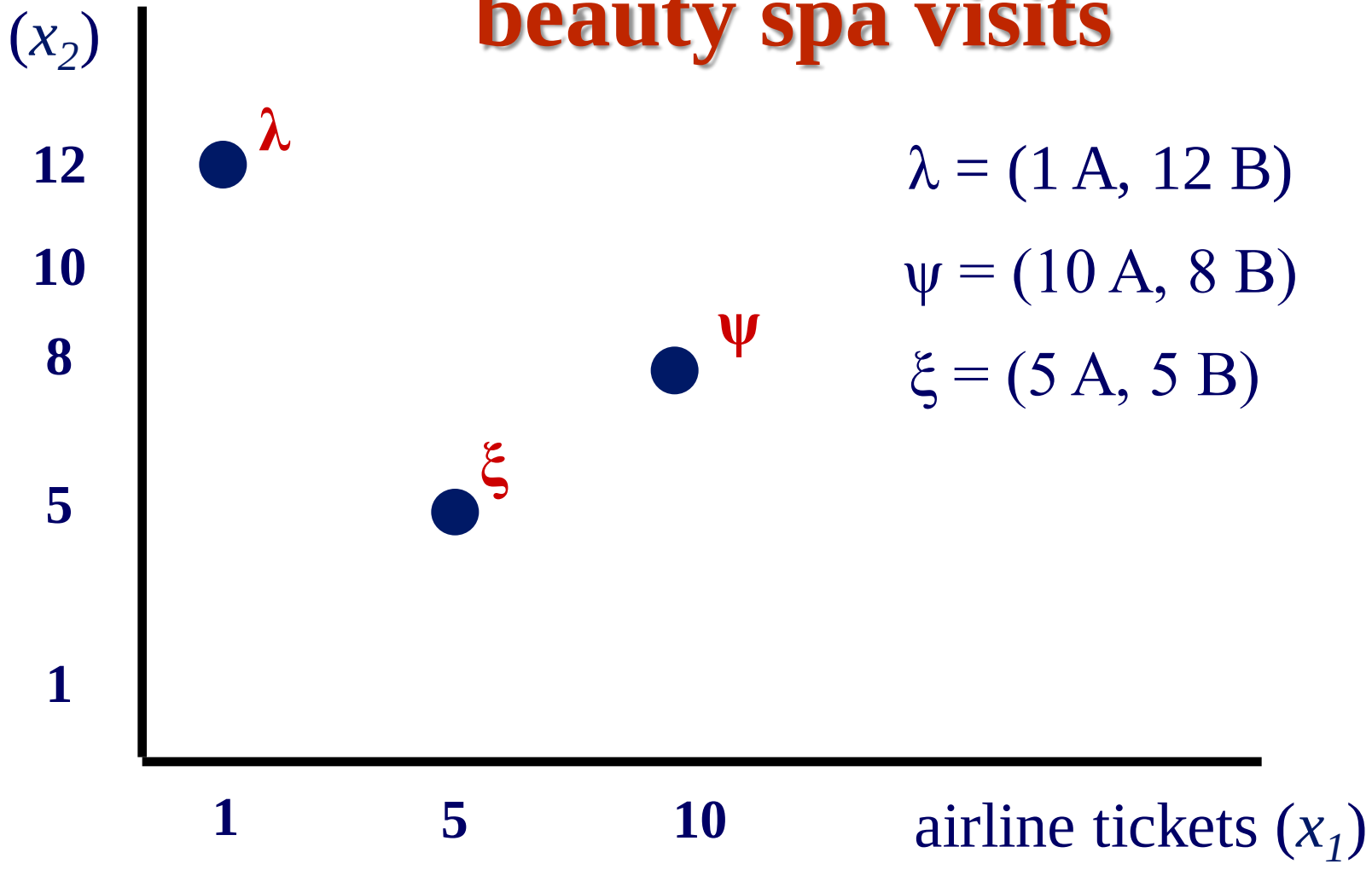
Paola Egonu (volley player)

… she purchases

airline tickets (x_1)

beauty spa visits (x_2)

bundles of airline tickets & beauty spa visits



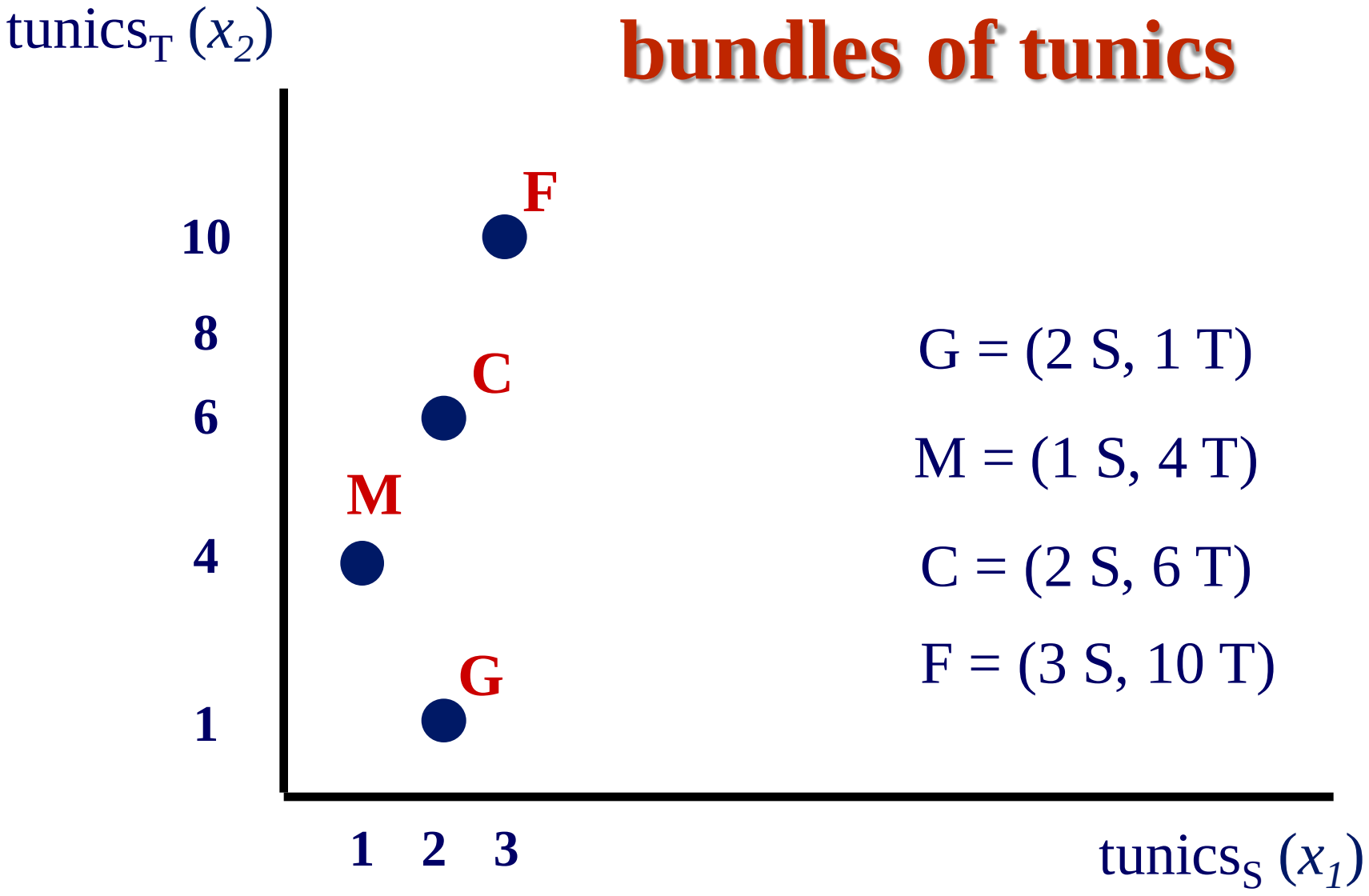
Julius Caesar

… he purchases tunics from

tailor Scipione (x_1)

tailor Terenzio (x_2)

bundles of tunics



G = (2 S, 1 T)

M = (1 S, 4 T)

C = (2 S, 6 T)

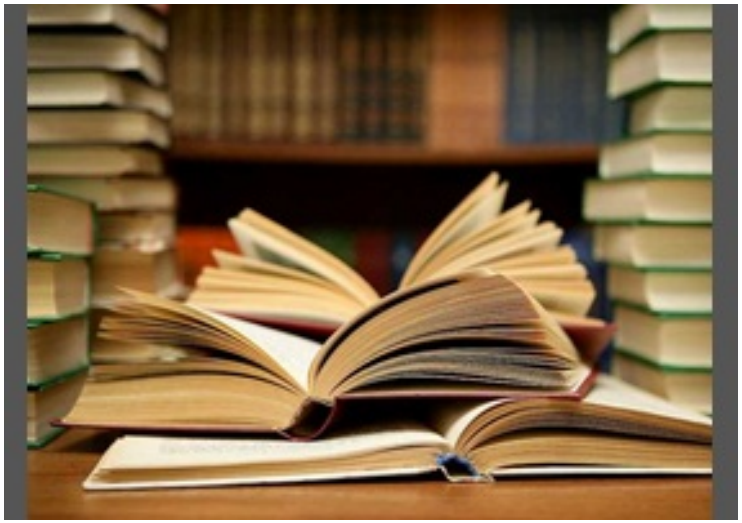
F = (3 S, 10 T)

Tim Cook

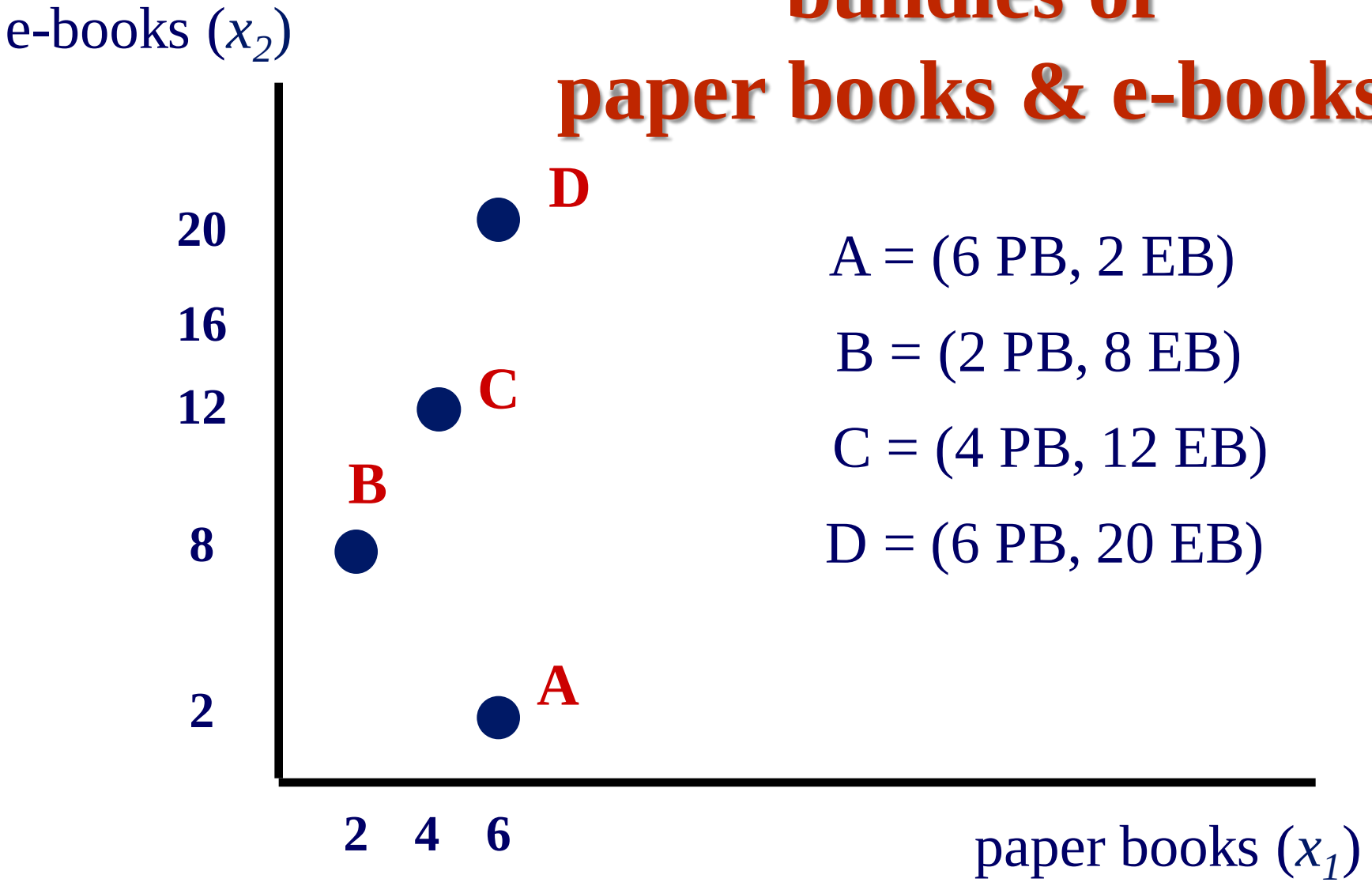
… he purchases

paper books (x_1)

e-books (x_2)



bundles of paper books & e-books



A = (6 PB, 2 EB)

B = (2 PB, 8 EB)

C = (4 PB, 12 EB)

D = (6 PB, 20 EB)

Rosa Parks

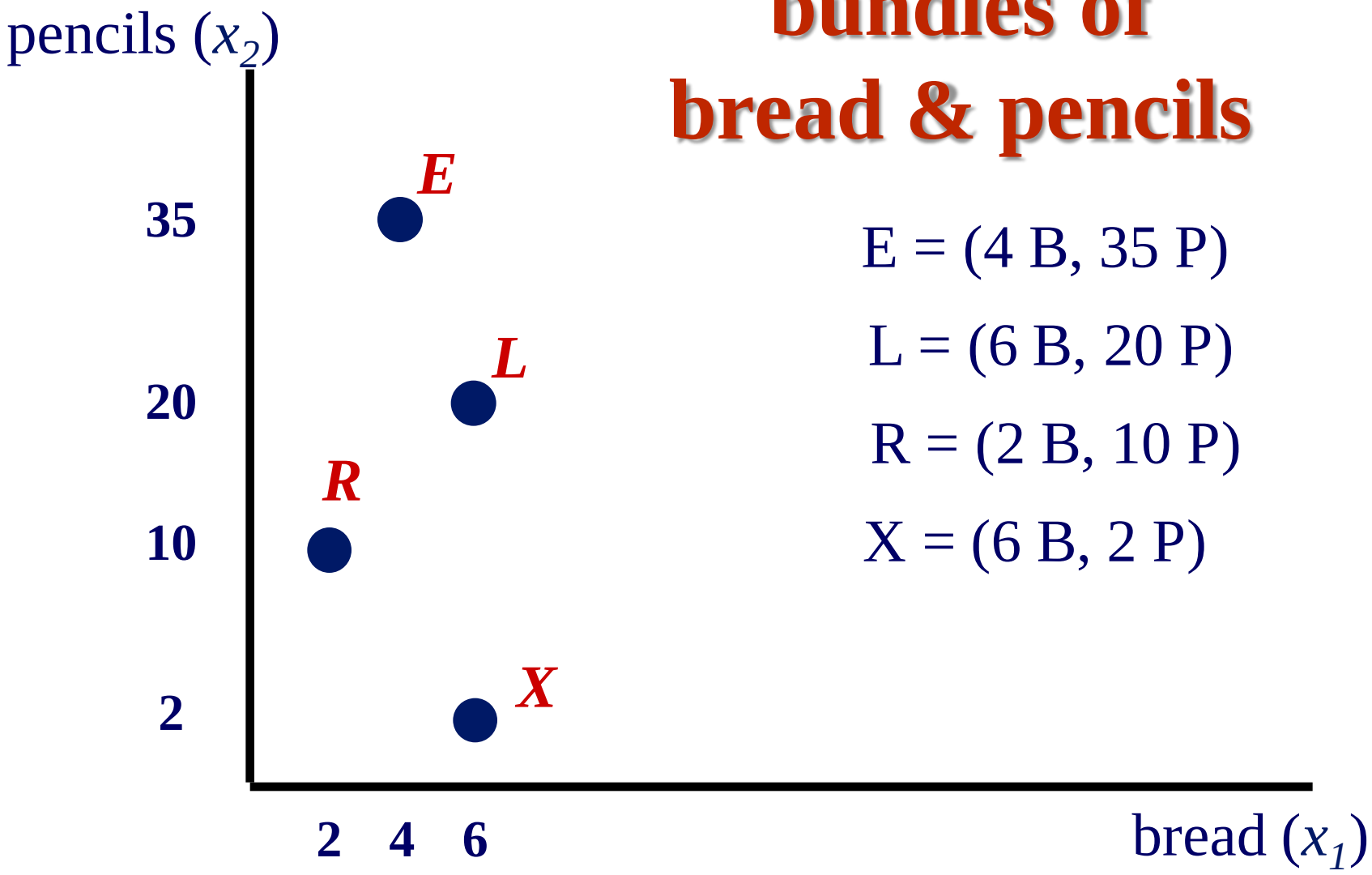
[Civil Rights activist, 1913-2005; 1955, Montgomery, Alabama]

… she purchases

bread (x_1)

pencils (x_2)

bundles of bread & pencils



E = (4 B, 35 P)

L = (6 B, 20 P)

R = (2 B, 10 P)

X = (6 B, 2 P)

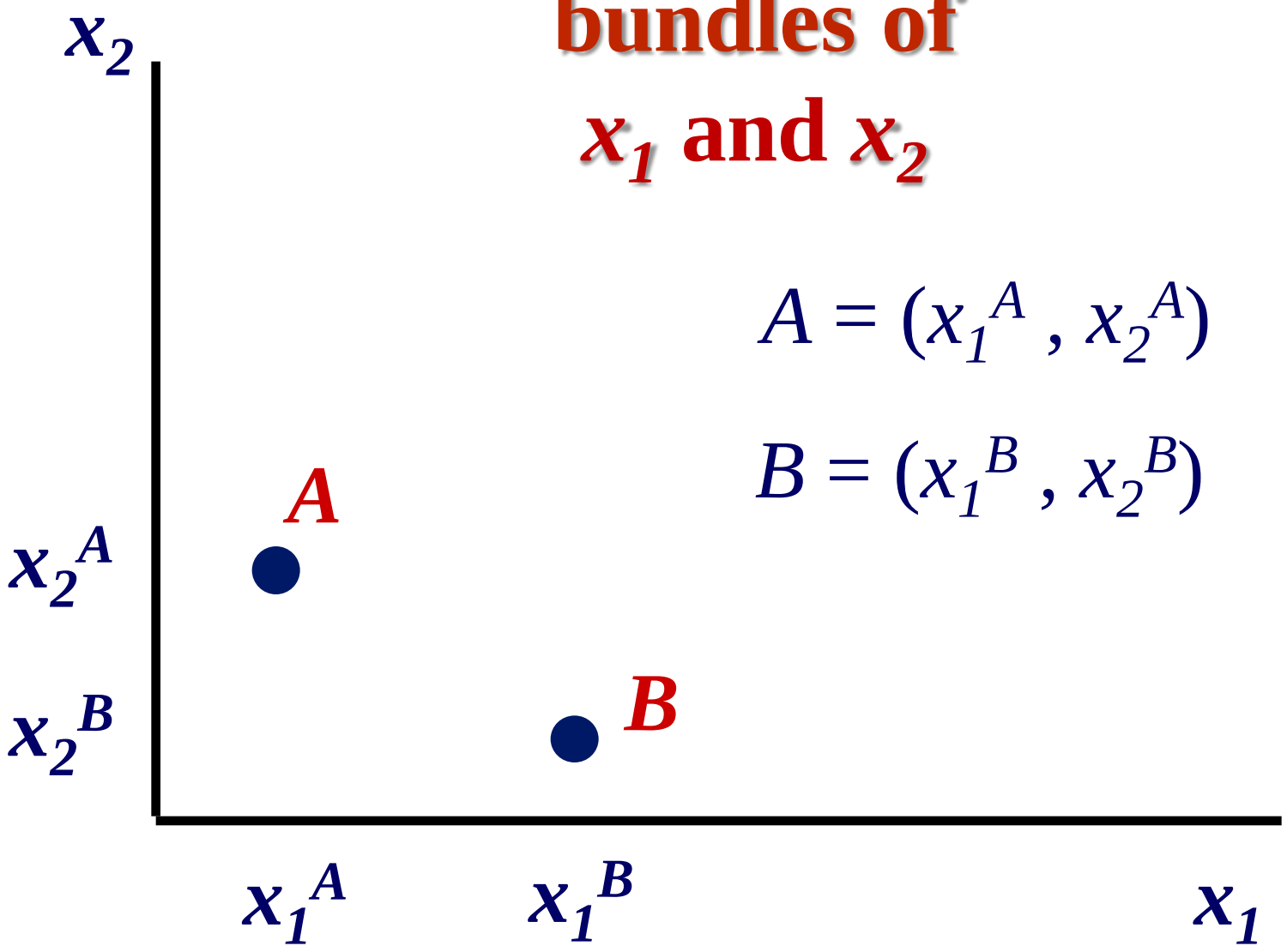
Mr. X

[in the year 2099]

… he purchases two commodities

x_1 x_2

bundles of x_1 and x_2



$$A = (x_1^A , x_2^A)$$

$$B = (x_1^B , x_2^B)$$

What determines what and how much I demand?

Budget constraint

– prices of goods & services

– income

determines

what I **CAN** purchase

Chapter 2: Budget constraint

Road map

1. Budget set: definition
2. Budget constraint: definition
3. Slope of budget constraint and opportunity cost
4. Impact of price and income changes on budget constraint and budget set
5. The numeraire (relative prices)
6. Budget constraint: straight line or curve?
   A. Quantity discount
   B. Quantity penalty
   C. Taxes and subsidies
   D. Quantity rationing
   E. Food stamps program

1. The budget set

Definition

The budget set identifies the set of **all** bundles that an individual can afford to buy (either I spend all my income or not).

The budget set is determined by

- ✓ an individual's (disposable) income ***m***
- ✓ the price vector $\boldsymbol{p = (p_1, p_2, p_3, \ldots, p_n)}$

Mathematically:

$$B(p_1, \ldots, p_n, m) = \{(x_1, \ldots, x_n) \mid x_1 \geq 0, \ldots, x_n \geq 0 \text{ and } p_1x_1 + \ldots + p_nx_n \leq m\}.$$

2. The budget constraint

Definition

The budget constraint identifies the set of bundles that an individual can **just** afford to buy (that is, I spend all my income).

That is, the budget constraint is the **upper boundary** of the budget set.

Mathematically:

$$\{(x_1, \ldots, x_n) \mid x_1 \geq 0, \ldots, x_n \geq 0 \quad \text{and} \quad p_1 x_1 + \ldots + p_n x_n = m\}.$$

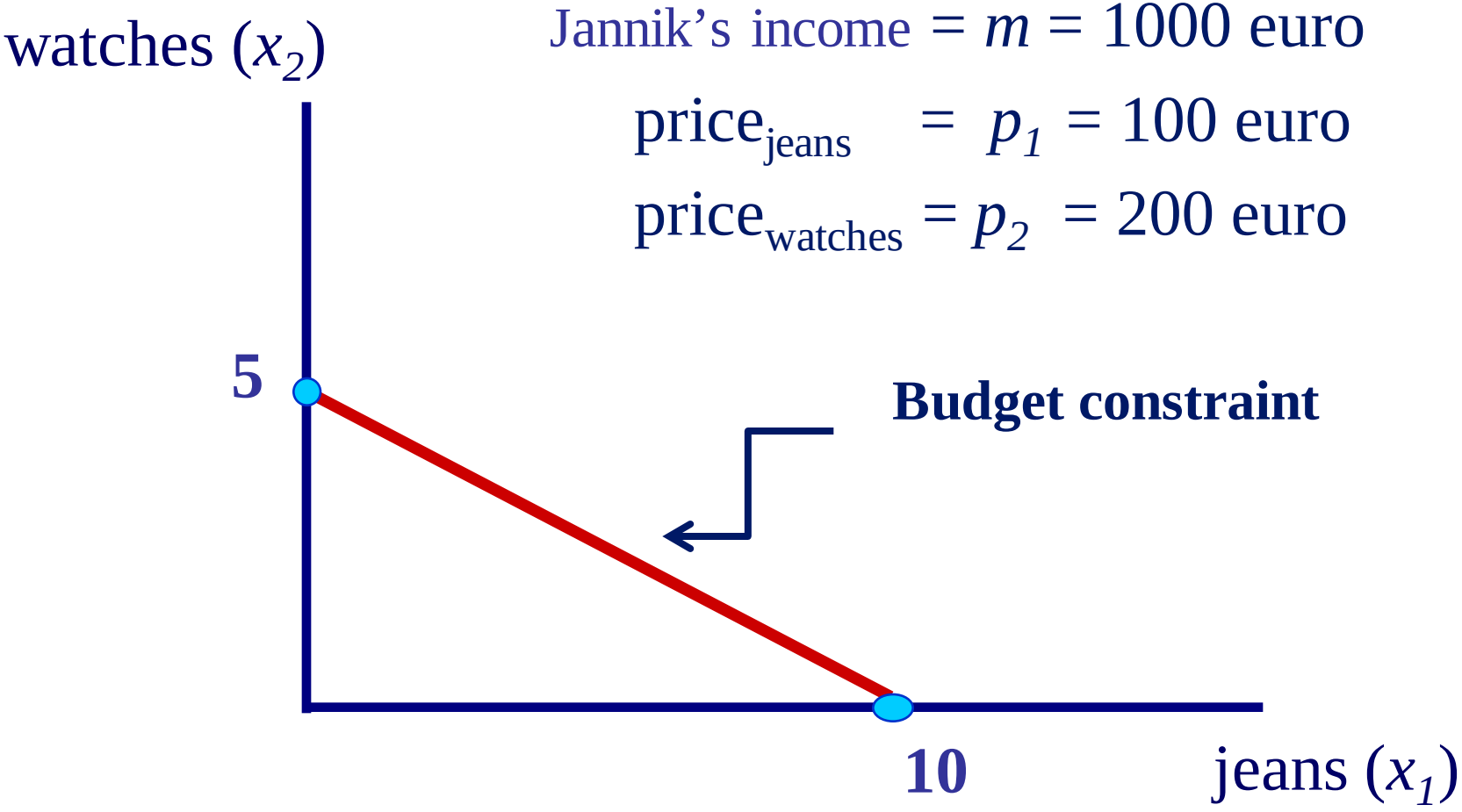
Example with 2 commodities

Budget constraint: graph

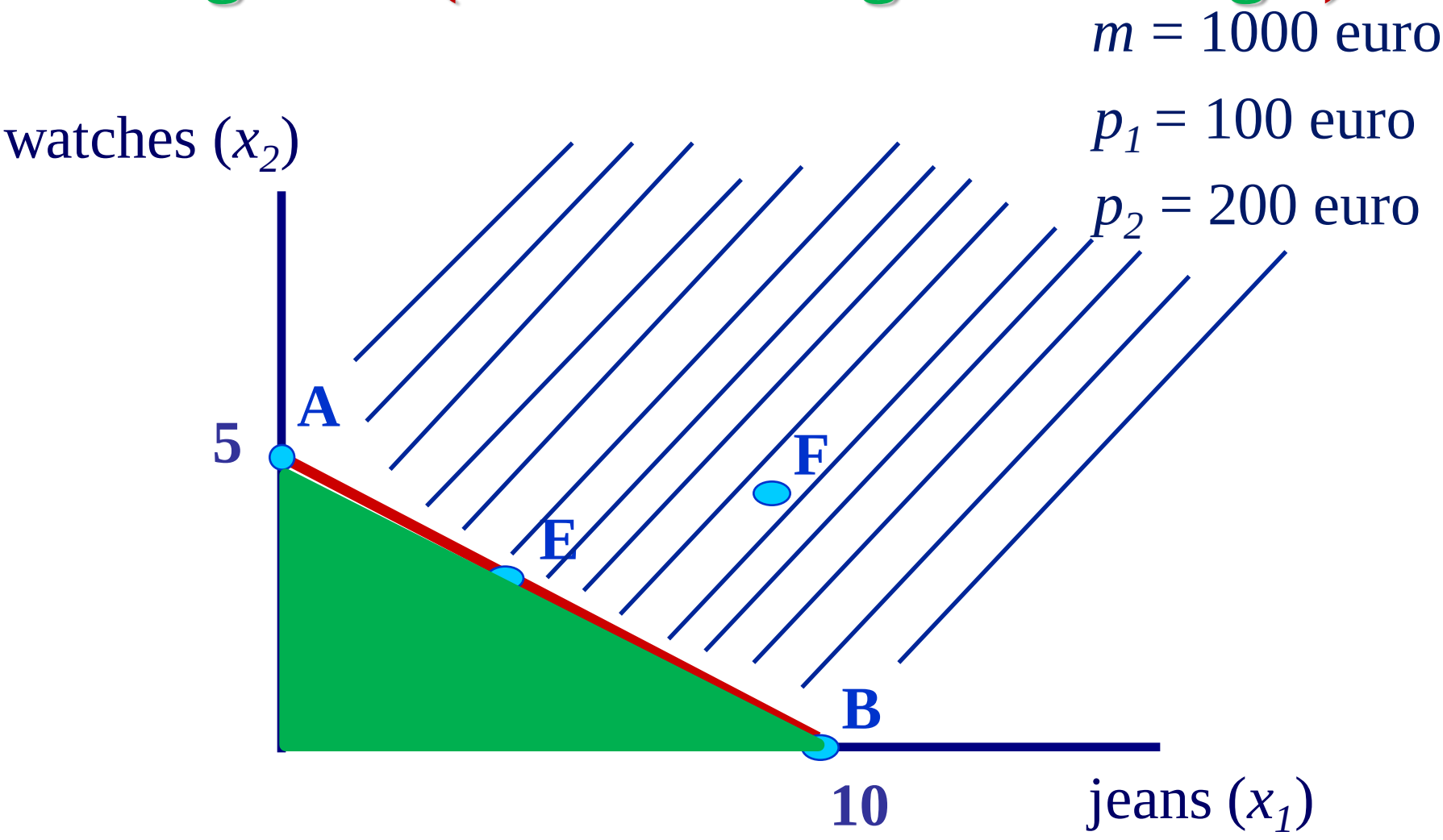
Jannik's income = m = 1000 euro

$\text{price}_{\text{jeans}} = p_1 = 100$ euro

$\text{price}_{\text{watches}} = p_2 = 200$ euro



budget constraint (red line)
budget set (red line and green triangle)



Budget constraint with 2 commodities: equation

$$p_1 \cdot x_1 + p_2 \cdot x_2 = m$$

where: m, p_1 , p_2 are exogenously given and the individual chooses x_1 and x_2

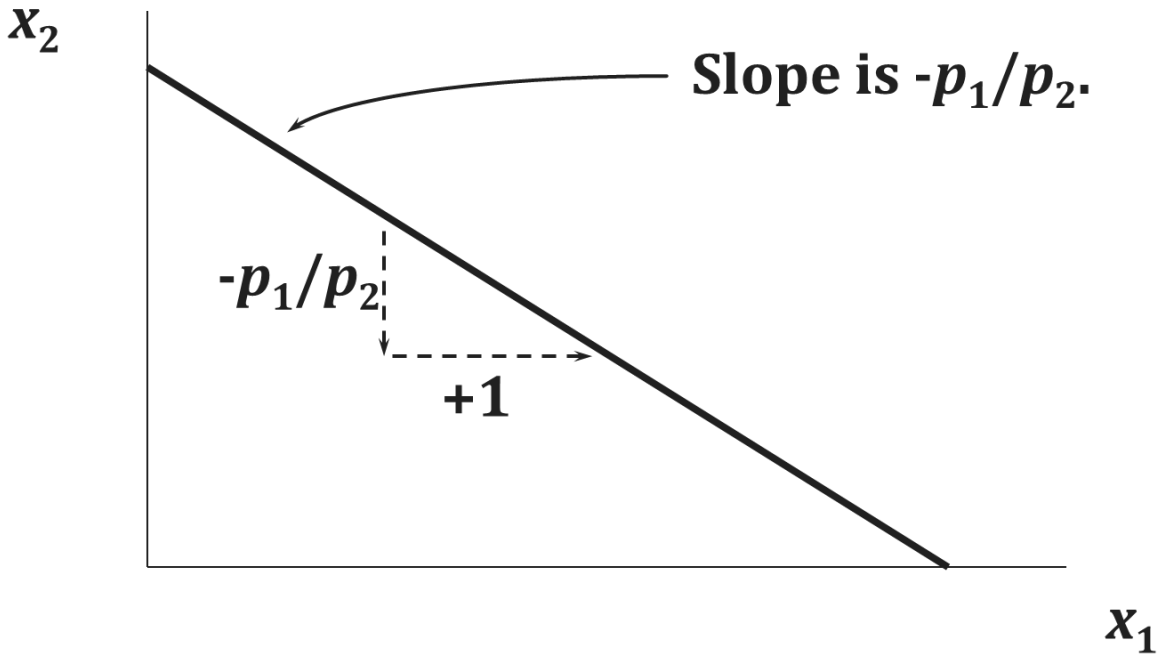
Solving for x_2, we obtain $$x_2 = \frac{m}{p_2} - \frac{p_1}{p_2} x_1$$

Vertical intercept $\frac{m}{p_2}$

Horizontal intercept $\frac{m}{p_1}$

Slope $-\frac{p_1}{p_2}$

3. The slope of the budget constraint: its economic interpretation



The slope of the budget constraint measures the **opportunity cost** of good x_1 with respect to good x_2. What does it mean ???
The opportunity cost of an extra unit of good 1 is p_1/p_2 units foregone of good 2.

Budget constraint: our example

$$100 \cdot x_1 + 200 \cdot x_2 = 1000$$

Solving for x_2, we obtain: $$x_2 = \frac{1000}{200} - \frac{100}{200} x_1$$

Vertical intercept

$$\frac{m}{p_2} = \frac{1000}{200} = 5$$

Horizontal intercept

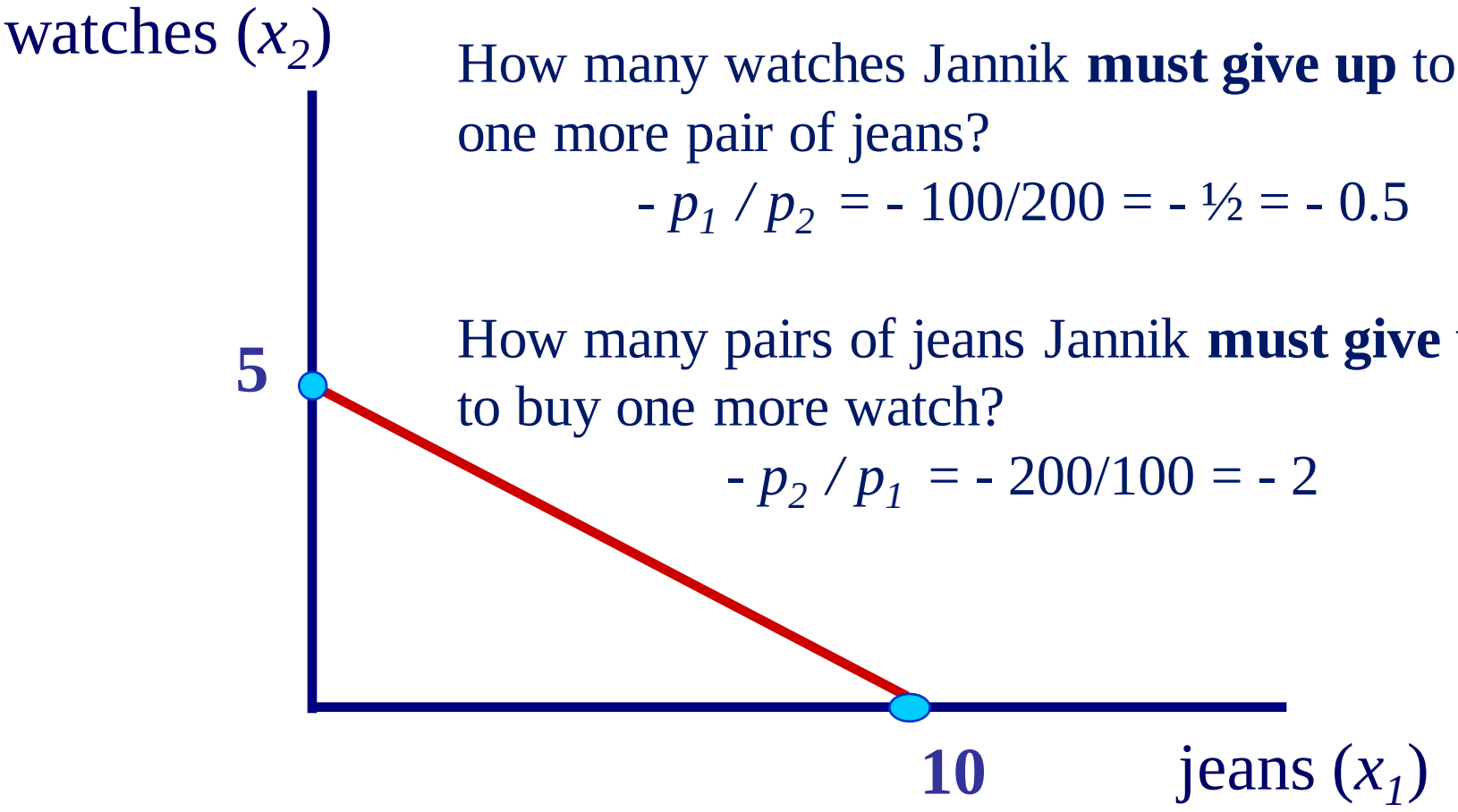
$$\frac{m}{p_1} = \frac{1000}{100} = 10$$

Slope

$$-\frac{p_1}{p_2} = -\frac{100}{200} = -\frac{1}{2} = -0.5$$

Budget contraint: opportunity cost --- trade-offs

p_1 = 100 euro p_2 = 200 euro



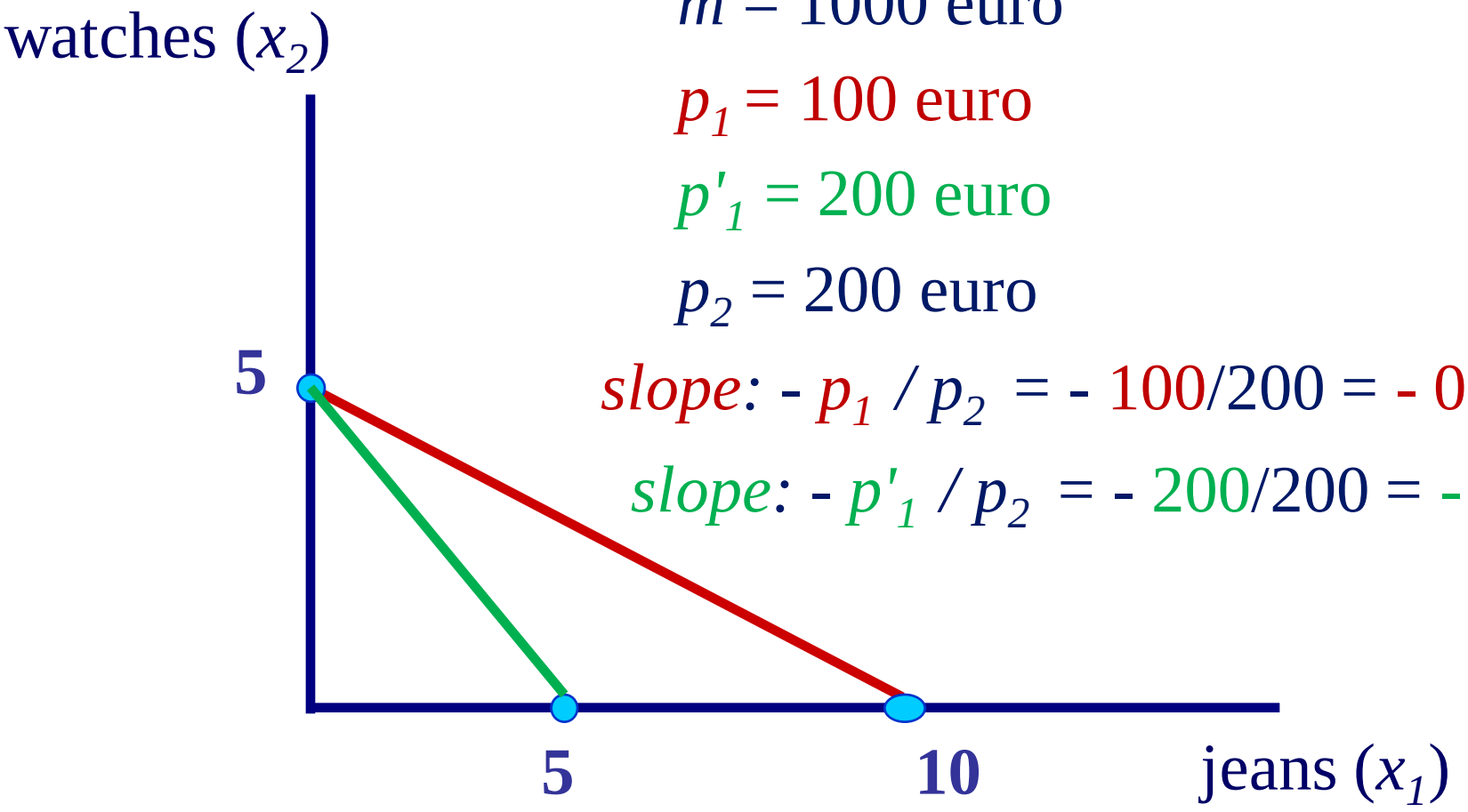
How many watches Jannik **must give up** to buy one more pair of jeans?

$$- p_1 / p_2 = - 100/200 = - ½ = - 0.5$$

How many pairs of jeans Jannik **must give up** to buy one more watch?

$$- p_2 / p_1 = - 200/100 = - 2$$

4. Price changes: if p_1 increases



m = 1000 euro

p_1 = 100 euro

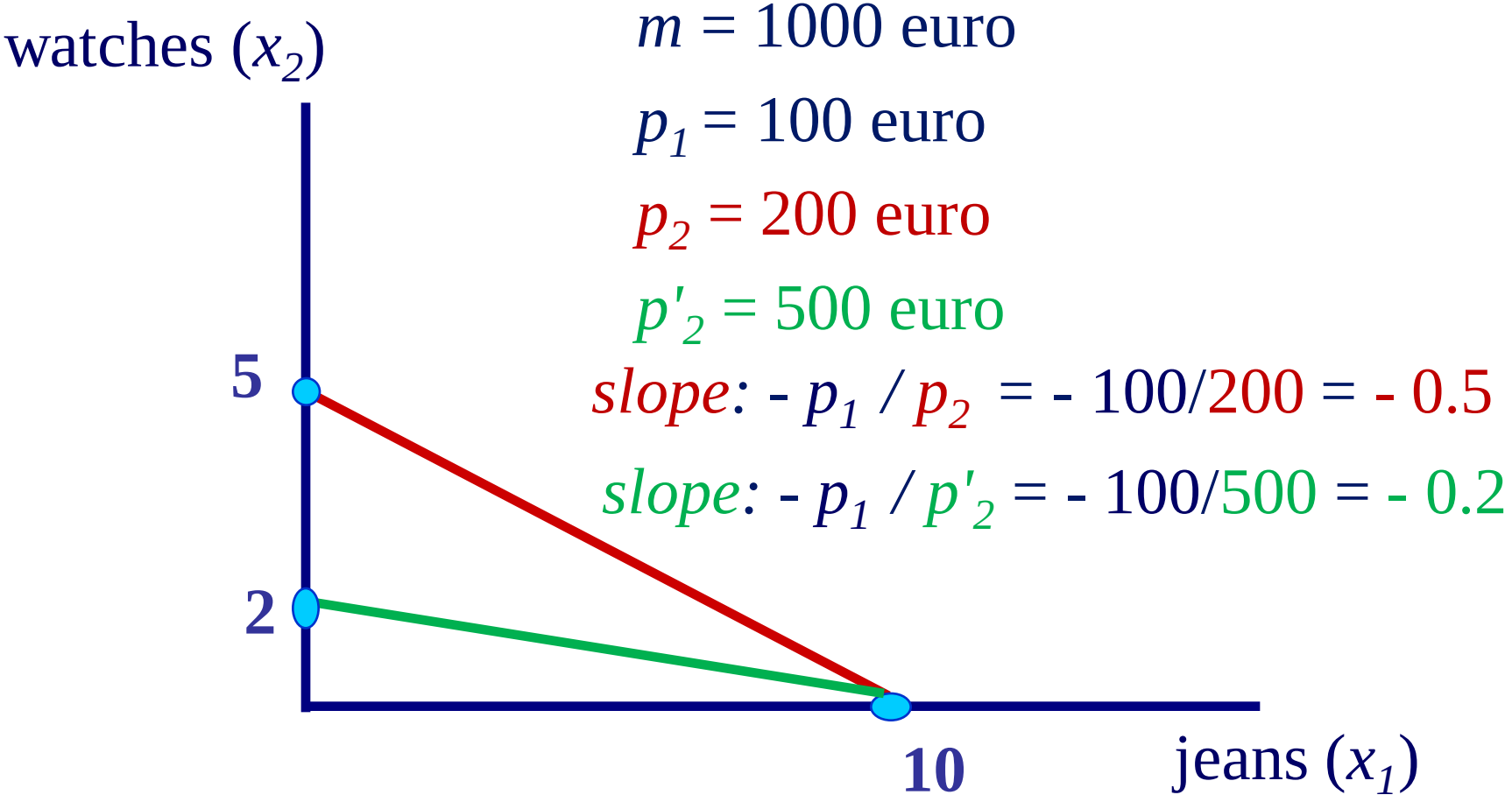
p'_1 = 200 euro

p_2 = 200 euro

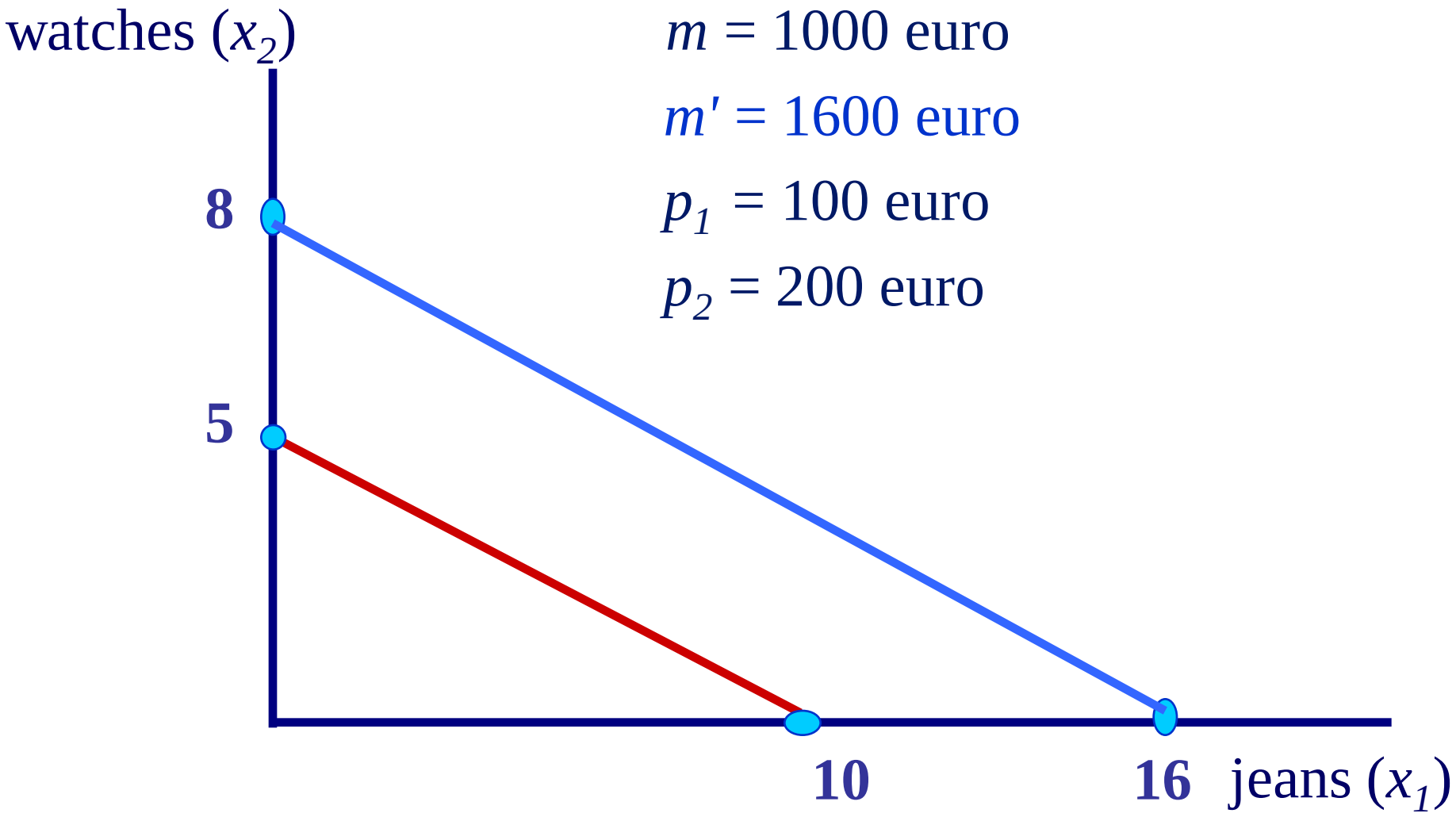
slope: - p_1 / p_2 = - 100/200 = - 0.5

slope: - p'_1 / p_2 = - 200/200 = - 1

4. Price changes: if p_2 increases



4. Price changes: if *m* increases



Mini-drill

- Architect Renzo Piano's montly income 9000 euro
- He purchases Rossetti shoes and Ipad

- price of Rossetti shoes = 300 Euro

  price of Ipad = 900 Euro

- Write his budget constraint, calculate intercepts and slope
- Calculate the opportunity cost of shoes in terms of I-Pad and I-Pad in terms of shoes

5. The numeraire

- (MB's view: slightly boring topic but) crucial concept that is part of the toolkit and jargon of microeconomics, macroeconomics, and finance.
- Study on your own the textbook (p. 26).
- **Key insight**: in economics the relevant concept when we consider prices of commodities is the **relative price** --- the price of one commodity in terms of the other commodity.

6. Shapes of budget constraints: straight lines or curves?

- If prices are constant, the budget constraint will always be a straight line.
- What happens if prices are not constant?
  - For example, bulk buying discounts, or price penalties for buying too much.
- Then the budget constraint will be curved.

6.A. Budget constraint with a quantity discount: equation

Suppose:

m = 100 euro

p_2 is constant at 1 euro

$p_1 = 2$ euro for $0 \leq x_1 \leq 20$ and $p_1 = 1$ euro for $x_1 > 20$

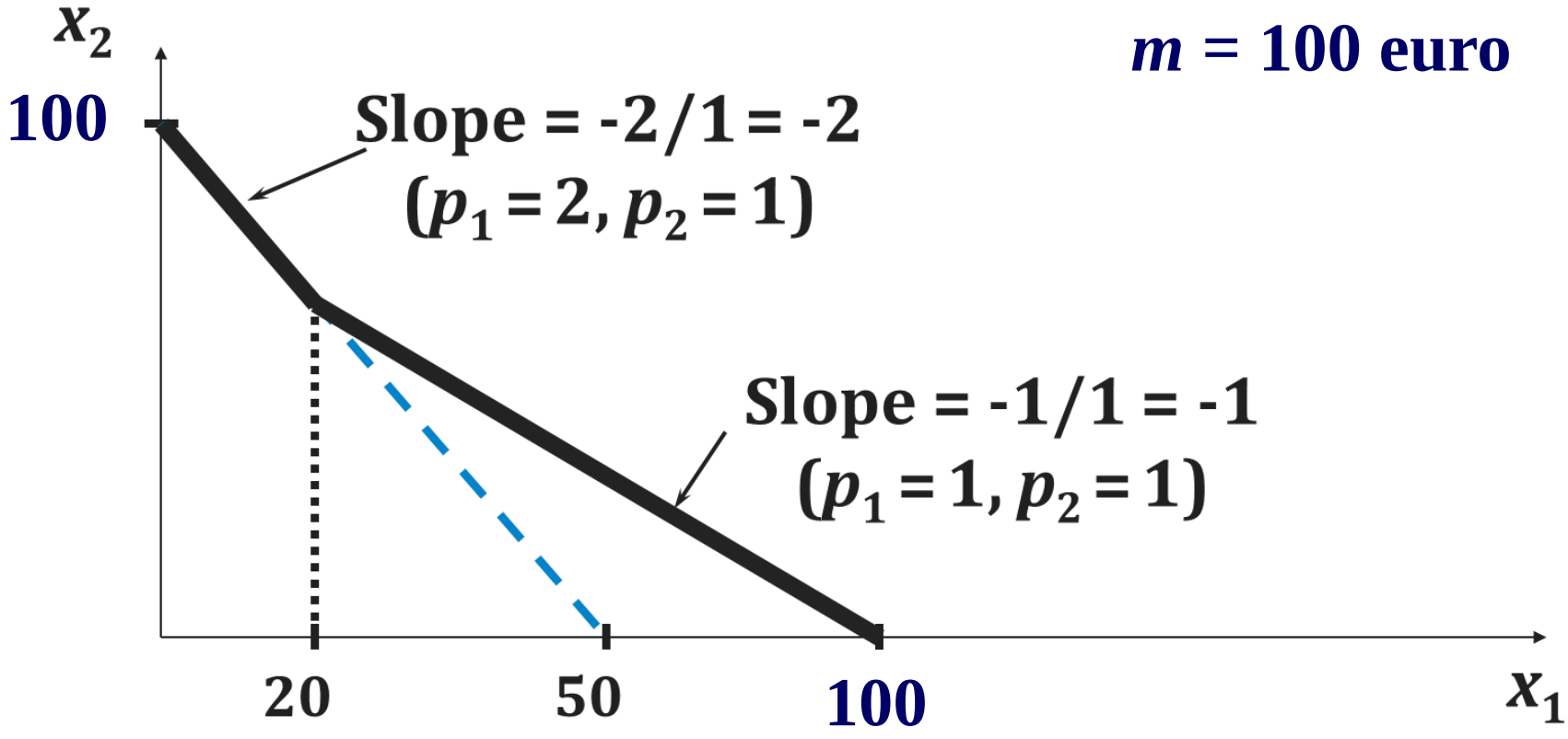
The **budget constraint** equation is:

$$2 \cdot x_1 + 1 \cdot x_2 = 100 \quad \text{for } 0 \leq x_1 \leq 20$$
$$1 \cdot x_1 + 1 \cdot x_2 = 100 \quad \text{for } x_1 > 20$$

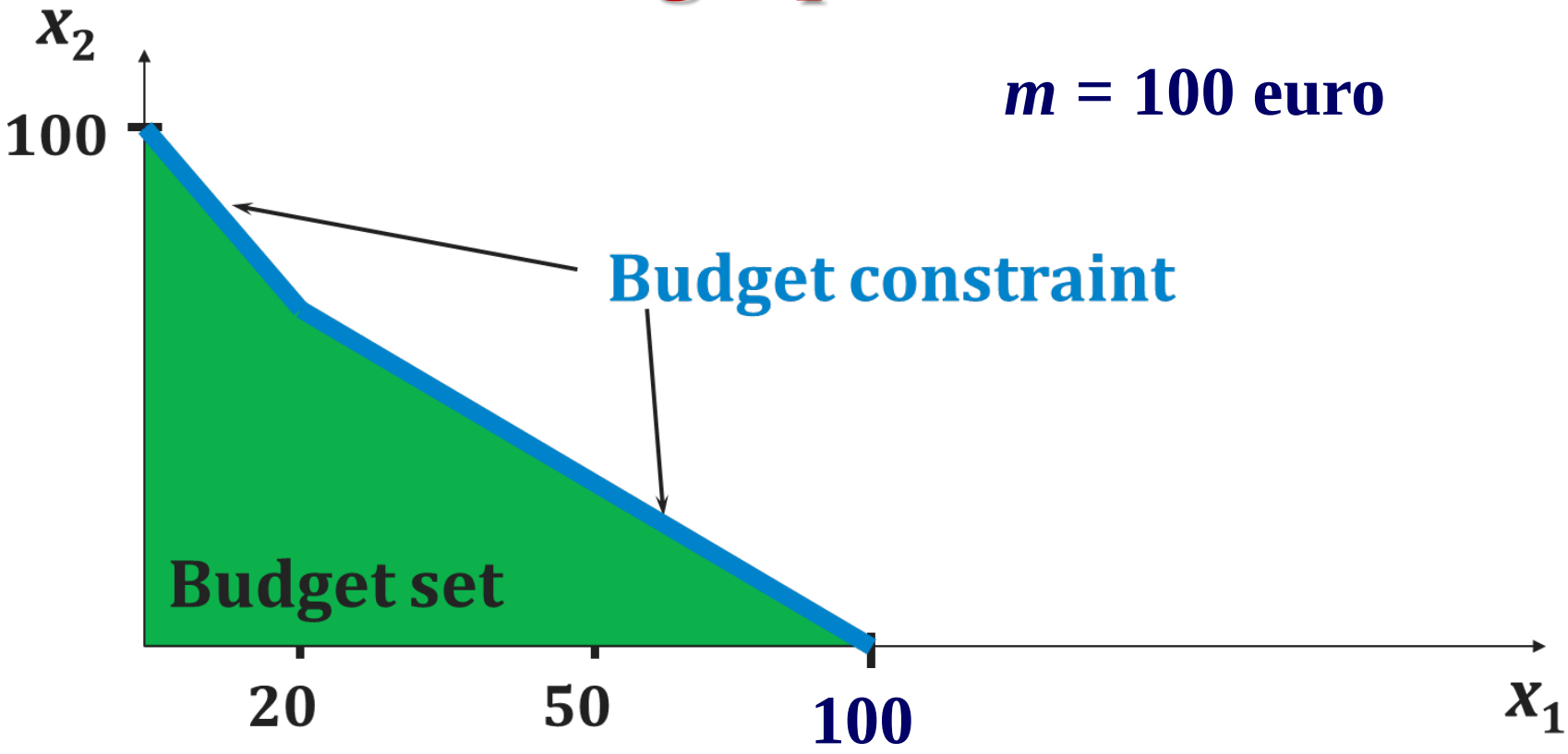
Then the budget constraint's **slope** ($- p_1/p_2$) is:

$$-2 \quad \text{for } 0 \leq x_1 \leq 20$$
$$-1 \quad \text{for } x_1 > 20$$

Budget constraint with a quantity discount: graph



Budget set with a quantity discount: graph



6.B. Budget constraint with a quantity penalty: equation

Suppose:

$m = 100$ euro

p_2 is constant at 1 euro

$p_1 = 1$ euro for $0 \leq x_1 \leq 20$ and $p_1 = 4$ euro for $x_1 > 20$

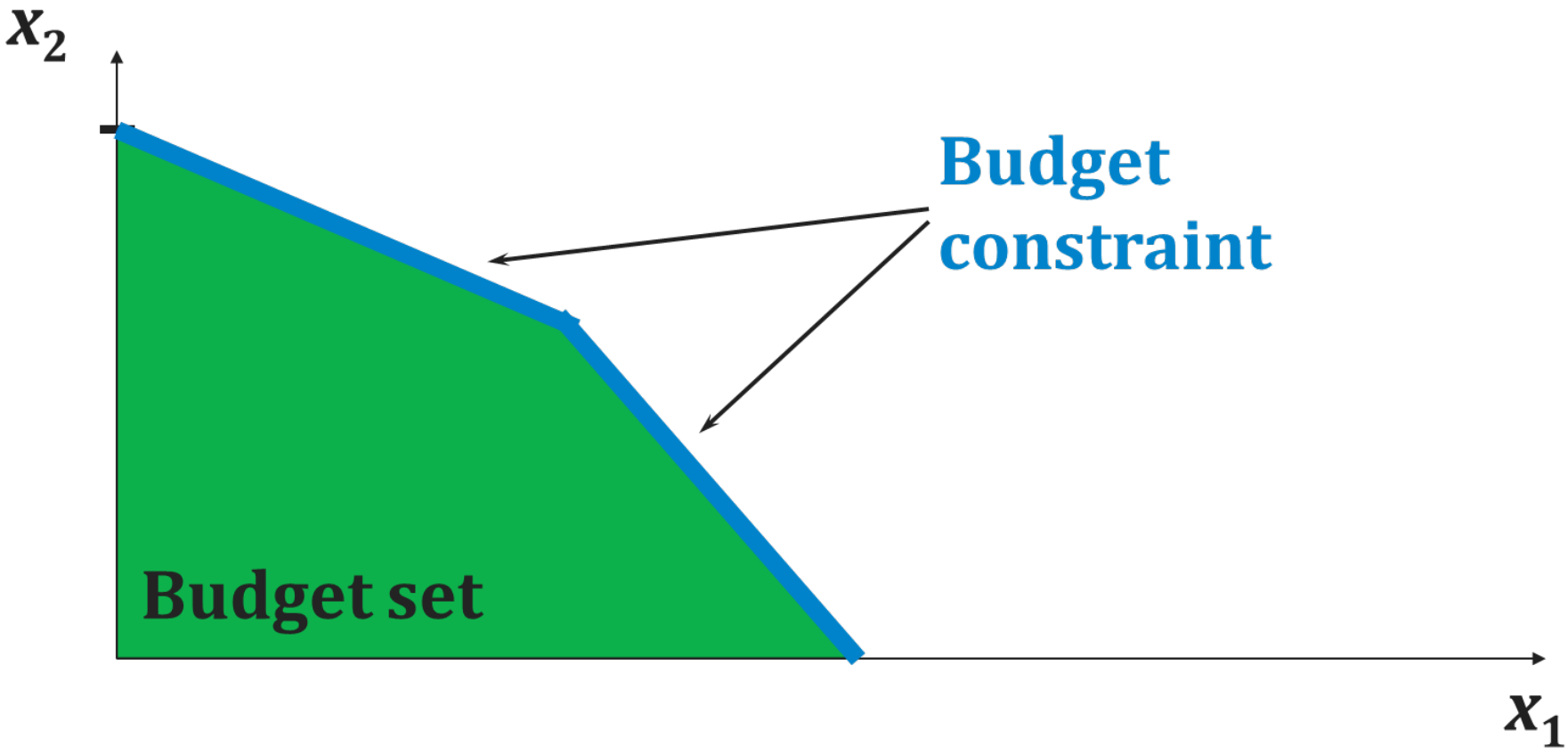
The **budget constraint** equation is:

$$1 \cdot x_1 + 1 \cdot x_2 = 100 \quad \text{for } 0 \leq x_1 \leq 20$$
$$4 \cdot x_1 + 1 \cdot x_2 = 100 \quad \text{for } x_1 > 20$$

Then the budget constraint's **slope** ($- p_1/p_2$) is:

$$-1 \quad \text{for } 0 \leq x_1 \leq 20$$
$$-4 \quad \text{for } x_1 > 20$$

Budget constraint and budget set with a quantity penalty: graph



6.C. Budget constraint with taxes and subsidies

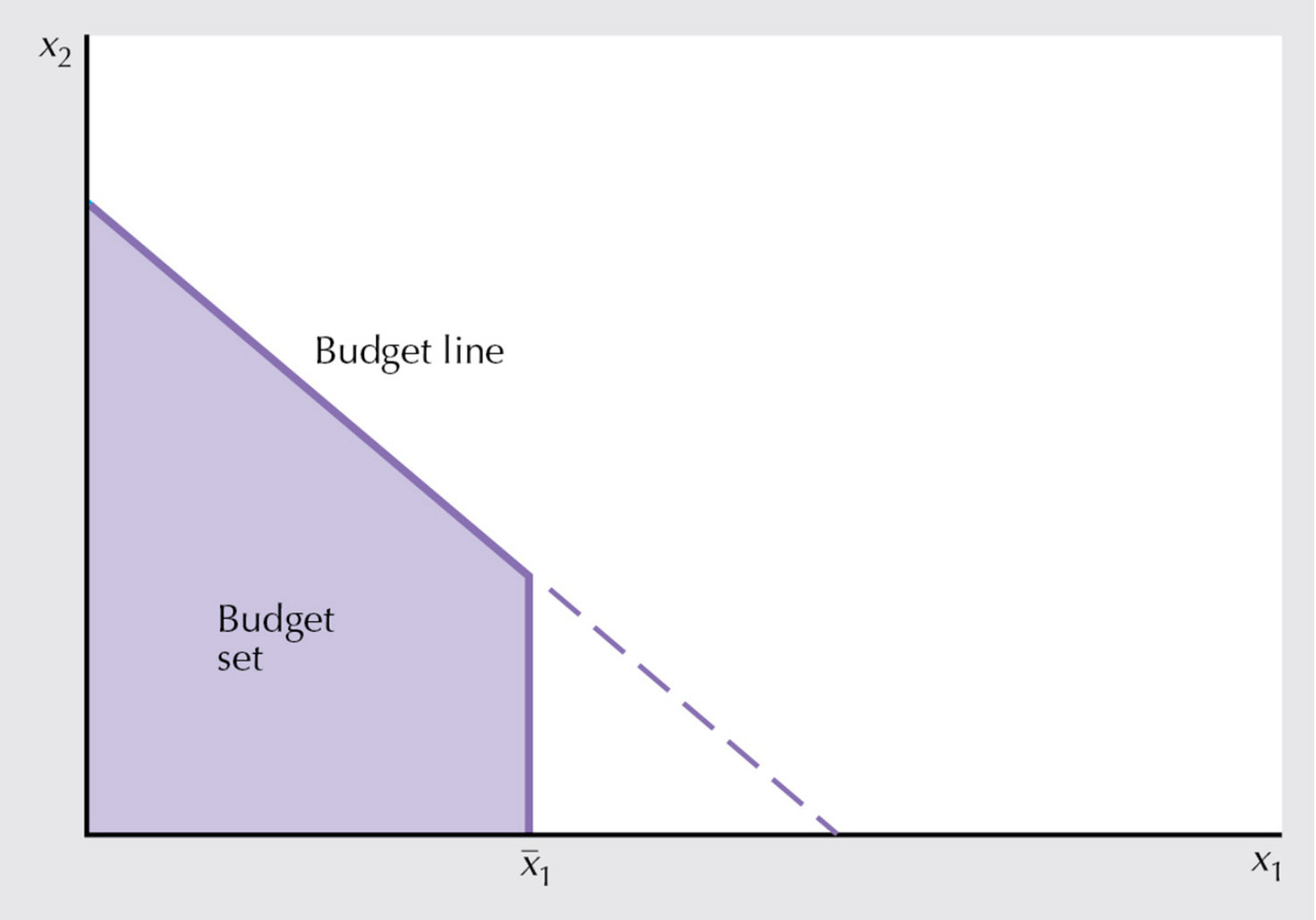
- Super-important!!! What happens if the government sets a tax or offers a subsidy on one of the two goods (or on both goods)?
- Study on your own in the textbook, pp. 26-29.

- Algebraically, it is easy to see what's happening.

  Insight:
  - will a given tax (or subsidy) change the slope of the budget constraint?
  - or will the tax (or subsidy) shift the budget constraint parallel?

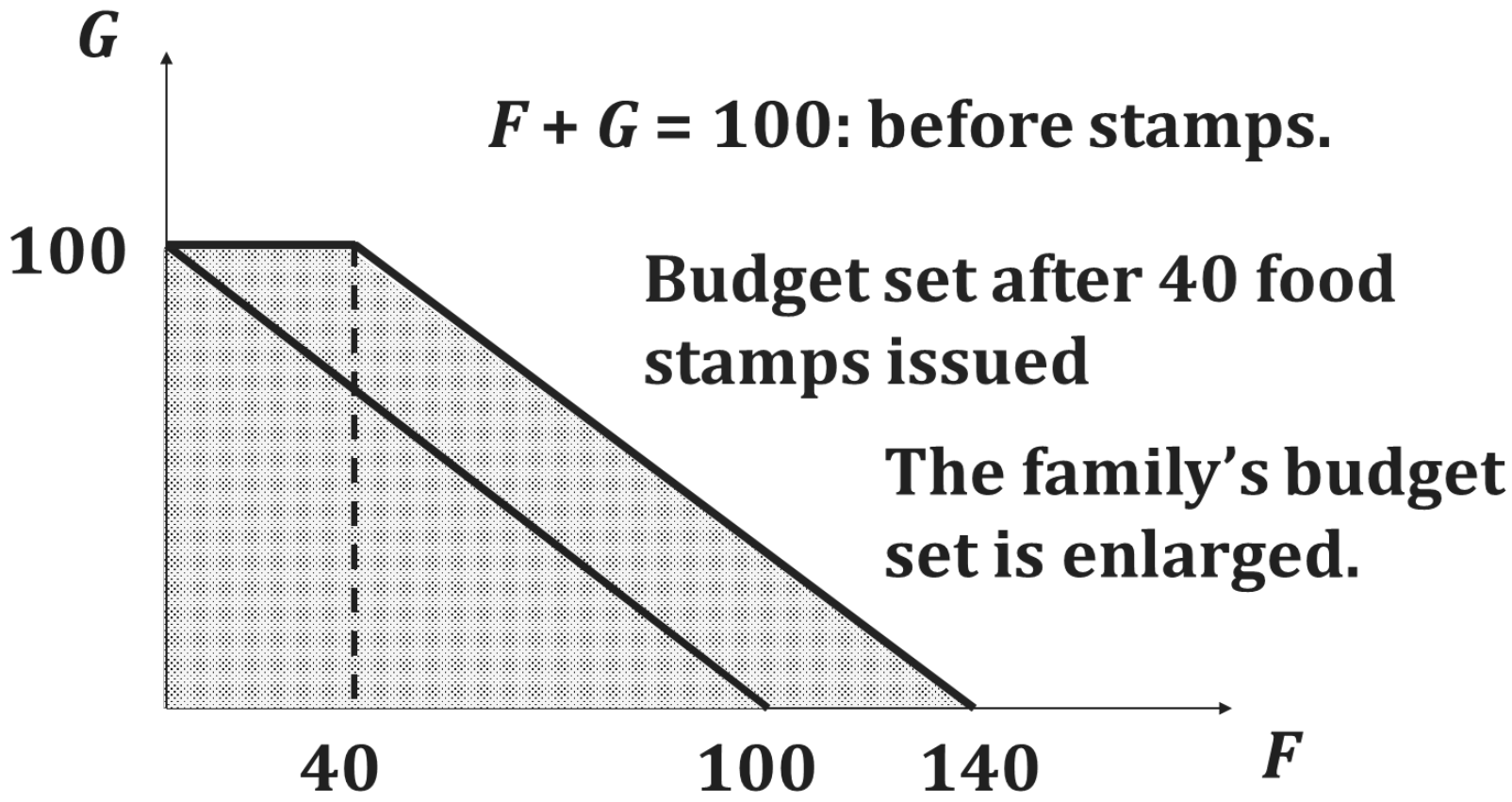
6.D. Budget constraint with quantity rationing

- Very interesting! Study on your own the textbook, p. 28.



6.E. Budget constraint: food stamps program

- Interesting and insightful: study on your own in the textbook, pp. 29-31.



Chapter 2:
Take home message

- What is the key concept we learned when studying the budget constraint?

Chapter 3: Preferences

Road map

1. Behavioral postulate
2. Preference relations: definitions
3. Regularity axioms for preferences
4. Well-behaved preferences
5. Indifference curves (IC): definition and properties
6. Marginal rate of substitution (MRS)
7. Violations of well-behaved preferences' axioms
   A. Perfect substitutes
   B. Perfect complements
   C. Concave IC
   D. Neutral goods
   E. Bads

What determines what and how much I demand?

Preferences, tastes

determine

what I **WANT** to purchase

Rationality in economics

Behavioral postulate

- A decision maker always chooses his or her **most preferred** alternative from his or her set of **available** alternatives.
- So, in order to understand and to model choice, we must model the decision maker's **preferences**.

Preferences

approach due to
Vilfredo Pareto, 1848-1923

Two ways of representing individual preferences

indifference curves (I)

utility functions (U)

Great and rigorous treatment of this topic in your Math book, Sections 6.2, 6.8 e 22.1.4

How does an individual rank consumption bundles?

- To explain consumer behavior, economists assume that consumers have a set of tastes/preferences that they use to guide them in choosing among commodities.
- Goods are ranked according to how much pleasure (utility) a consumer gets from consuming each good.
- Preference relations summarize a consumer's ranking:

$\succ$ **strict preference**, e.g., a consumer strictly prefers bundle $a = (x_1^a , x_2^a)$ to bundle $b = (x_1^b , x_2^b)$

$\sim$ **indifference**, e.g., a consumer is indifferent between a and b

$\succsim$ **weak preference**, a consumer either prefers a to b, or is indifferent between a and b

Food for thought

- A fascinating and critical question: **where do preferences (tastes) come from?**
- In most economic models and applications, economists take **preferences as given** and do not discuss/value/judge an individual's preferences (*de gustibus non disputandum est*).
- Does this mean that economists are not interested in understanding where preferences come from and how they evolve? NOOO!!!
- Simply, this is a complicated issue at the crossroad of several disciplines (you will see some glimpses in advanced courses).

How does an individual rank consumption bundles?

To build a model that explains and predicts consumers' choices, economists **assume** that individual preferences satisfy a minimum set of **regularity assumptions (axioms)**.

Minimum set of regularity axioms for preferences

1. **Completeness** ("always have an answer")
   For any bundles a and b, either $a \succsim b$, or $b \succsim a$, or $a \sim b$

2. **Reflexivity** (… unless you are a small kid)
   Any bundle $a \succsim a$

3. **Transitivity** ("avoid contradictory answers")
   If $b \succsim a$ and $c \succsim b$, then $c \succsim a$

Well-behaved preferences

1. **Completeness** ("always have an answer")

   For any bundles a and b, either $a \succsim b$, or $b \succsim a$, or $a \sim b$

2. **Reflexivity** (… unless you are a small kid)

   Any bundle $a \succsim a$

3. **Transitivity** ("avoid contradictory answers")

   If $b \succsim a$, and $c \succsim b$, then $c \succsim a$

4. (Strict) **Monotonicity** ("more is better")

   if $x_1^b \geq x_1^a$ and $x_2^b > x_2^a$, then $b \succ a$

   or

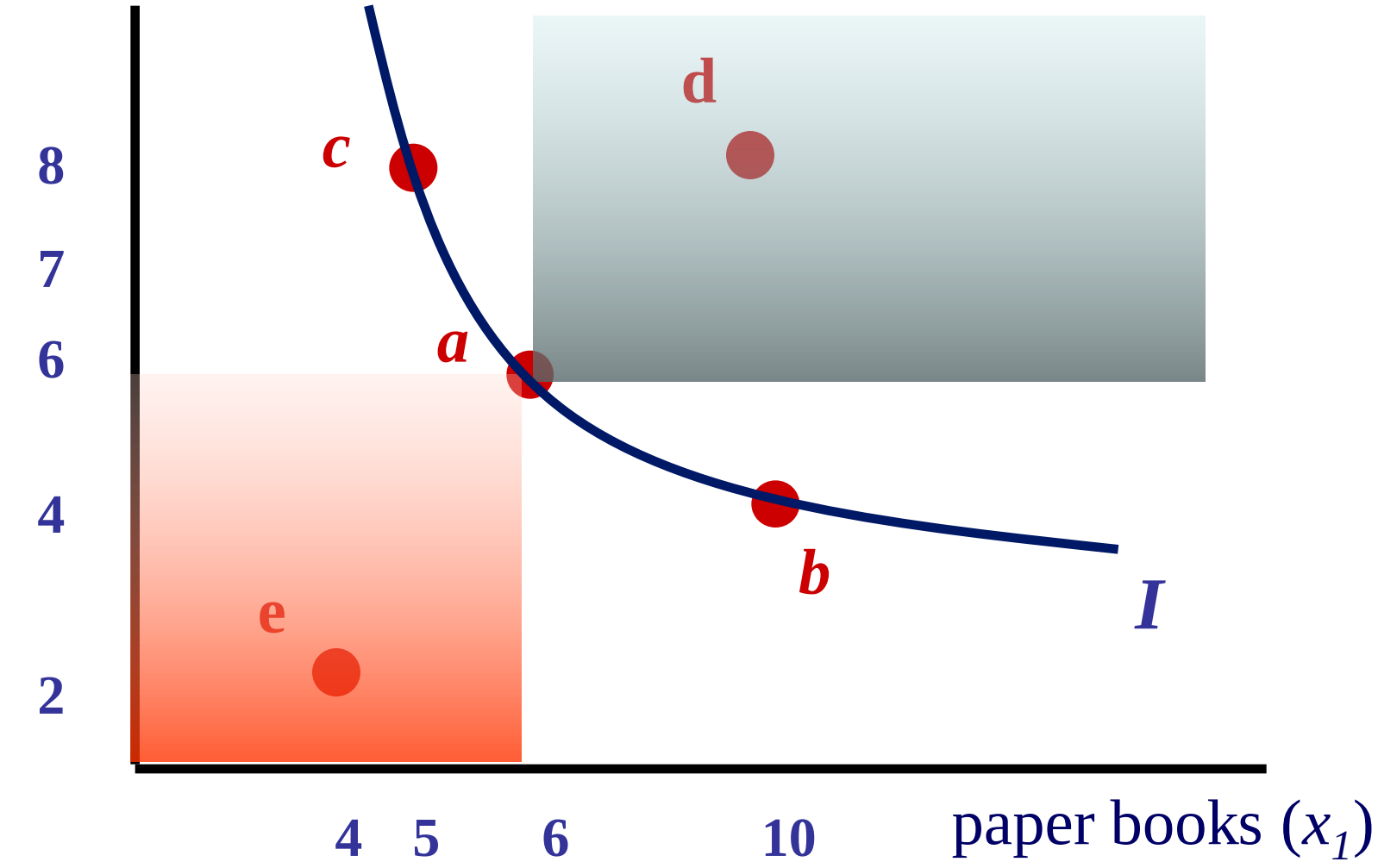
   if $x_1^b > x_1^a$ and $x_2^b \geq x_2^a$, then $b \succ a$

5. **Convexity** ("people prefer variety of goods to extremes")

   If $a \sim b$, then for any $0 \leq t \leq 1$

   $$t \cdot a + (1 - t) \cdot b \succsim a$$
   $$t \cdot a + (1 - t) \cdot b \succsim b$$

Consider Tim Cook's choice problem



Axioms 1 to 4 enable me to say a lot about Cook's preferences. Why?

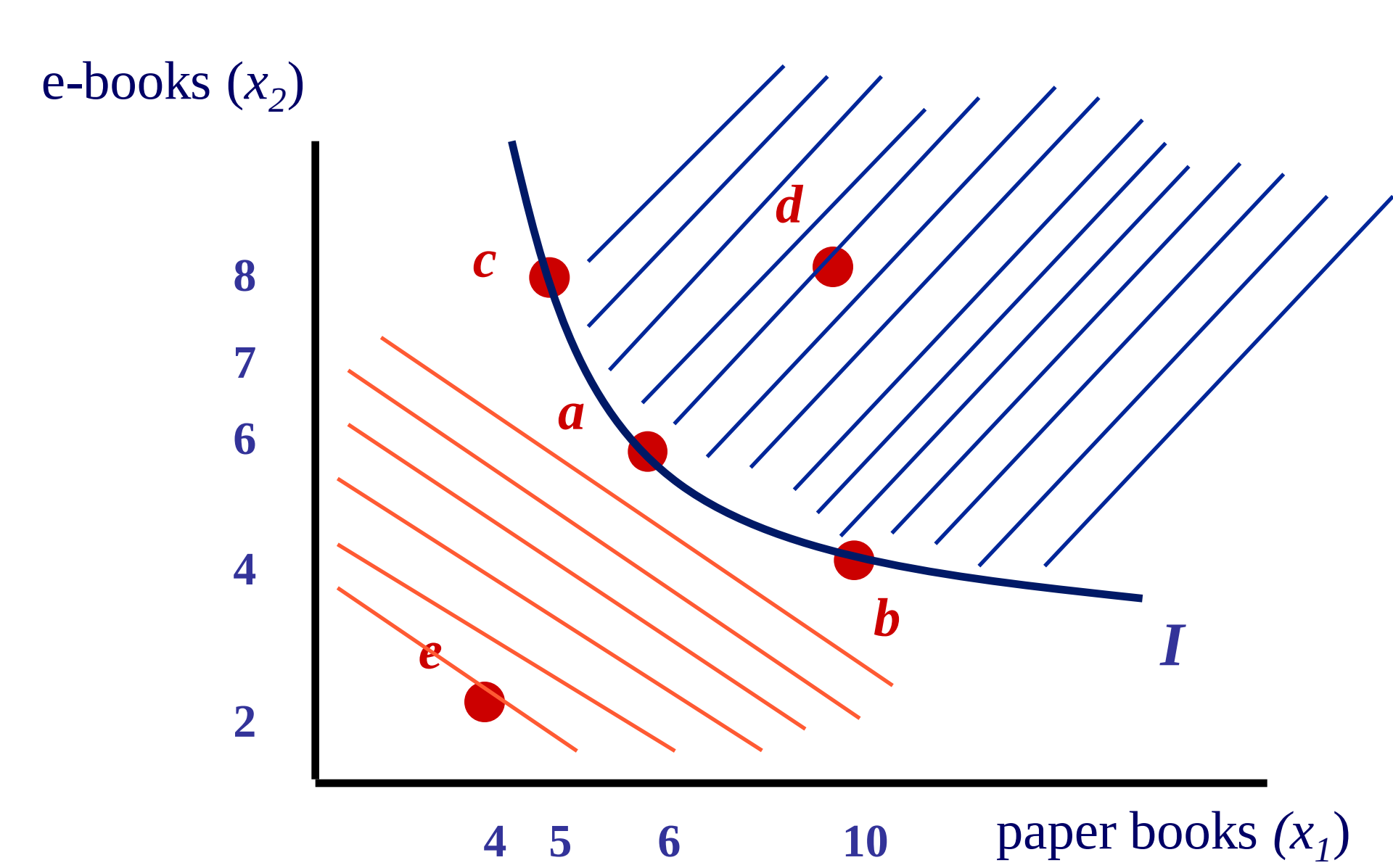
Indifference curve (I)

Definition

Given bundle $a = (x^a_1 , x^a_2)$, indifference curve I is the set of bundles (x_1 , x_2) which the individual considers as good as bundle a

$$I = \{ (x_1 , x_2) \mid (x_1 , x_2) \sim a \}$$

The individual is «indifferent» in the sense that he/she is willing to exchange them and be equally «happy».



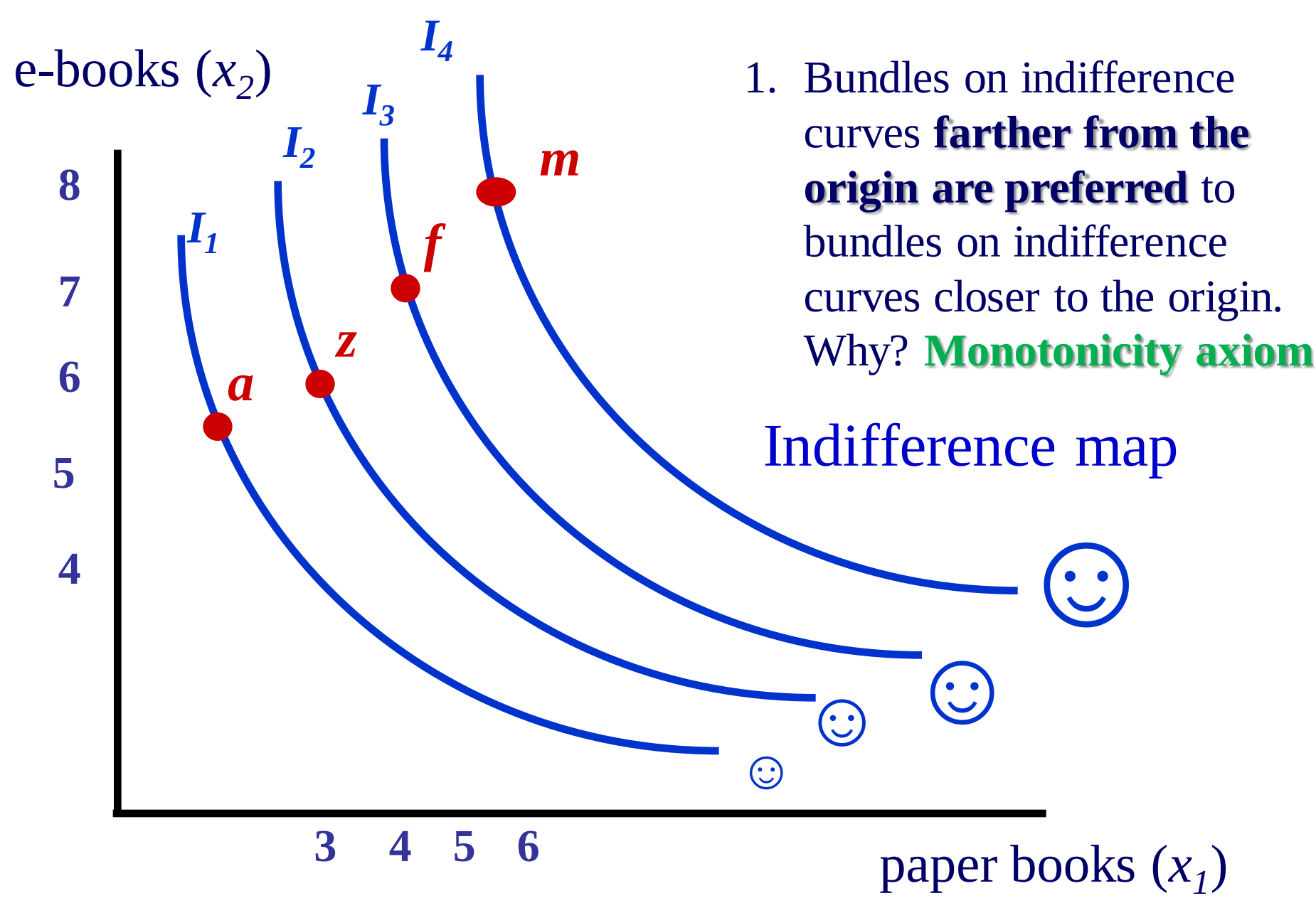
I divides all bundles in three groups

Well-behaved indifference curves: properties

If preferences satisfy the five axioms (slide 55), then indifference curves have six properties:

1. Bundles on indifference curves **farther from the origin** are **preferred** to bundles on indifference curves closer to the origin
2. Every bundle **lies on** an indifference curve
3. Indifference curves for the same individual **cannot cross**
4. Indifference curves **slope downward** for **"goods"**
5. Indifference curves **cannot be thick**
6. Indifference curves are **convex**

Which of the axioms deliver these properties?



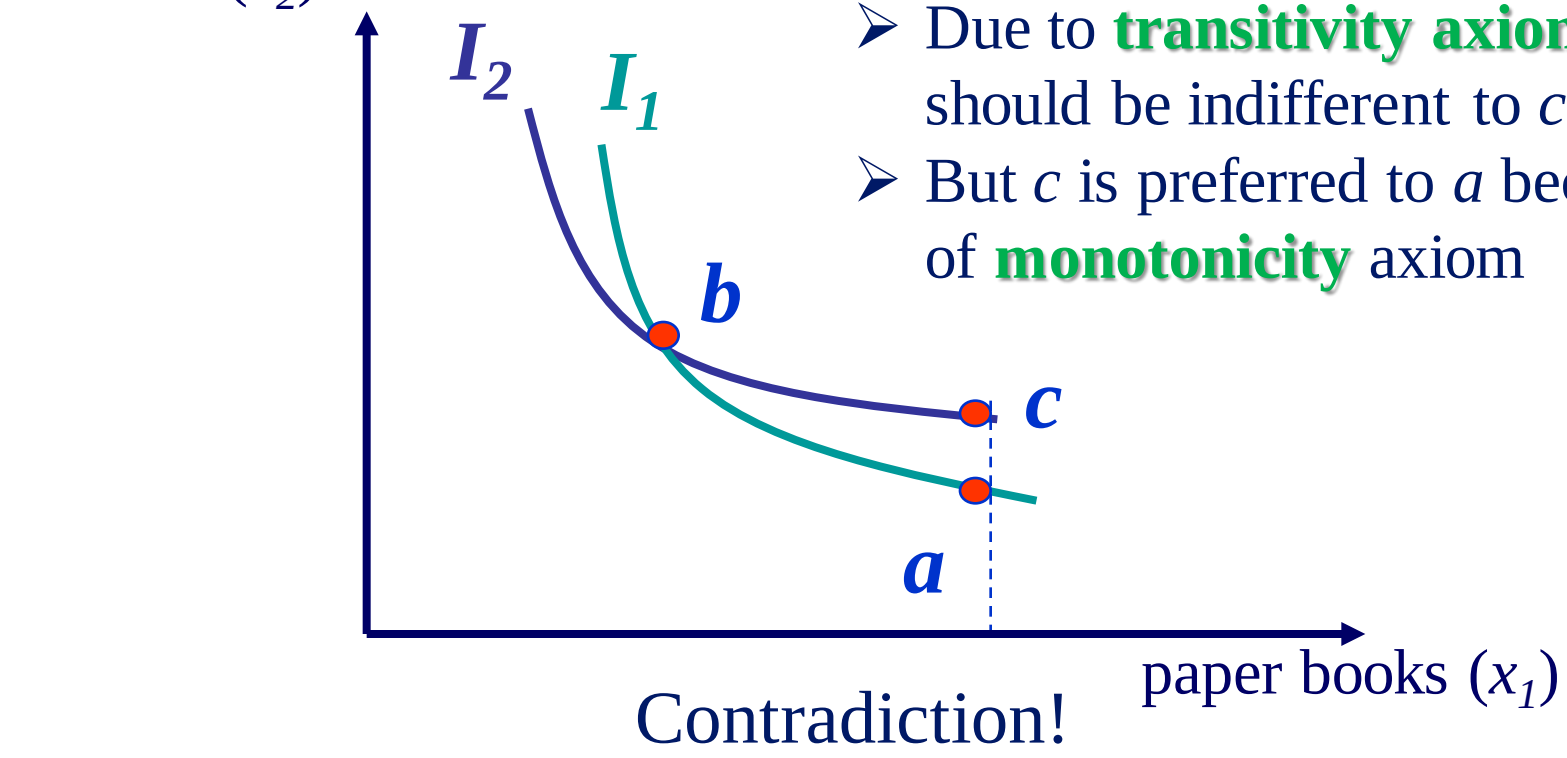
1. Bundles on indifference curves **farther from the origin are preferred** to bundles on indifference curves closer to the origin. Why? **Monotonicity axiom**

Indifference map

2. **Every bundle lies on** an indifference curve **(completeness axiom)**

3. *I* for the same individual **cannot cross**

Proof: assume they do.

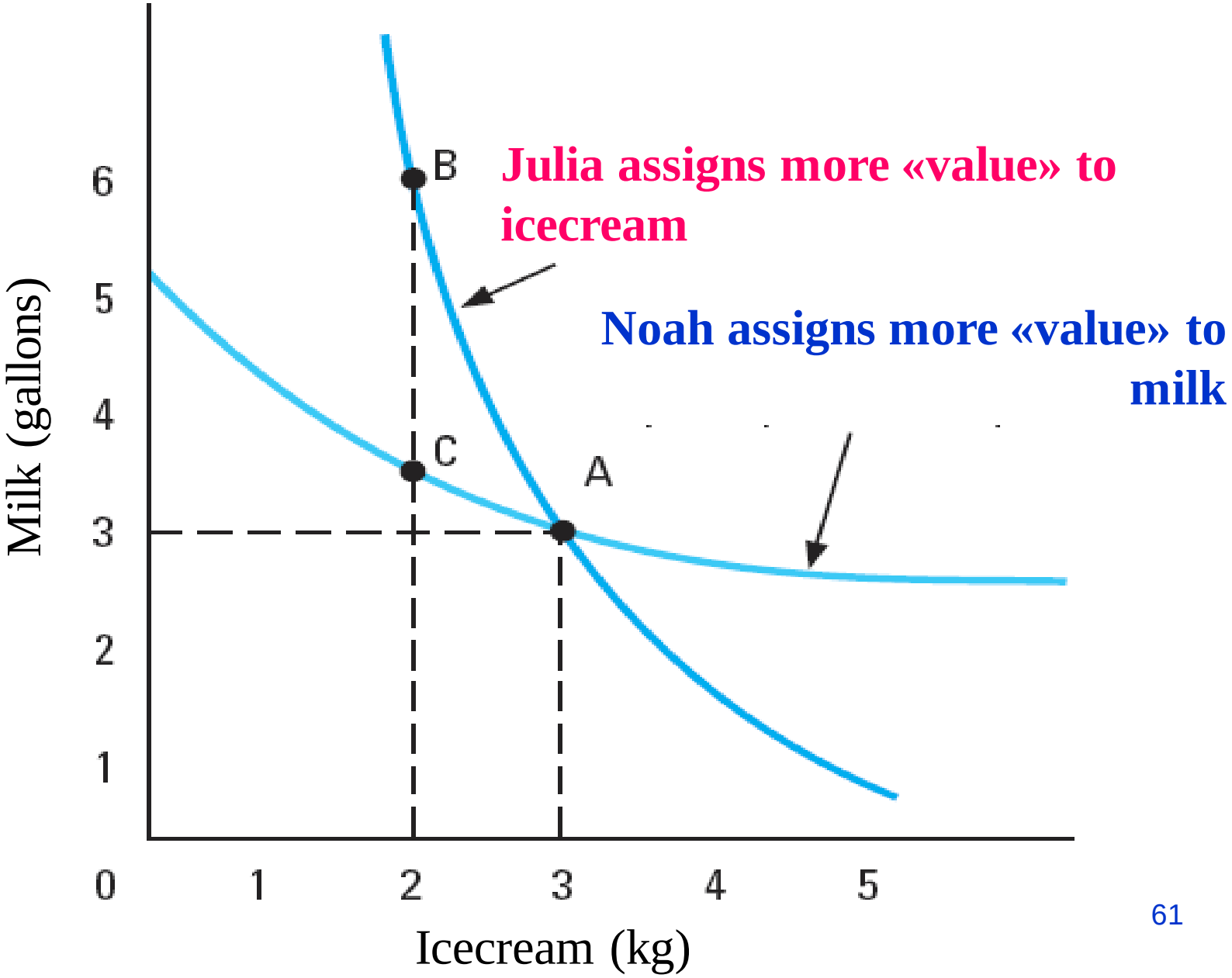


- *a* is indifferent to *b*
- *b* is indifferent to *c*
- Due to **transitivity axiom**, *a* should be indifferent to *c*
- But *c* is preferred to *a* because of **monotonicity** axiom

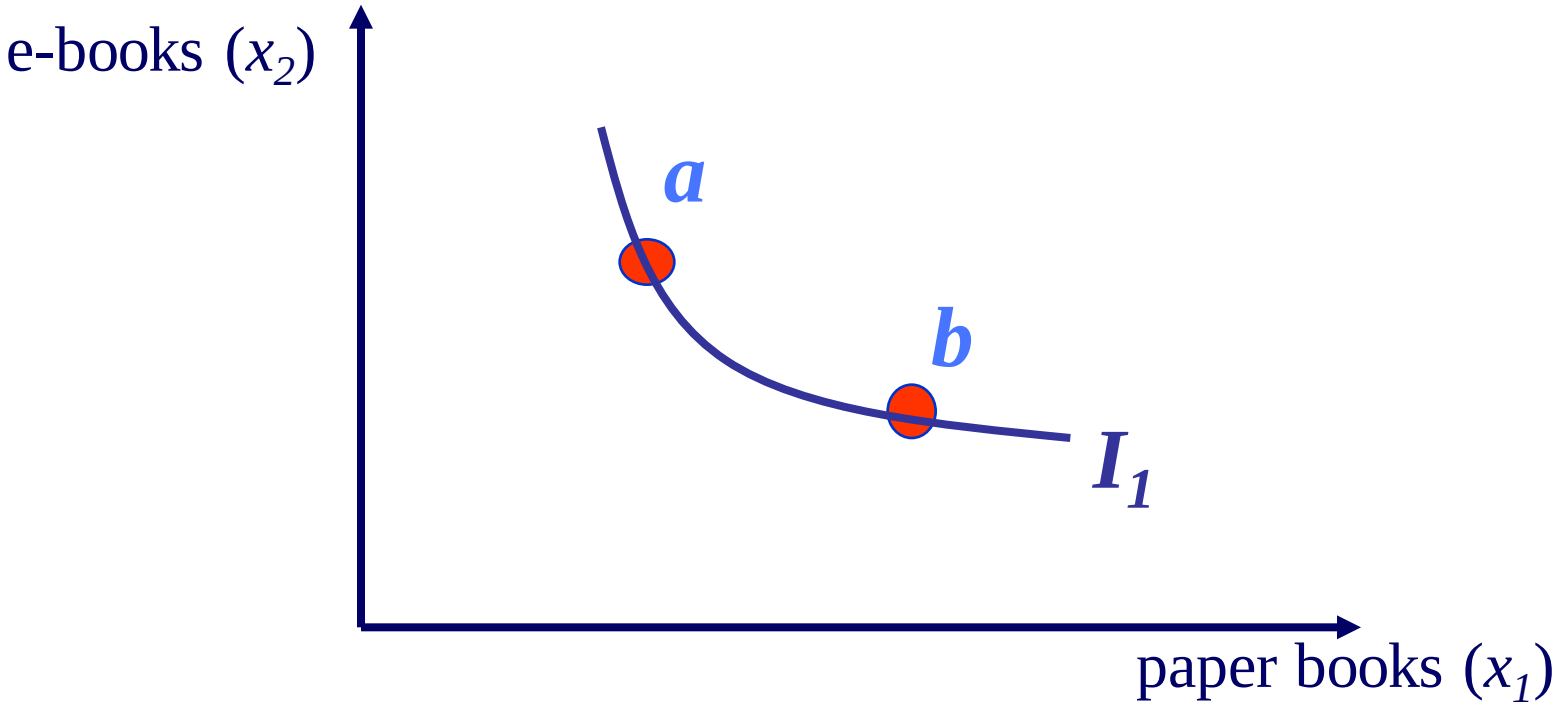
Contradiction!

Food for thought: can indifference curves of <u>different</u> individuals cross?

Comparing two individuals' preferences



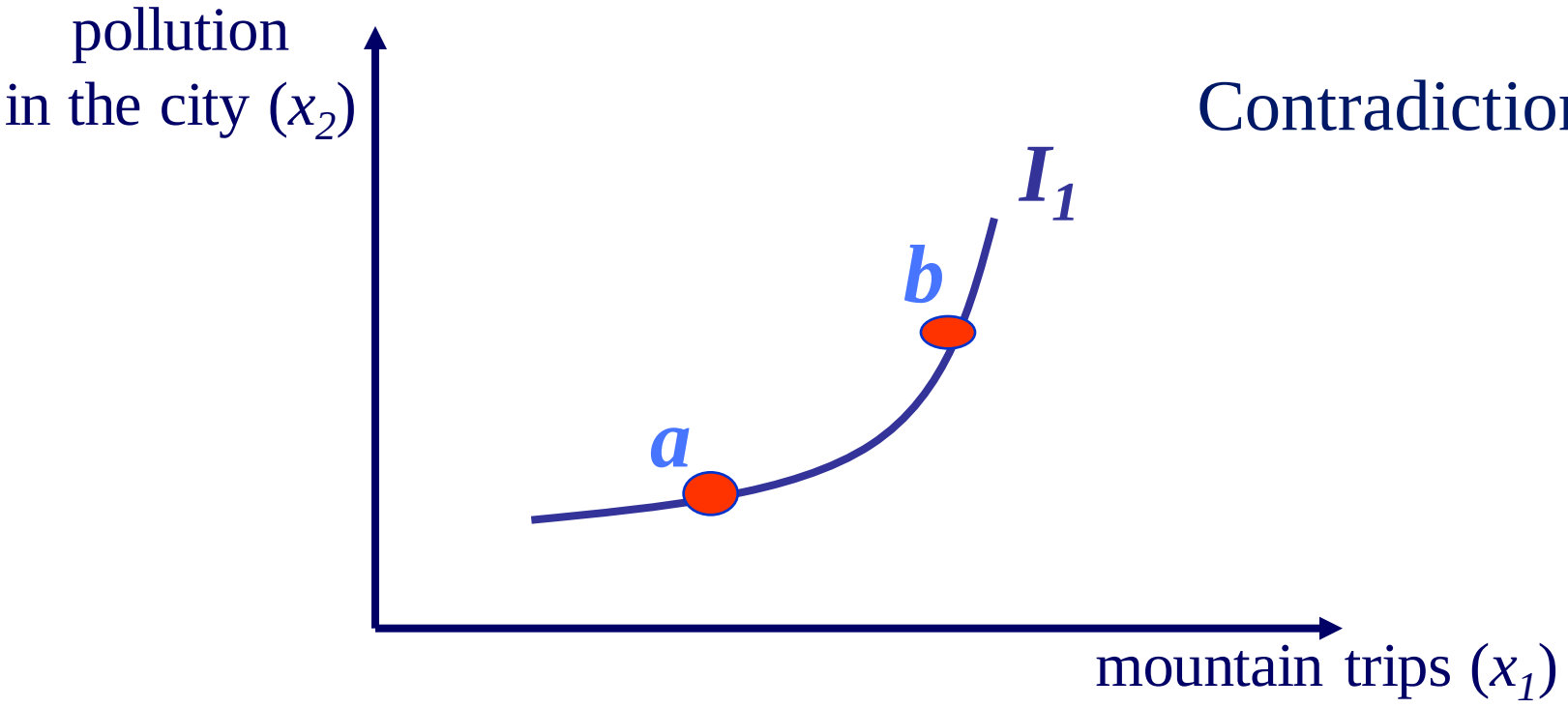
4. When both commodities are “goods”, **indifference curves slope downward** (i.e., have negative slopes)



4. When indifference curves have positive slopes, one of the two goods is a “bad”.

PROOF:

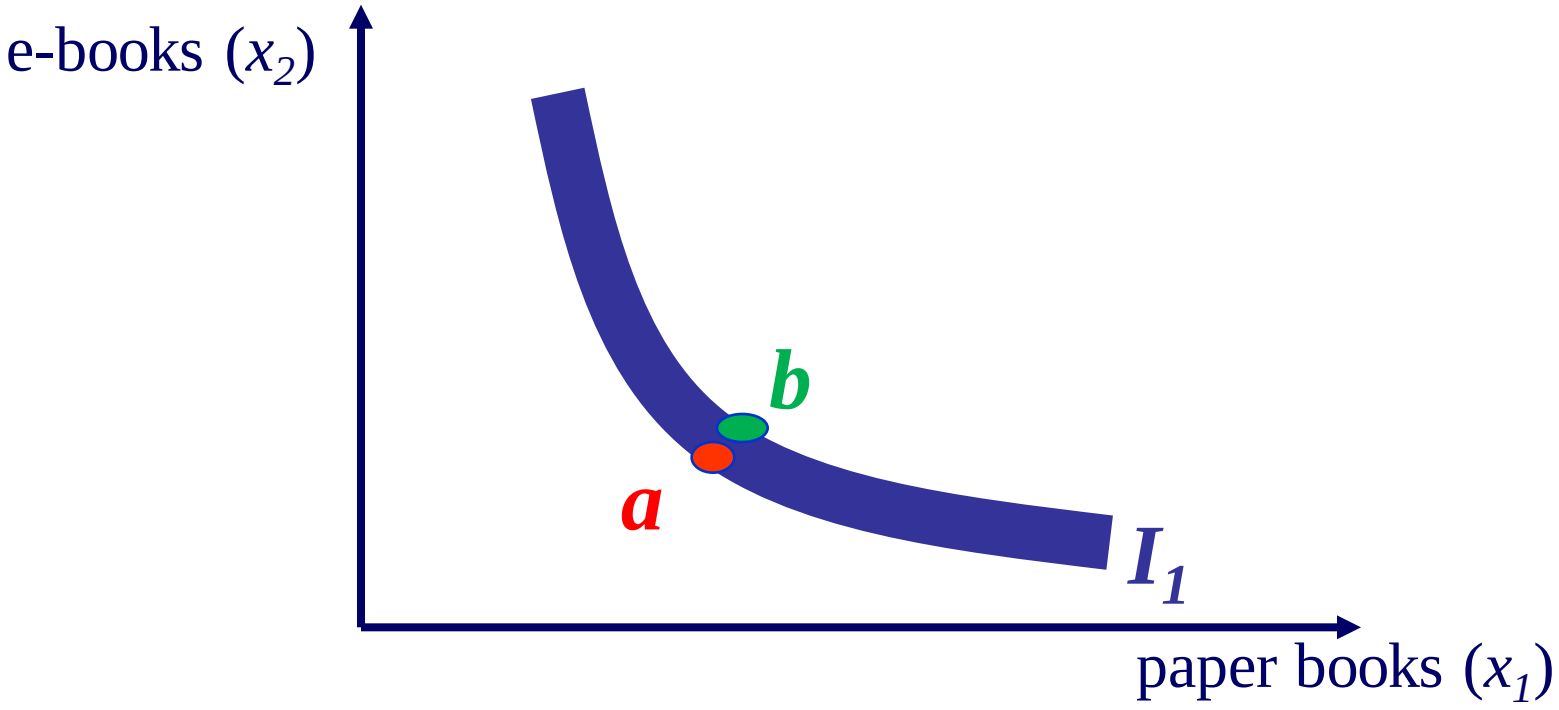
- *a* should be indifferent to *b* because they lie on the same indifference curve.
- But *b* should be preferred to *a* because of **monotonicity axiom**.



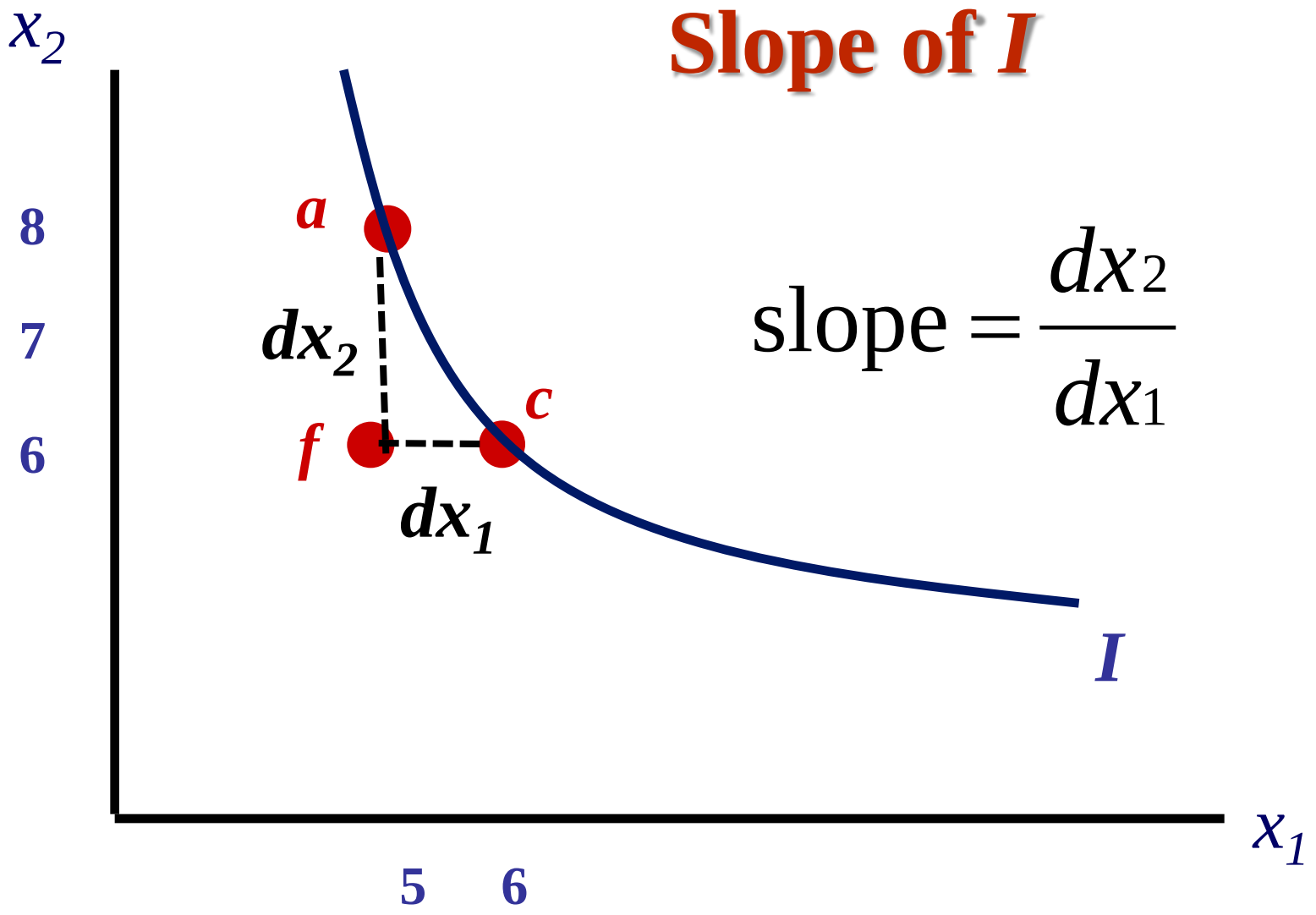
5. Indifference curves **cannot be thick**. If they were thick…

- *a* should be indifferent to *b* because they lie on the same indifference curve.
- But *b* should be preferred to *a* because of **monotonicity axiom**.

Contradiction!



Slope of *I*



$$\text{slope} = \frac{dx_2}{dx_1}$$

Under the **monotonicity** axiom, the **slope** of *I* is always **negative**

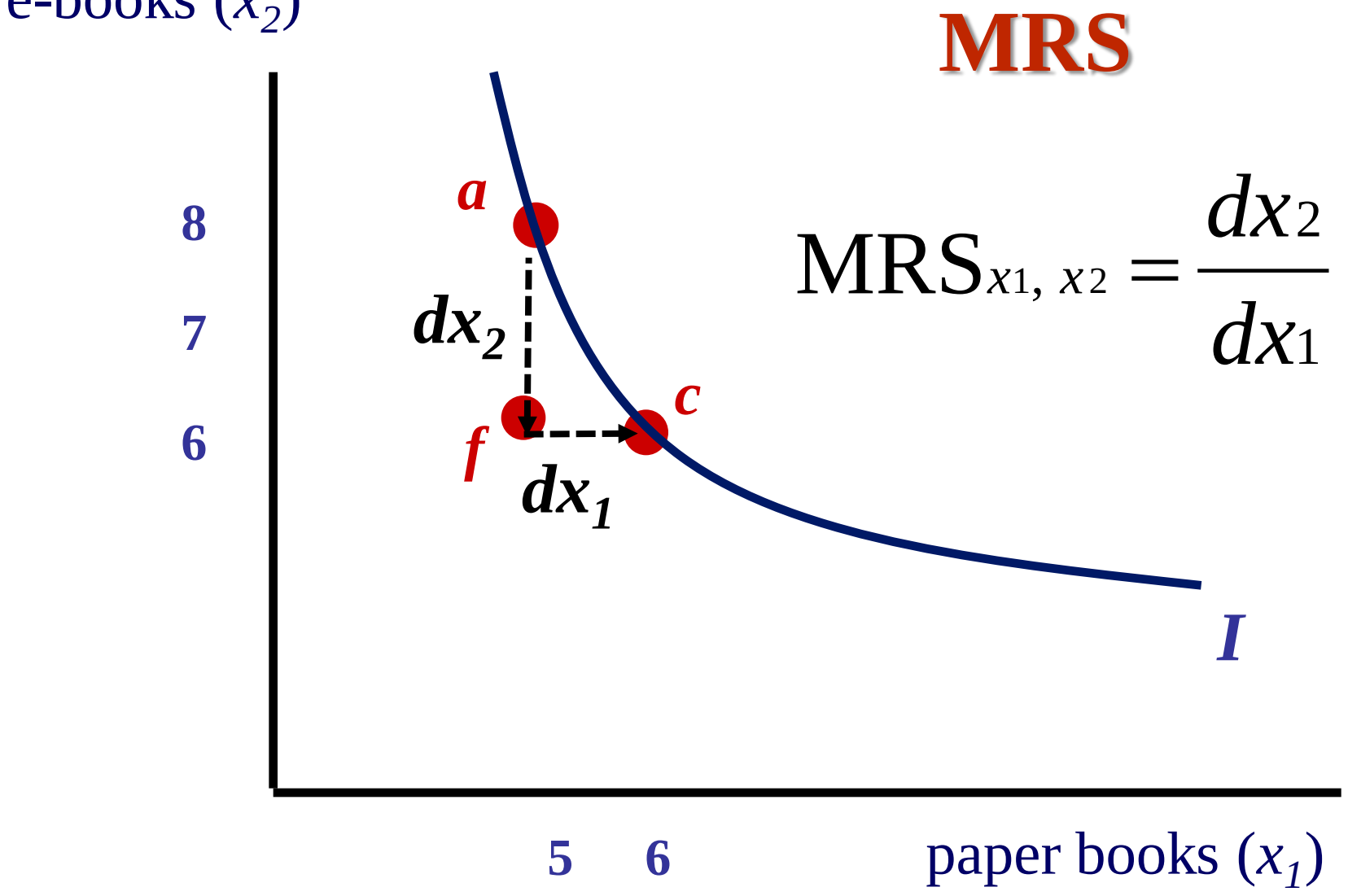
Marginal rate of substitution (MRS)

Definition

MRS is the ratio at which the individual is **willing to trade** / exchange one good with the other **and remain equally «happy»**. That is, it is the maximum quantity of good x_2 the individual is **willing to give up** (trade off) in order to get one additional unit of x_1 and remain equally «happy».

Mathematically: **MRS is the slope of the indifference curve *I*** (remark: some textbooks define the MRS as the inverse of the slope, that is, they take the positive value of the slope; but we use Varian's textbook, so we follow Varian's notation).

MRS



$$\text{MRS}_{x1,\,x2} = \frac{dx_2}{dx_1}$$

In this specific example, MRS between *a* and *c* = - 2

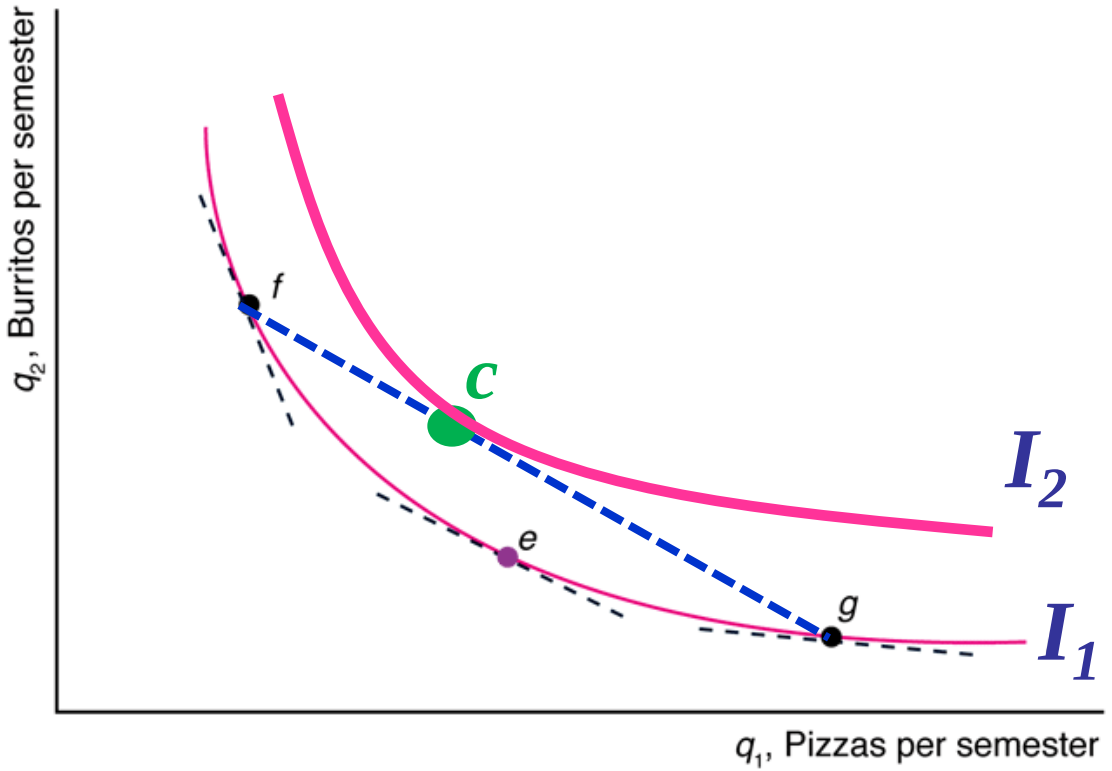
Tedious (but helpful) remark

- If you do not like to work with negative numbers, you can take the **absolute value** to obtain the MRS, get a positive number and compare the different MRS along the indifference curve using the absolute values.
- Example: if the slope at bundle *a* is – 5 and the slope at bundle *c* is – 3, we can say that, in **absolute value**, MRS at bundle *a* is equal to 5 and at bundle *c* is equal to 3.
- Then you can argue that the MRS at bundle *a* is greater than the MRS at bundle *c*, which means that the indifference curve at bundle *a* is steeper than the indifference curve at bundle *c*.
- Enough for mathematics! What's the **economic intuition** of all this mathematical taratatam???

6. Indifference curves are **convex** (due to **convexity axiom**)

A. Individuals **prefer to diversify their consumption** (any linear combination of two bundles lying on an IC is preferred to either bundles, e.g., *c* is preferred to either *f* or *g*)

B. MRS is diminishing



Food for thought

- **Theory vs theory**

What happens if an individual's preferences violate one (or more) of the axioms?
Very interesting things happen!!!

- **Theory vs the real world**

Does the assumption of well-behaved preferences mean that in the real world every individual has preferences that satisfy the five regularity axioms?
NO!!! Insights from behavioral economics

- **So what???**

Why economists assume that people's preferences satisfy those axioms if people's preferences may not be well-behaved in the real world?

Food for thought

Theory vs theory

What happens if an individual's preferences violate one (or more) of the axioms?

Perfect substitutes: strict convexity violated

Perfect complements: monotonicity violated

Concave IC: convexity violated

Neutral goods: monotonicity and convexity violated

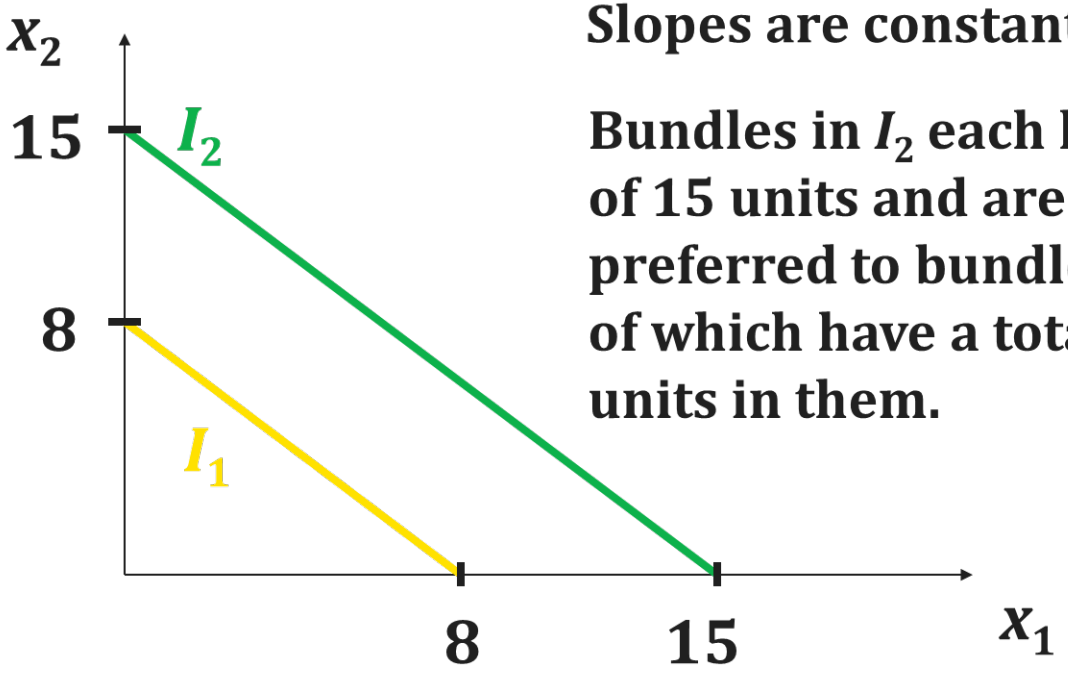
Bads: monotonicity violated

Perfect substitutes

- If a consumer always regards units of commodities 1 and 2 as equivalent, then the commodities are perfect substitutes and only the total amount of the two commodities in bundles determines their preference rank-order.
- For this type of preferences, the **indifference curves are straight lines with constant slope**.
- Hence, the **MRS is constant** for this type of preferences.

Perfect substitutes

example (sugar and honey)



Slopes are constant at -1.

Bundles in I_2 each have a total of 15 units and are strictly preferred to bundles in I_1, each of which have a total of only 8 units in them.

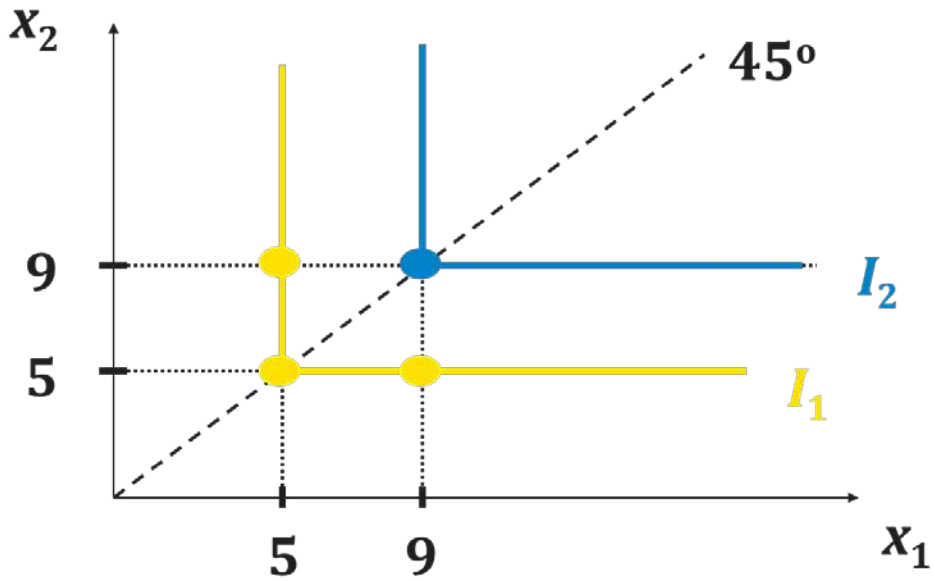
Perfect complements

- If a consumer always consumes commodities 1 and 2 in fixed proportions (e.g., 1 to 1, or 2 to 1, or 1 to 7), then the commodities are perfect complements and only the number of pairs of units of the two commodities determines the preference rank-order of bundles.
- For this type of preferences, the **indifference curves are L-shaped**, with slope equal to zero on the horizontal tract, infinite on the vertical tract, and undefined at the kink.
- Correspondingly, the **MRS is zero, infinite, or undefined**.

- «L-shaped» preferences due to economist Wassily Leontief (born 1906; died 1999; Nobel Prize in 1973).

Perfect complements

Example (tea and sugar)

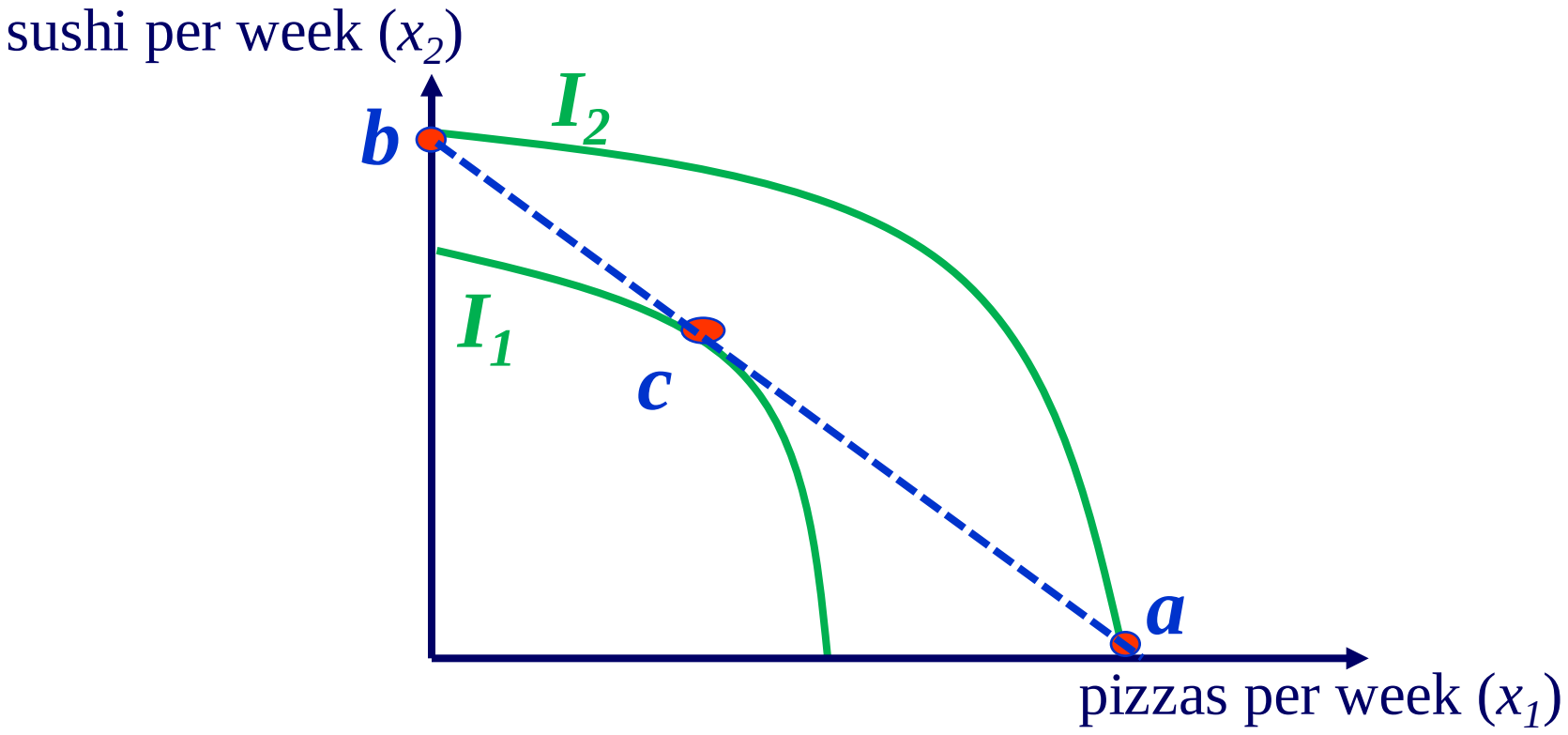


Each of (5,5), (5,9), and (9,5) contains 5 pairs so each is equally preferred.

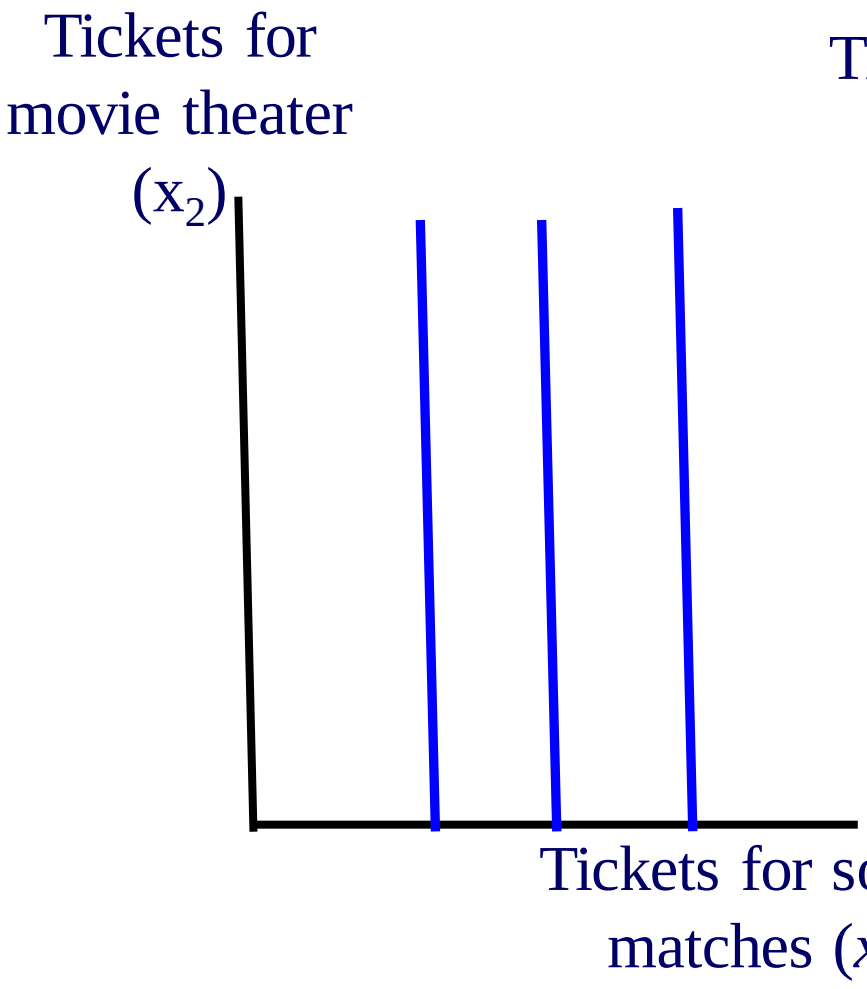
And each is less preferred to (9,9), which has 9 pairs.

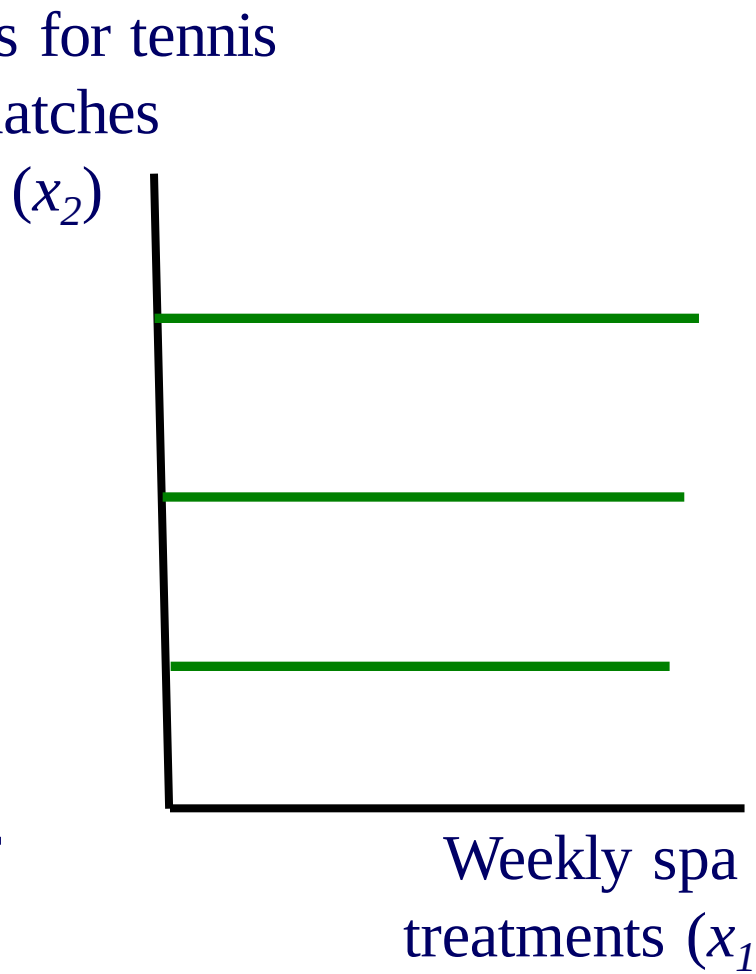
Concave IC

1. Individuals prefer NOT to diversify their consumption
2. IC curves are concave (any linear combination of two bundles lying on an IC is less preferred to either bundles, e.g., *a* or *b* are strictly preferred to *c*)
3. **MRS is increasing**



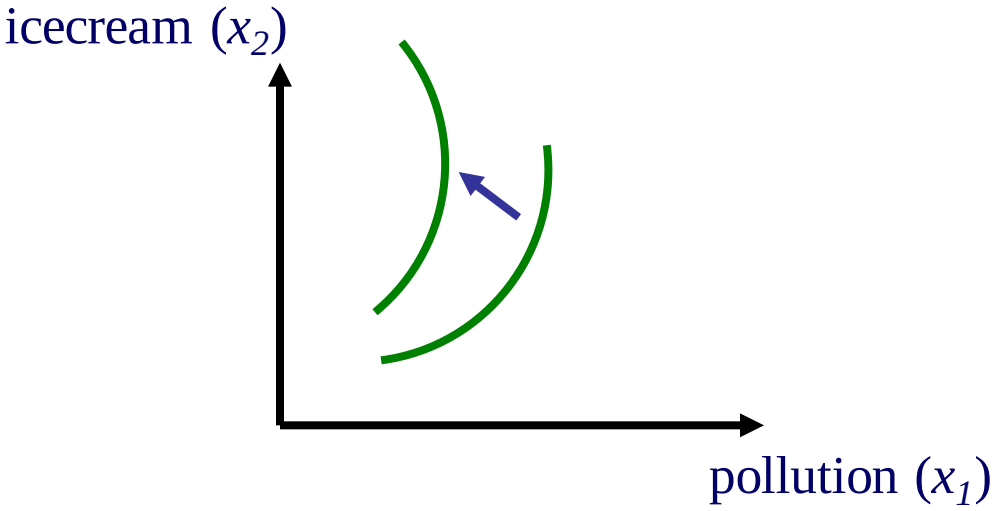
Neutral goods





and how about preferences over “bads” ?…

Examples: pollution, garbage, noise



- Monotonicity axiom is violated (more «bads» is less preferred)
- Indifference curves are posivitely sloped (MRS is positive)

Topics to study on your own

- Satiation (p. 41)
- Discrete goods (p. 42)
- Other interpretation of the MRS (p. 48)

Chapter 3:
Take home message

- What is the key concept we learned when studying how economists model preferences?