Microeconomics 2

EVROPSKÁ UNIE
Evropské strukturální a investiční fondy
Operační program Výzkum, vývoj a vzdělávání

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VŠE - Silvester van Koten

- The presentation is based on the following sources:

- Snyder Christopher M Walter Nicholson and Robert Stewart. 2015. Microeconomic Theory : Basic Principles and Extensions EMEA ed. Andover: Cengage Learning. +
- Varian Hal R. 2020. Intermediate Microeconomics : A Modern Approach Ninth ed. New York: W.W. Norton & Company. +
- Excerpts from Gravelle H O Hart and R Rees. 2004. Advanced Microeconomics.

- Some more math refinements

Exponential and natural logarithmic functions – basic relations

$$x^a \cdot x^b = x^{a+b}$$

$$(x^a)^b = x^{a \cdot b}$$

Exponential and natural logarithmic functions – basic relations

$$\frac{de^x}{dx} = e^x \qquad y = e^x \qquad x = \ln[y]$$

$$x = \ln[e^x] \qquad y = e^{\ln[y]}$$

$$e^0 = 1 \qquad \lim_{x\to+\infty} e^x = +\infty \qquad \lim_{x\to-\infty} e^x = 0$$

$$\ln[1] = 0 \qquad \lim_{x\to+\infty} \ln[\mathrm{x}] = +\infty \qquad \lim_{x\downarrow 0} \ln[\mathrm{x}] = -\infty$$

For proofs, see: “Proof of Log Properties.pdf” on the google drive

Now we can derive 2 important properties of the ln function

$$x \cdot y = (x)\cdot(y) = e^{\ln[x]} \cdot e^{\ln[y]} = e^{\ln[x]+\ln[y]}$$

$$x \cdot y = e^{\ln[x\cdot y]}$$

$$\boxed{\ln[x] + \ln[y] = \ln[x \cdot y]}$$

$$x^a = (x)\cdot(x)\cdot \ldots \cdot(x)\{a \text{ times}\}$$

$$e^{\ln[x^a]} = e^{\ln[x]} \cdot e^{\ln[\mathrm{x}]} \cdot \ldots \cdot e^{\ln[\mathrm{x}]}\{a \text{ times}\}$$

$$= e^{\ln[x]+\ln[x]+\ldots+\ln[x]\{a \text{ times}\}}$$

$$= e^{a\cdot\ln[x]}$$

$$e^{\ln[x^a]} = e^{a\cdot\ln[x]}$$

$$\Leftrightarrow \ln[x^a] = a \cdot \ln[x]$$

Exponential and natural logarithmic functions - derivatives

$$y = e^x \qquad x = \ln[e^x]$$

$$y = e^{\ln[y]}$$

$$\frac{de^x}{dx} = e^x \qquad \frac{d\ln[x]}{dx} = x^{-1}$$

$$\frac{d2^x}{dx} = \ldots \qquad 2 = e^{\ln[2]} \qquad 2^x = (e^{\ln[2]})^x = e^{\mathrm{x}\ln[2]}$$

$$\frac{d2^x}{dx} = \frac{de^{\mathrm{x}\ln[2]}}{dx} = e^{\mathrm{x}\ln[2]} \cdot \ln[2]$$

General: $$\frac{da^x}{dx} = \frac{de^{\mathrm{x}\ln[\mathrm{a}]}}{dx} = e^{\mathrm{x}\ln[\mathrm{a}]} \cdot \ln[\mathrm{a}]$$

Partial derivatives

$$z = f(x, y)$$

$$z = f(x[t], y[t])$$

$$\frac{dz}{dt} = \frac{df(x[t], y[t])}{dt}$$

$$= \frac{\partial f(x[t], y[t])}{\partial x}\frac{dx[t]}{dt} + \frac{\partial f(x[t], y[t])}{\partial y}\frac{dy[t]}{dt}$$

$$\equiv f_1(x[t], y[t])\frac{dx[t]}{dt} + f_2(x[t], y[t])\frac{dy[t]}{dt}$$

$$\frac{dz}{dt} = 1 \cdot 1 + 2 \cdot 1 = 3$$

Example 1

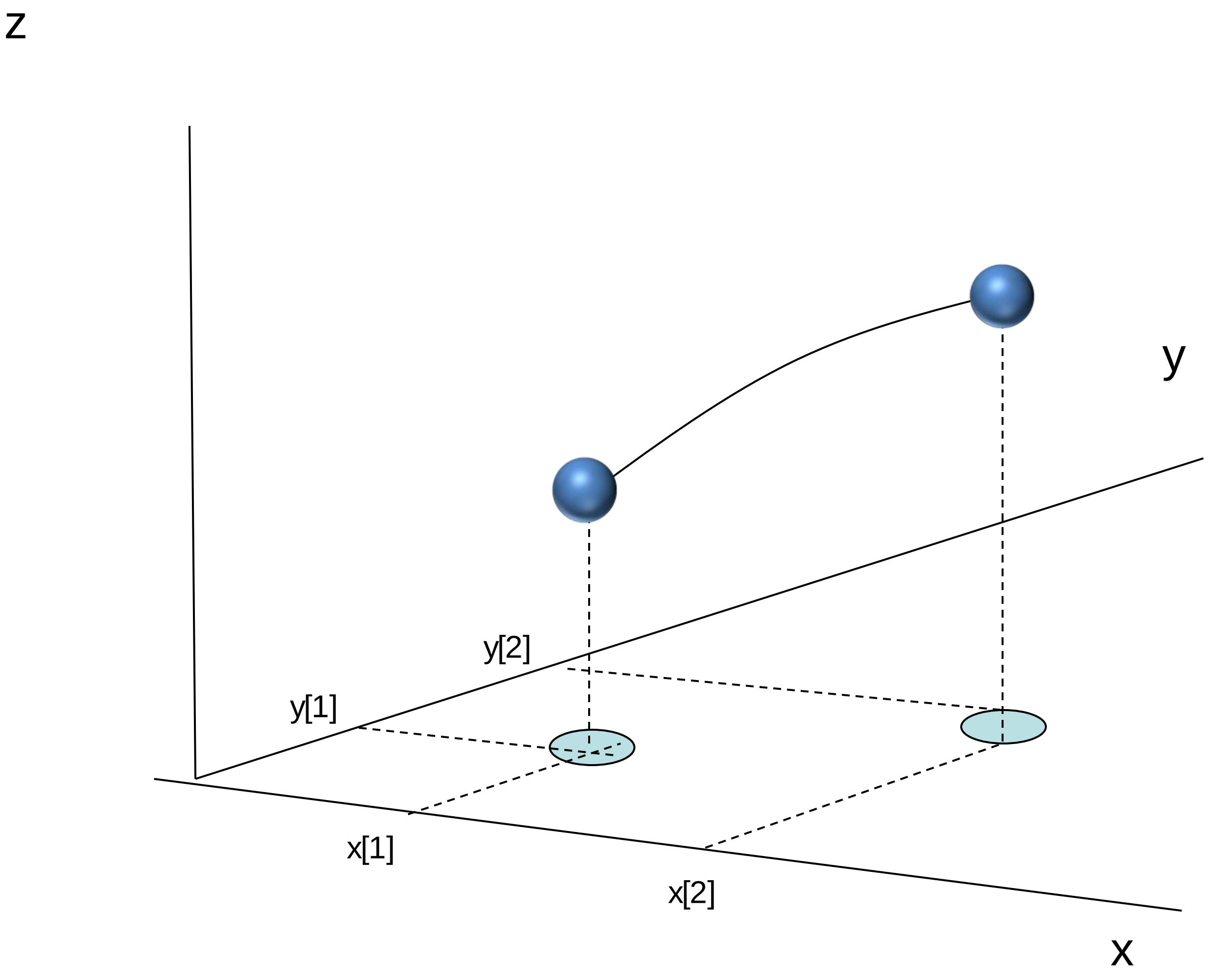
$$z = f(x, y) = \mathrm{x} + 2\,\mathrm{y}$$

$$x[t] = t, y[t] = t$$

$$z = \mathrm{x} + 2\,\mathrm{y} = \mathrm{t} + 2\,\mathrm{t} = 3\mathrm{t}$$

$$\frac{dz}{dt} = 3$$

Partial derivatives



Partial derivatives

$$z = f(x, y)$$

$$z = f(x[t], y[t])$$

$$\frac{dz}{dt} = \frac{df(x[t], y[t])}{t}$$

$$= \frac{\partial f(x[t], y[t])}{\partial x}\frac{dx[t]}{dt} + \frac{\partial f(x[t], y[t])}{\partial y}\frac{dy[t]}{dt}$$

$$\equiv f_1(x[t], y[t])\frac{dx[t]}{dt} + f_2(x[t], y[t])\frac{dy[t]}{dt}$$

$$\frac{dz}{dt} = y \cdot 1 + x \cdot 1 = y + x = t + t = 2t$$

Example 2

$$z = f(x, y) = \mathrm{xy}$$

$$x[t] = t, y[t] = t$$

$$z = \mathrm{xy} = \mathrm{t} \cdot \mathrm{t} = \mathrm{t}^2$$

$$\frac{dz}{dt} = 2t$$

Partial derivatives

$$z = f(x, y[x])$$

$$\frac{dz}{dx} = \frac{\partial f(x,y)}{\partial x} + \frac{\partial f(x,y)}{\partial y}\frac{dy}{dx}$$

$$\equiv f_1(x, y[\mathrm{x}]) + f_2(x, y[\mathrm{x}])\frac{dy[x]}{dx}$$

Example 3

$$z = f(x,y) = \mathrm{xy}$$

$$y = 20 \cdot x^{-1}$$

$$z = \mathrm{xy} = x \cdot 20 \cdot x^{-1} = 20$$

$$\frac{dz}{dx} = 0$$

$$\frac{dz}{dx} = y + x \cdot (-1 \cdot 20 \cdot x^{-2}) =$$

$$= 20 \cdot x^{-1} - 20x^{-1} = 0$$

Partial derivatives

$$z = f(x, y[x])$$

$$\frac{dz}{dx} = \frac{\partial f(x,y)}{\partial x} + \frac{\partial f(x,y)}{\partial y}\frac{dy}{dx}$$

$$\equiv f_1(x, y[\mathrm{x}]) + f_2(x, y[\mathrm{x}])\frac{dy[x]}{dx}$$

Example 4

$$z = f(x, y) = x \cdot y$$

$$y = 100 - x$$

$$z = x \cdot y = x \cdot (100 - x) = 100x - x^2$$

$$\frac{dz}{dx} = 100 - 2x$$

$$\frac{dz}{dx} = \quad y + x \cdot (-1) =$$

$$= y - x =$$

$$= 100 - x - x$$

$$= 100 - 2x$$

Exercises

$$f[x, y] = x + \ln[\mathrm{y}]$$

$$\frac{\partial f[x, y]}{\partial x} = 1$$

$$\frac{\partial f[x, y]}{\partial y} = \frac{1}{y}$$

$$f[x, y, z] = z^2 xy + \ln[y - x]$$

$$\frac{\partial f[x, y, z]}{\partial x} = z^2 y + \frac{1}{y - x} \cdot -1$$

$$\frac{\partial f[x, y, z]}{\partial y} = z^2 x + \frac{1}{y - x}$$

$$\frac{\partial f[x, y, z]}{\partial z} = 2zxy$$

Exercises

$$f[x, y] = x + y^2$$

$$\frac{\partial f[x, y]}{\partial x} = 1$$

$$\frac{\partial f[x, y]}{\partial y} = 2y$$

$$y = g(x)$$

$$f(x, g(x)) = x + g(x)^2$$

$$\frac{df(x, \mathrm{g}(\mathrm{x}))}{dx} = 1 + 2g(x) \cdot g'(x)$$

Exercises

$$y = g(x) = \ln[x]$$

$$\frac{\partial f(x, g(x))}{\partial x} = 1 + 2g(x) \cdot g'(x)$$

$$= 1 + 2\ln[x] \cdot \frac{1}{x}$$

$$= 1 + \frac{2\ln[x]}{x}$$

$$f(x, y) = f(x, \ln[x])$$

$$= x + \ln[x]^2$$

$$\frac{\partial f(x, y)}{\partial x} = 1 + 2\ln[x] \cdot \frac{1}{x}$$

Partial derivatives

In the examples before, $\frac{dy[x]}{dx}$ was given (by announcing $y = f[x]$)

while f_1 and f_2 needed to be calculated.

Often we are in the opposite situation. We can easily find f_1 and f_2,

but need to find, $\frac{dy[x]}{dx}$ with $\frac{dz}{dx} = 0.$?

> $z[x, y]$ could be the
> indiffence curve (consump. theory)
> or the iso-cost curve or
> the iso-quant (product. theory)

$$\frac{dz}{dx} = f_1(x, y[\mathrm{x}]) + f_2(x, y[\mathrm{x}])\frac{dy[x]}{dx}$$

$$\Leftrightarrow f_2(x, y[\mathrm{x}])\frac{dy[x]}{dx} = \frac{dz}{dx} - f_1(x, y[\mathrm{x}])$$

$$\Leftrightarrow \frac{dy[x]}{dx} = \frac{1}{f_2(x, y[\mathrm{x}])}\frac{dz}{dx} - \frac{f_1(x, y[\mathrm{x}])}{f_2(x, y[\mathrm{x}])}$$

$$\text{if } \frac{dz}{dx} = 0 \quad \Leftrightarrow \frac{dy[x]}{dx} = -\frac{f_1(x, y[\mathrm{x}])}{f_2(x, y[\mathrm{x}])}$$

The Consumer's Budget Constraint

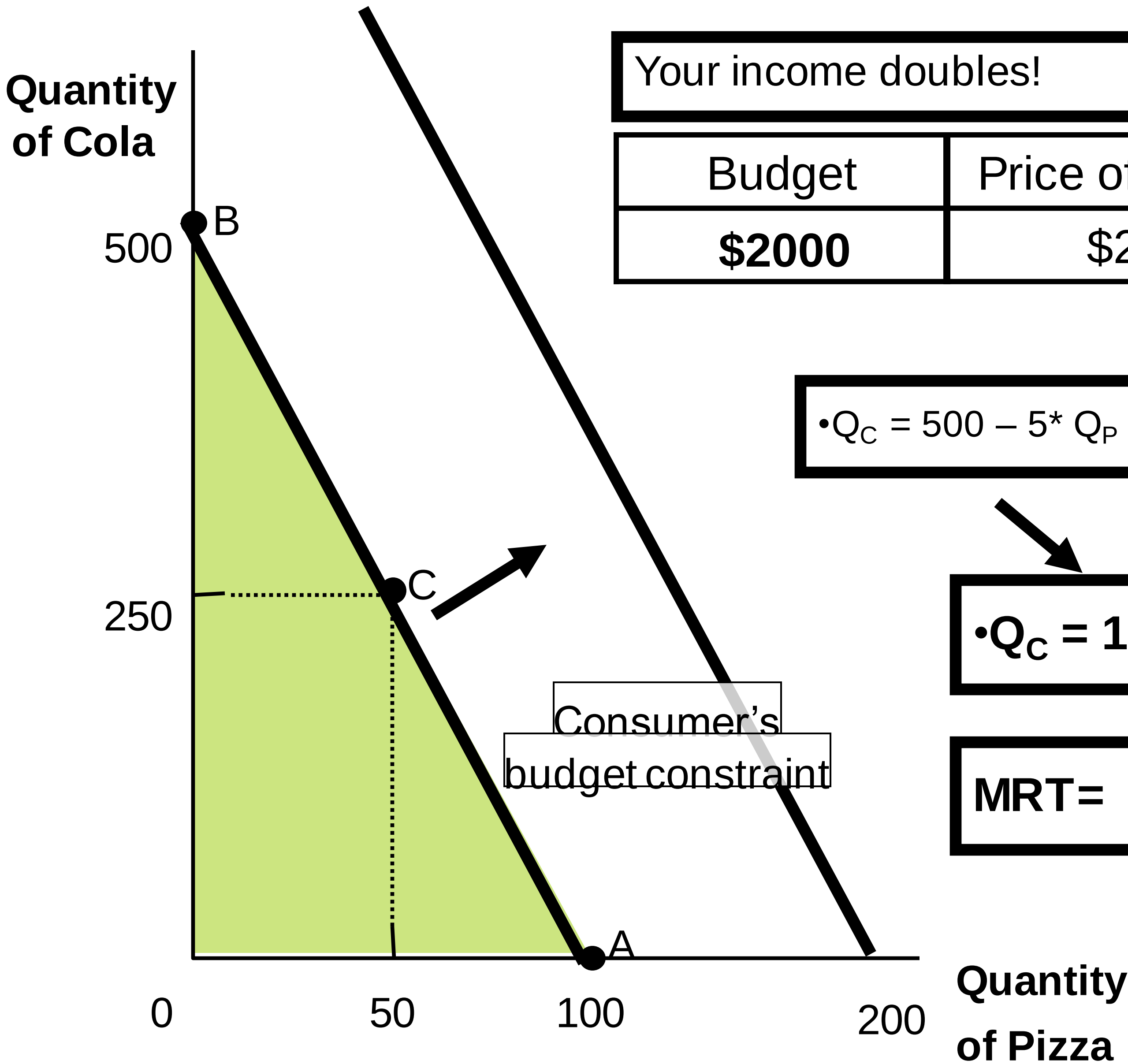
Your income doubles!

Budget	Price of Cola	Price of Pizza
$2000	$2	$10

•$Q_C = 500 – 5 * Q_P$

•$Q_C = 1000 – 5 * Q_P$

MRT= -10



How to find the slope of the budget restriction in the product space

1. **Write down the budget restriction** as $M = p1 * x1 + p2 * x2$
2. **Isolate x2**

   $p2 * x2 = M - p1 * x1$

   $x2 = (M - p1 * x1)/p2$

   $x2 = M/p2 – (p1/p2)\ x1$

3. **Differentiate x2 to x1**

   $dx2/dx1 = -(p1/p2)$

$$p_1 x_1 + p_2 x_2 = m$$

and

$$p_1(x_1 + \Delta x_1) + p_2(x_2 + \Delta x_2) = m.$$

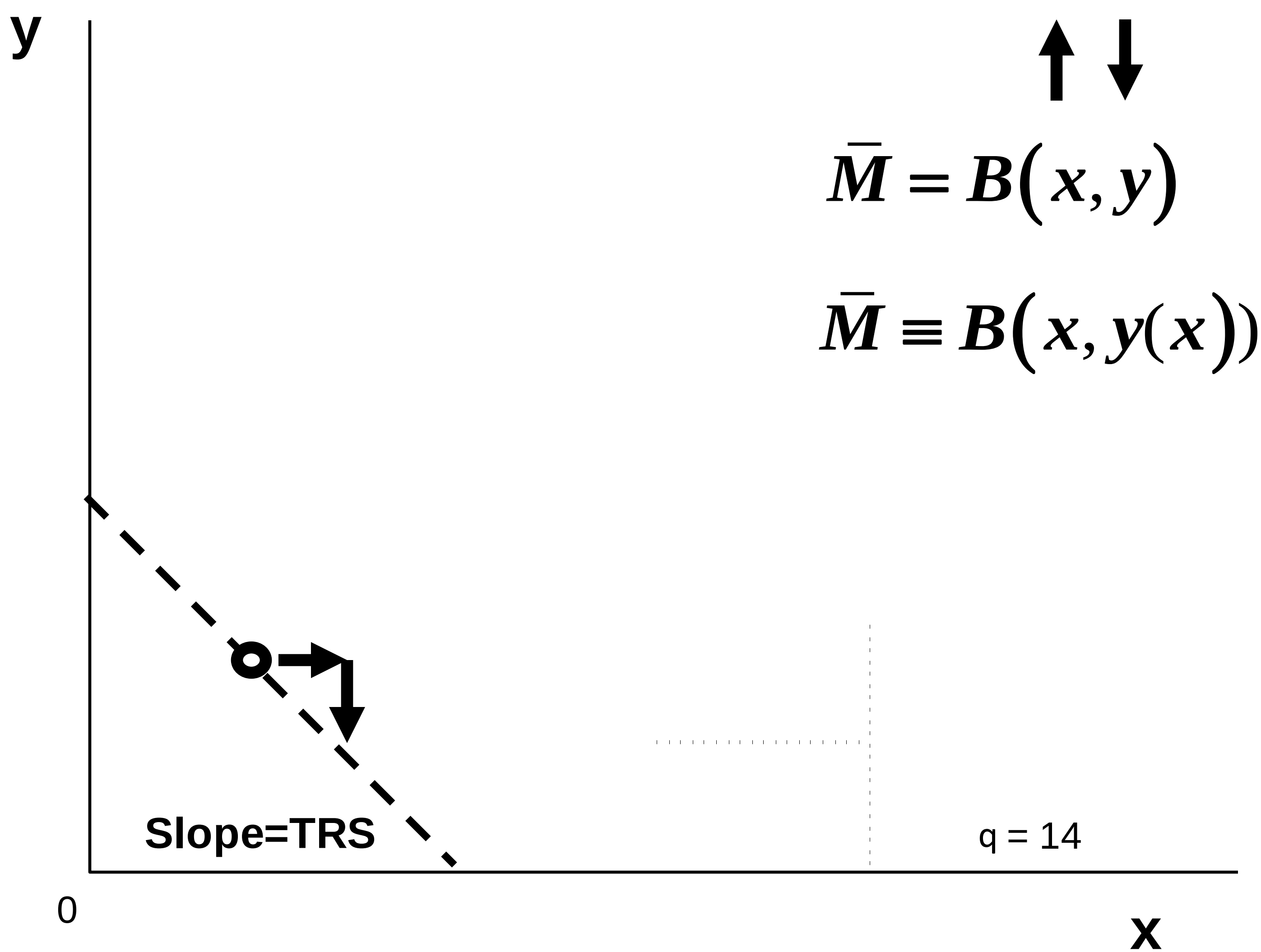
Subtracting the first equation from the second gives

$$p_1 \Delta x_1 + p_2 \Delta x_2 = 0.$$

This says that the total value of the change in her consumption must be zero. Solving for $\Delta x_2 / \Delta x_1$, the rate at which good 2 can be substituted for good 1 while still satisfying the budget constraint, gives

$$\frac{\Delta x_2}{\Delta x_1} = -\frac{p_1}{p_2}.$$

Budget restriction



$$\bar{M} = B(x, y)$$

$$\bar{M} \equiv B(x, y(x))$$

Derivation method 1: implicit function derivation

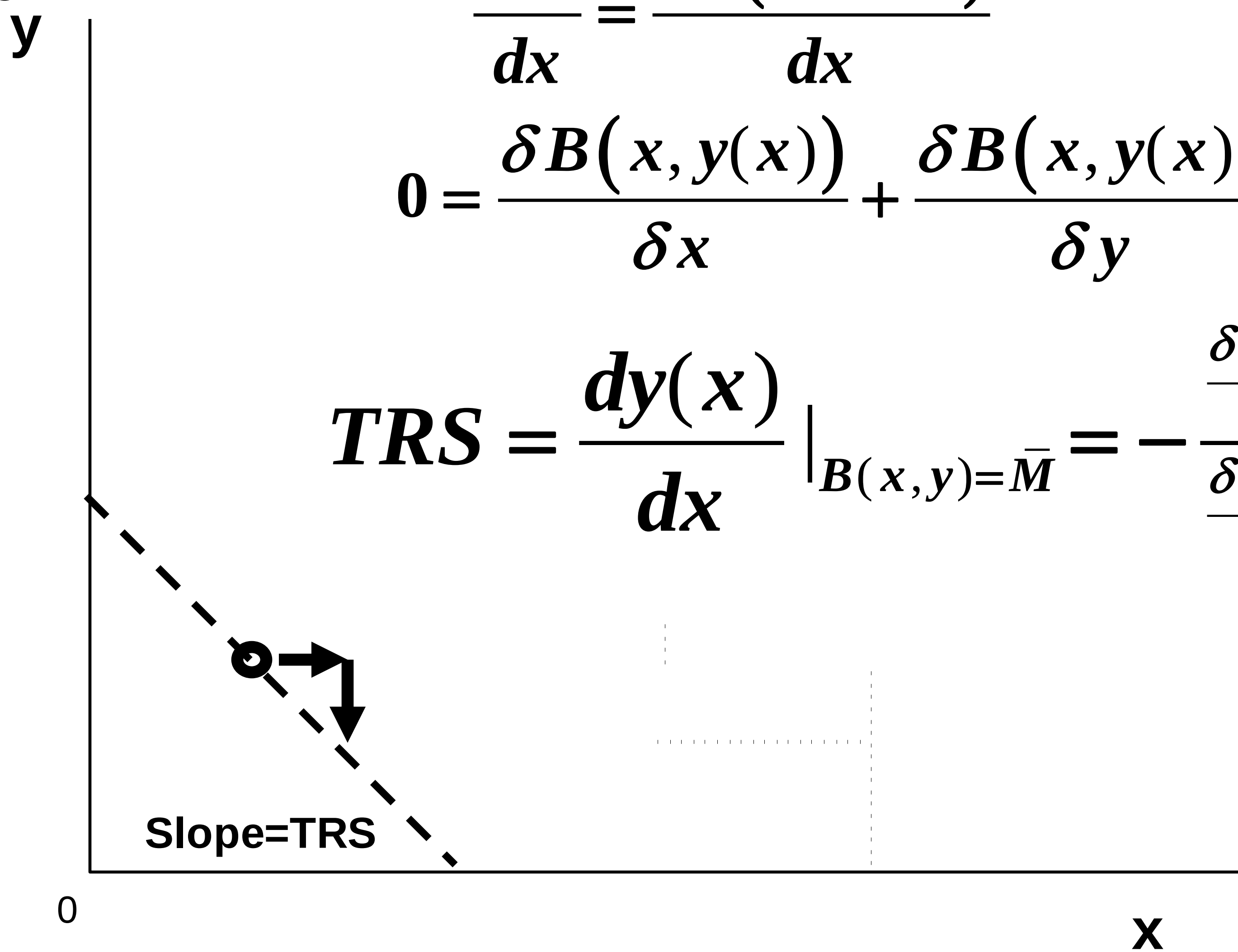
$$\bar{M} \equiv B\left(x, y(x)\right)$$

$$\frac{d\bar{M}}{dx} = \frac{dB\left(x, y(x)\right)}{dx}$$

$$0 = \frac{\delta B\left(x, y(x)\right)}{\delta x} + \frac{\delta B\left(x, y(x)\right)}{\delta y}\frac{dy}{dx}$$

$$TRS = \frac{dy(x)}{dx}\Big|_{B(x,y)=\bar{M}} = -\frac{\frac{\delta M(x,y)}{\delta x}}{\frac{\delta M(x,y)}{\delta y}}$$

Budget restriction



- **Consumer preferences:** Chap 3

A

B

C

D

E

F

G

A

B

- Consumer can rank bundles of goods, eg A and B
- Ranking done by a preference relation “>”
  - A=B
    - I like A and B equally much
  - A ≥ B
    - I prefer A to B (can include the case that A=B)
  - A > B
    - I strictly prefer A to B (thus excludes the case that A=B)

Consumer preferences are:

1. Complete
   – A ≥ B or B ≥ A (or both: then A=B)

2. Reflexive
   – A ≥ A

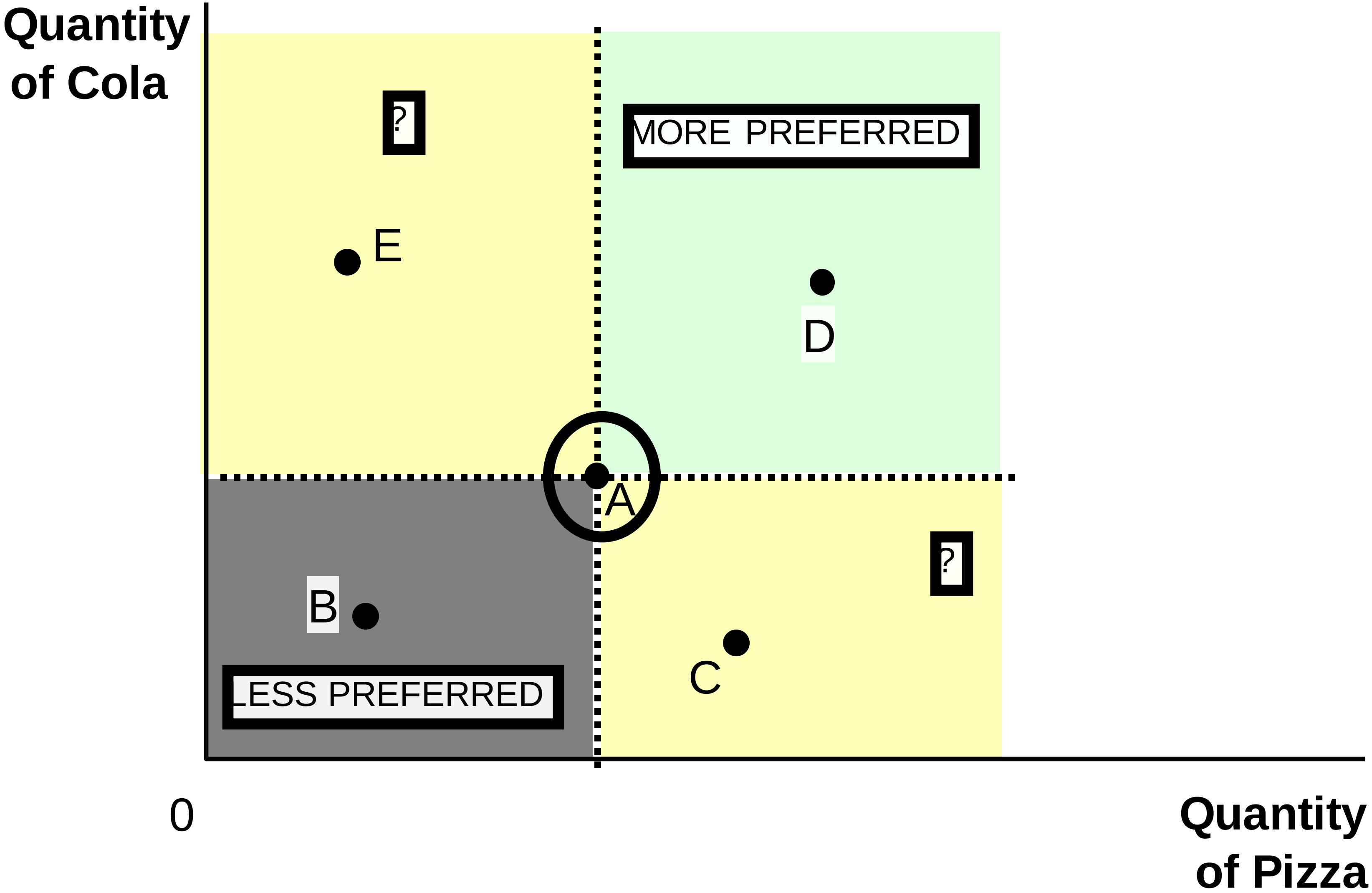
3. Transitive
   – A ≥ B
   – B ≥ C
   – A ≥ C

http://affiliater.hubpages.com/hub/from-chunk-to-hunk-how-one-person-lost-four-hundred-pounds

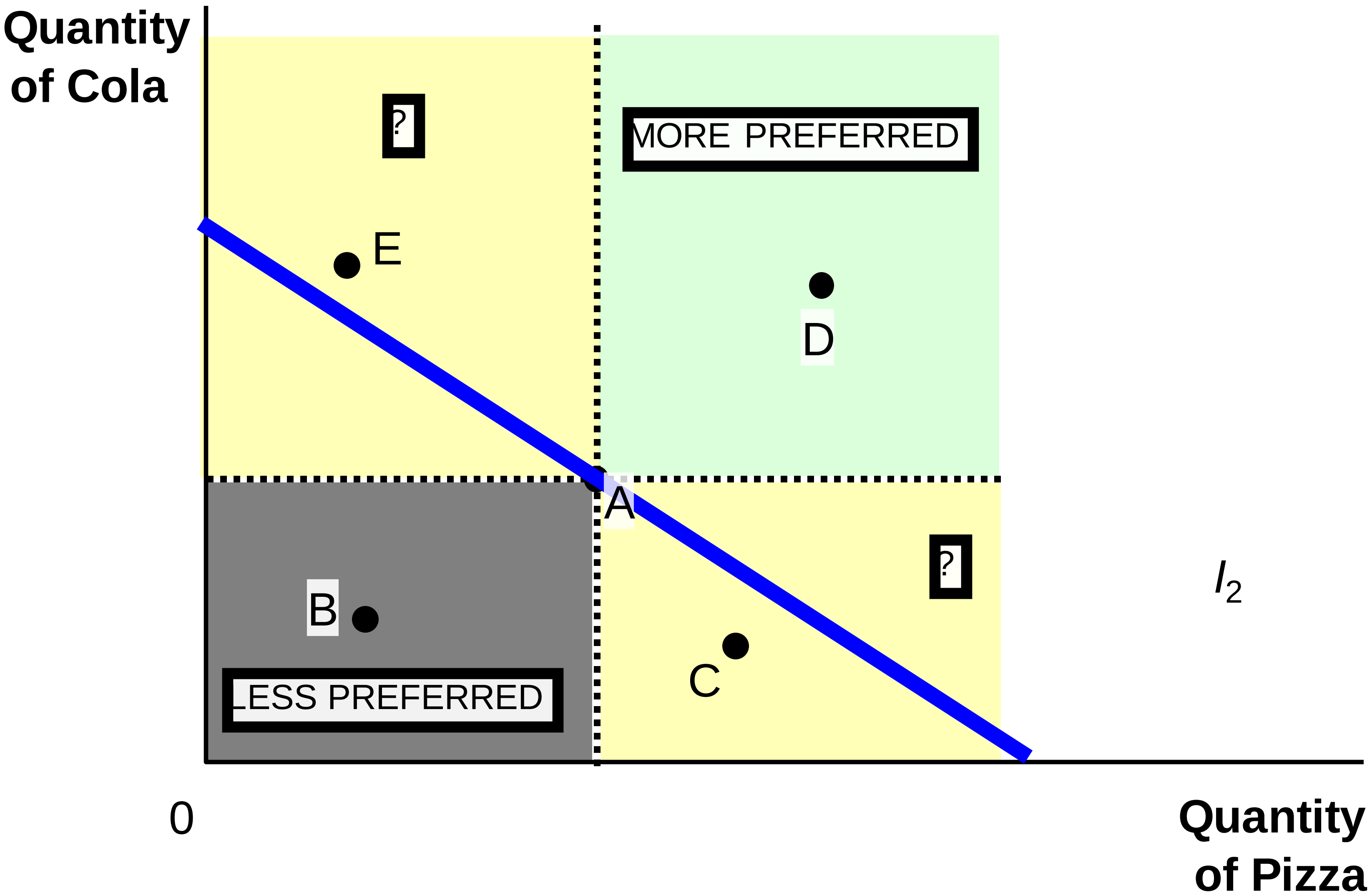
Repeat
100.000x

Consumer preferences are:

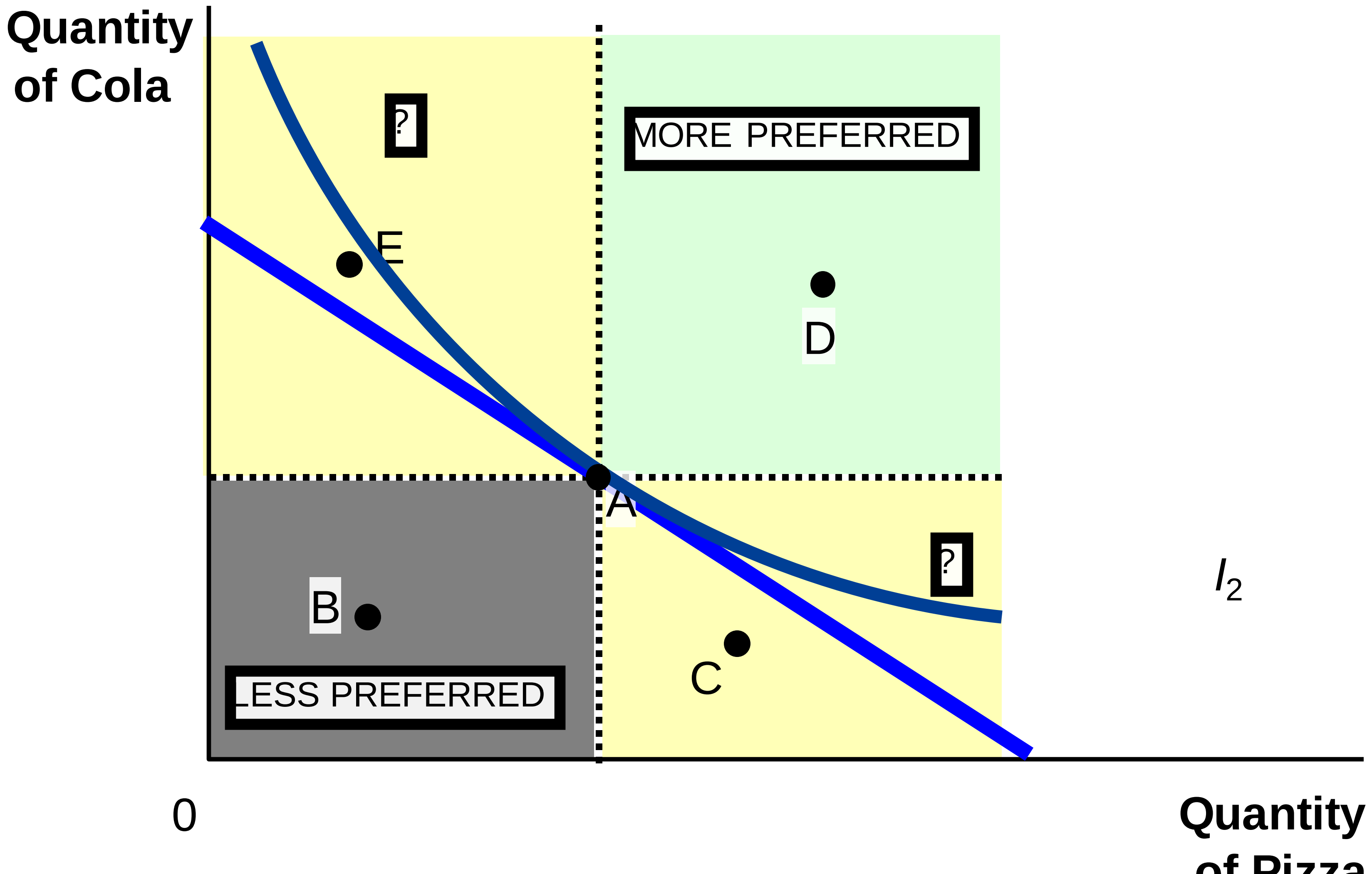
4. More is better: Monotonicity
   (more details to follow)


Quantity
of Cola
?
MORE PREFERRED
E
D
A
?
B
C
LESS PREFERRED
0
Quantity
of Pizza

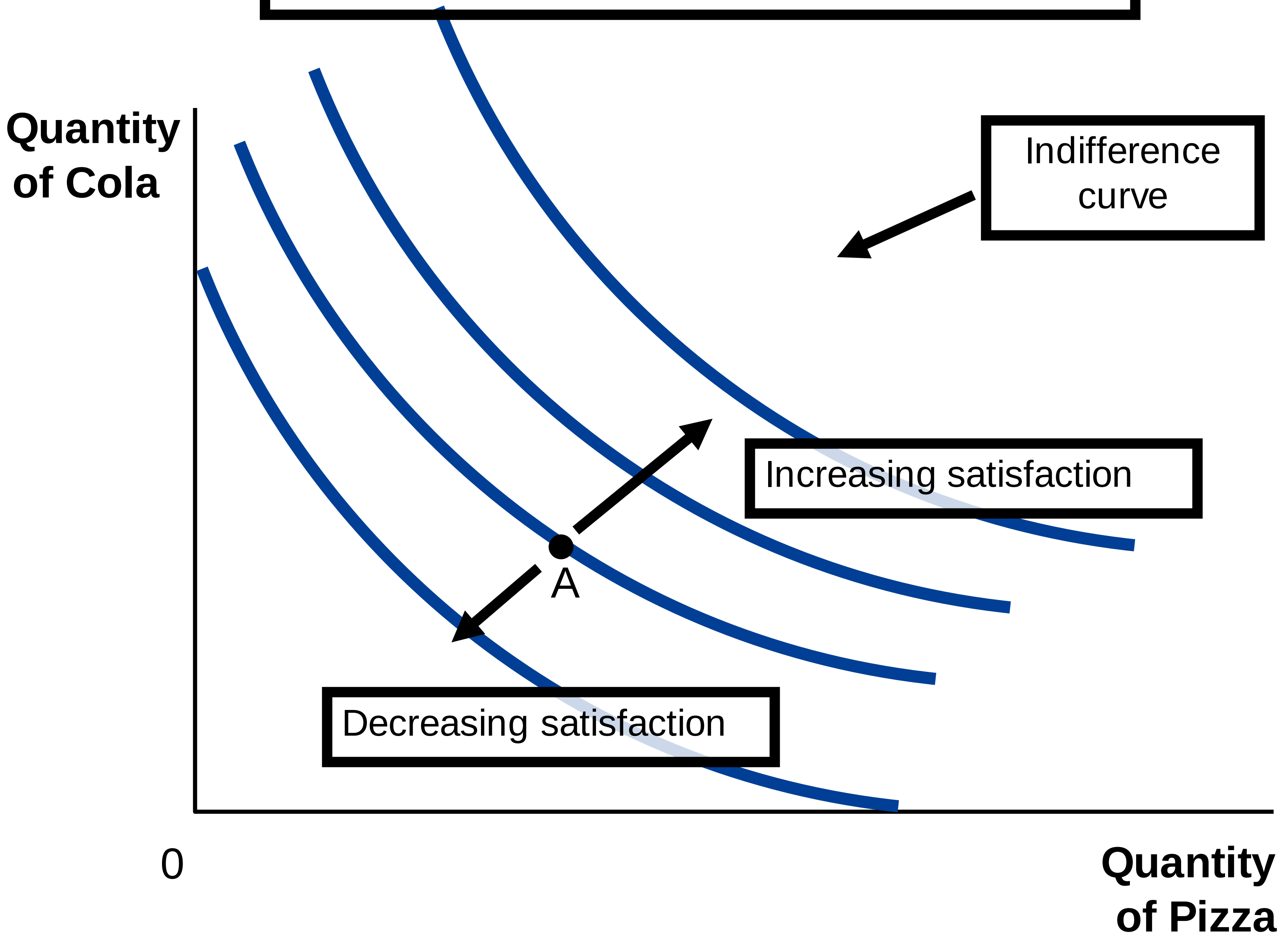
Indifference curve

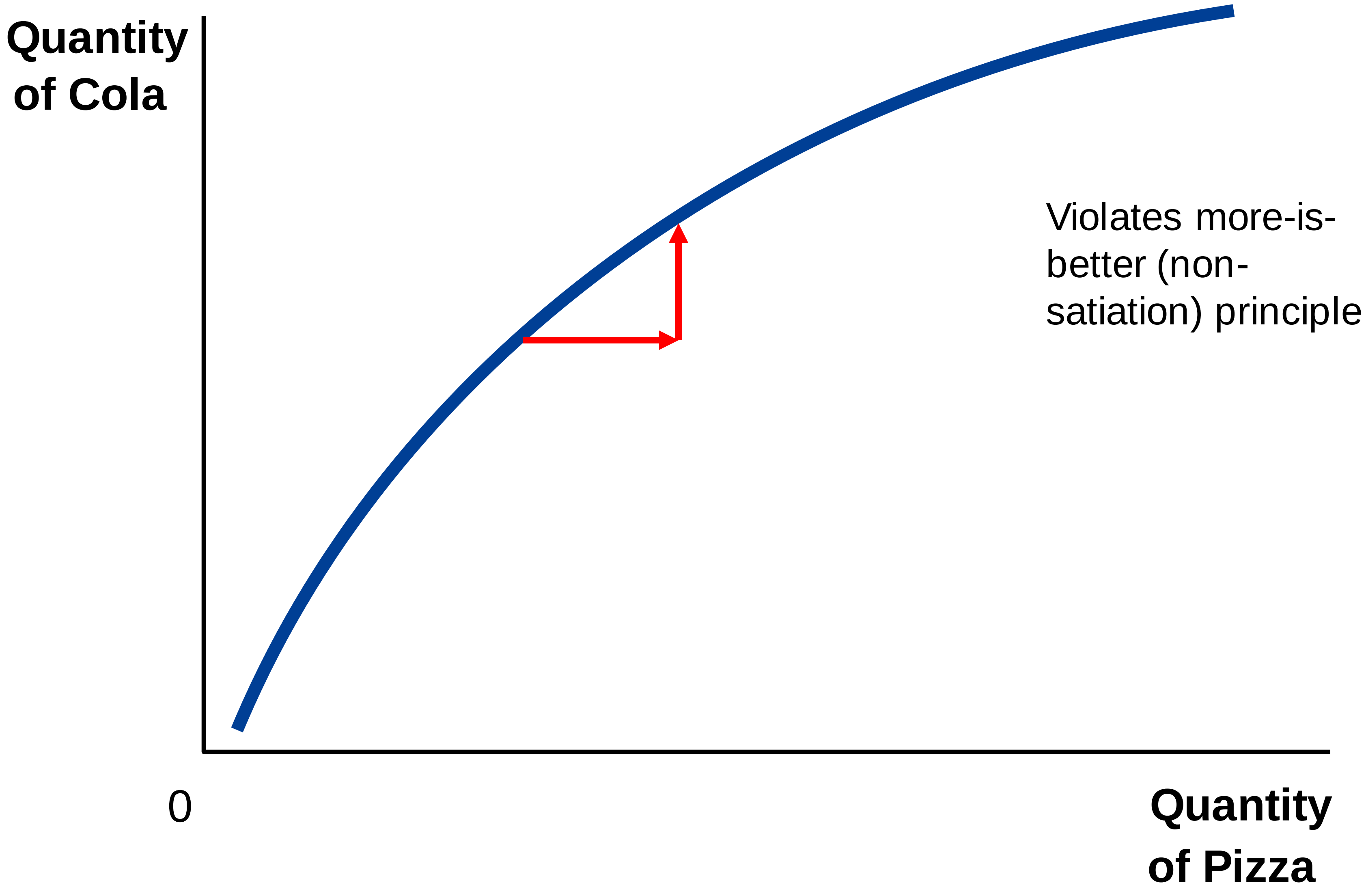


Indifference curve

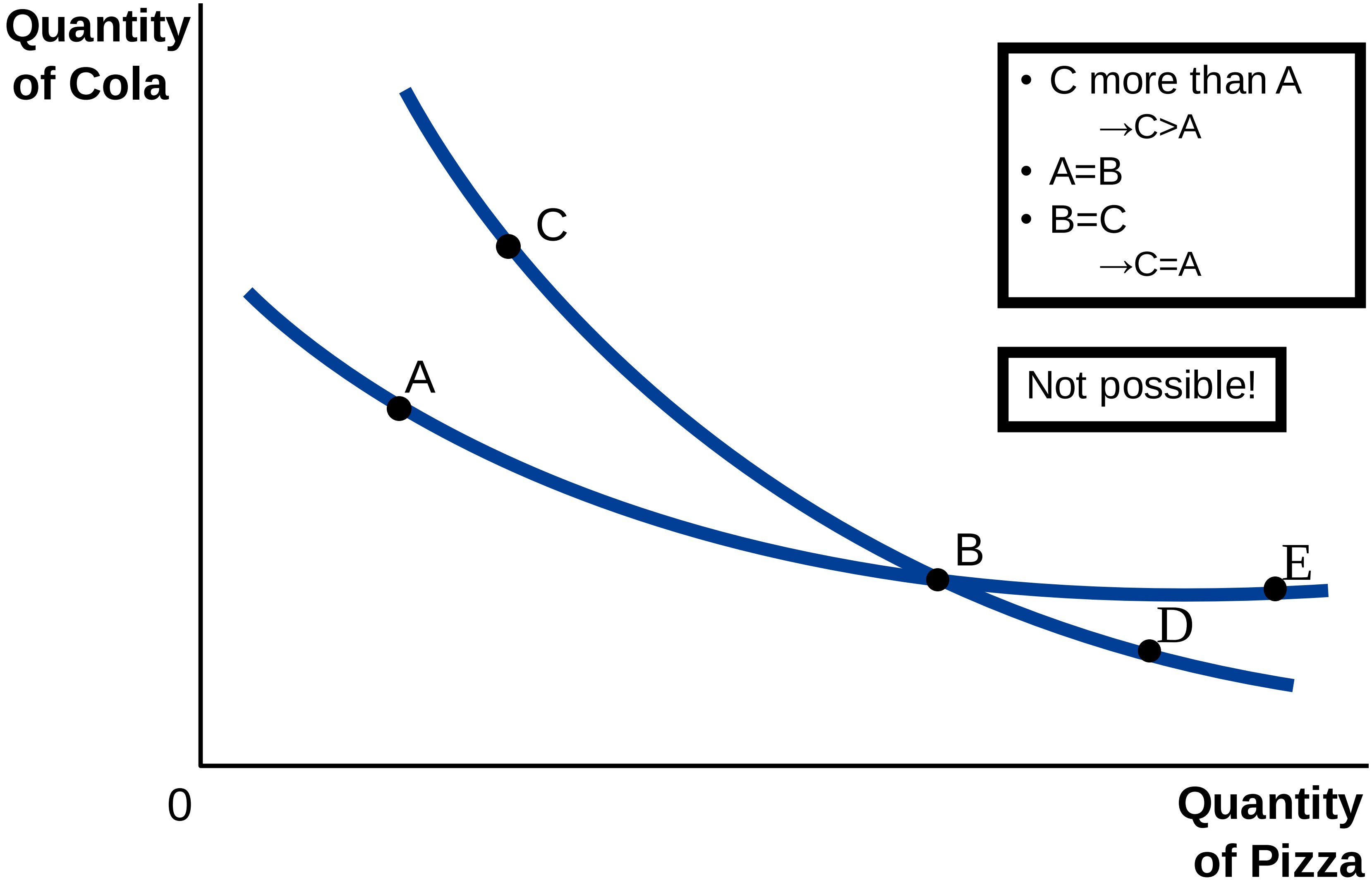


Indifference curves



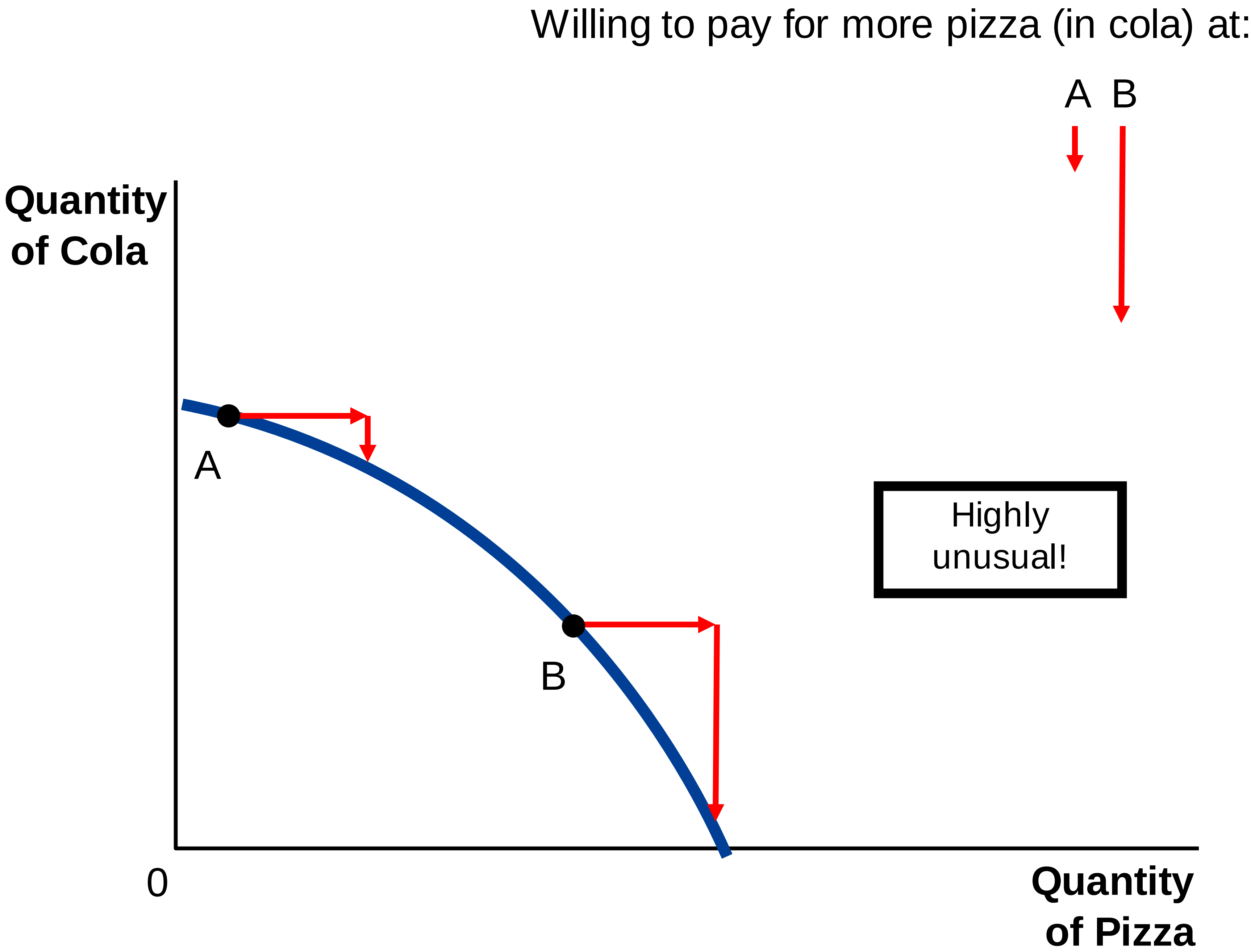

Quantity
of Cola
Violates more-is-
better (non-
satiation) principle
0
Quantity
of Pizza

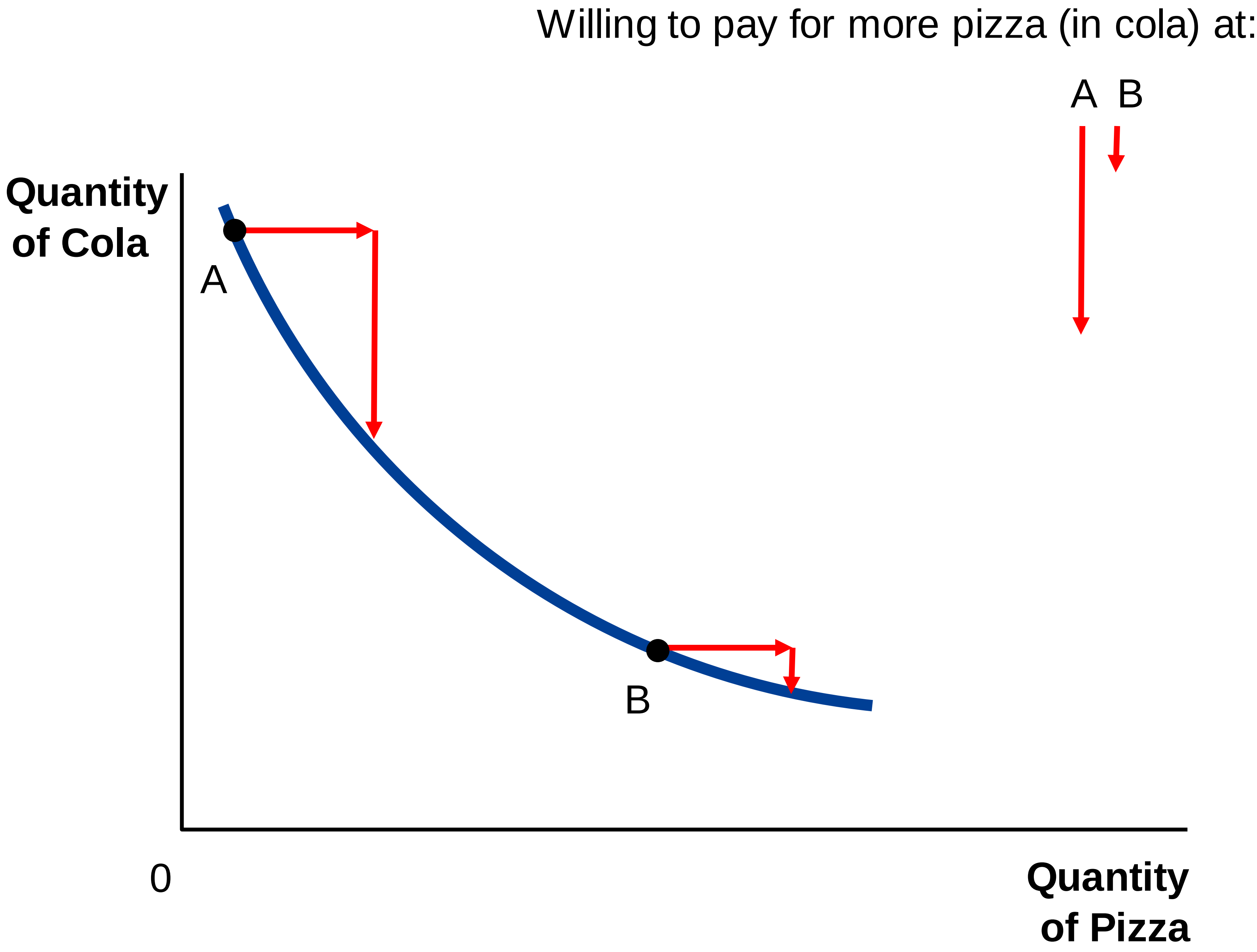
Possible?



- C more than A
  →C>A
- A=B
- B=C
  →C=A

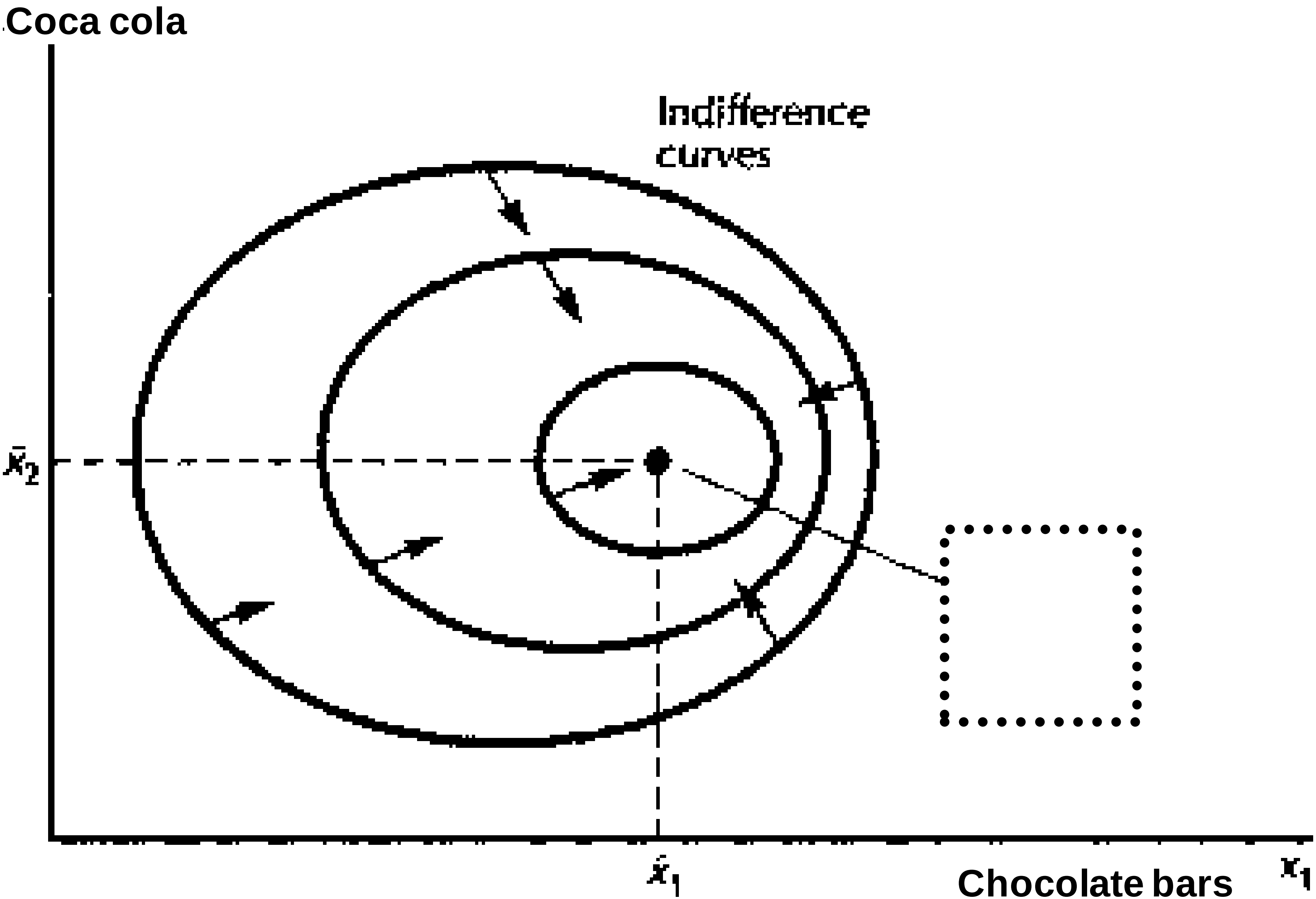
Not possible!

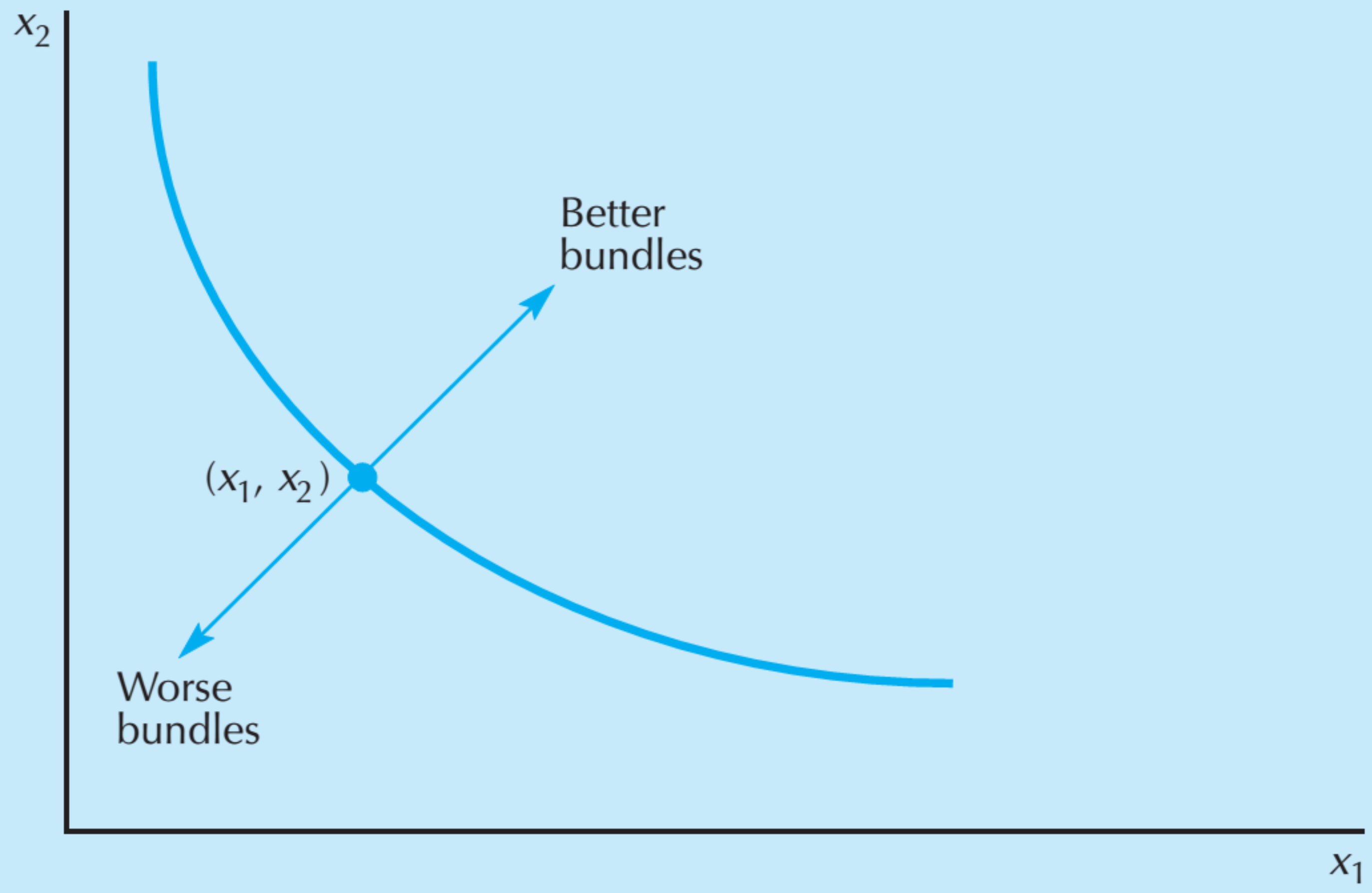

Willing to pay for more pizza (in cola) at:
A B
Quantity
of Cola
A
B
Highly
unusual!
0
Quantity
of Pizza


Willing to pay for more pizza (in cola) at:
A B
Quantity of Cola
A
B
0
Quantity of Pizza

Four Properties of Indifference Curves

1. Higher indifference curves are preferred to lower ones.
2. Indifference curves are bowed inward
3. Indifference curves are downward sloping
4. Indifference curves do not cross


Coca cola
Indifference curves
$\bar{x}_2$
$\bar{x}_1$
x_1
Chocolate bars



Monotonic preferences. More of both goods is a better bundle for this consumer; less of both goods represents a worse bundle.

Consumer preferences are:

4. More is better: Monotonicity

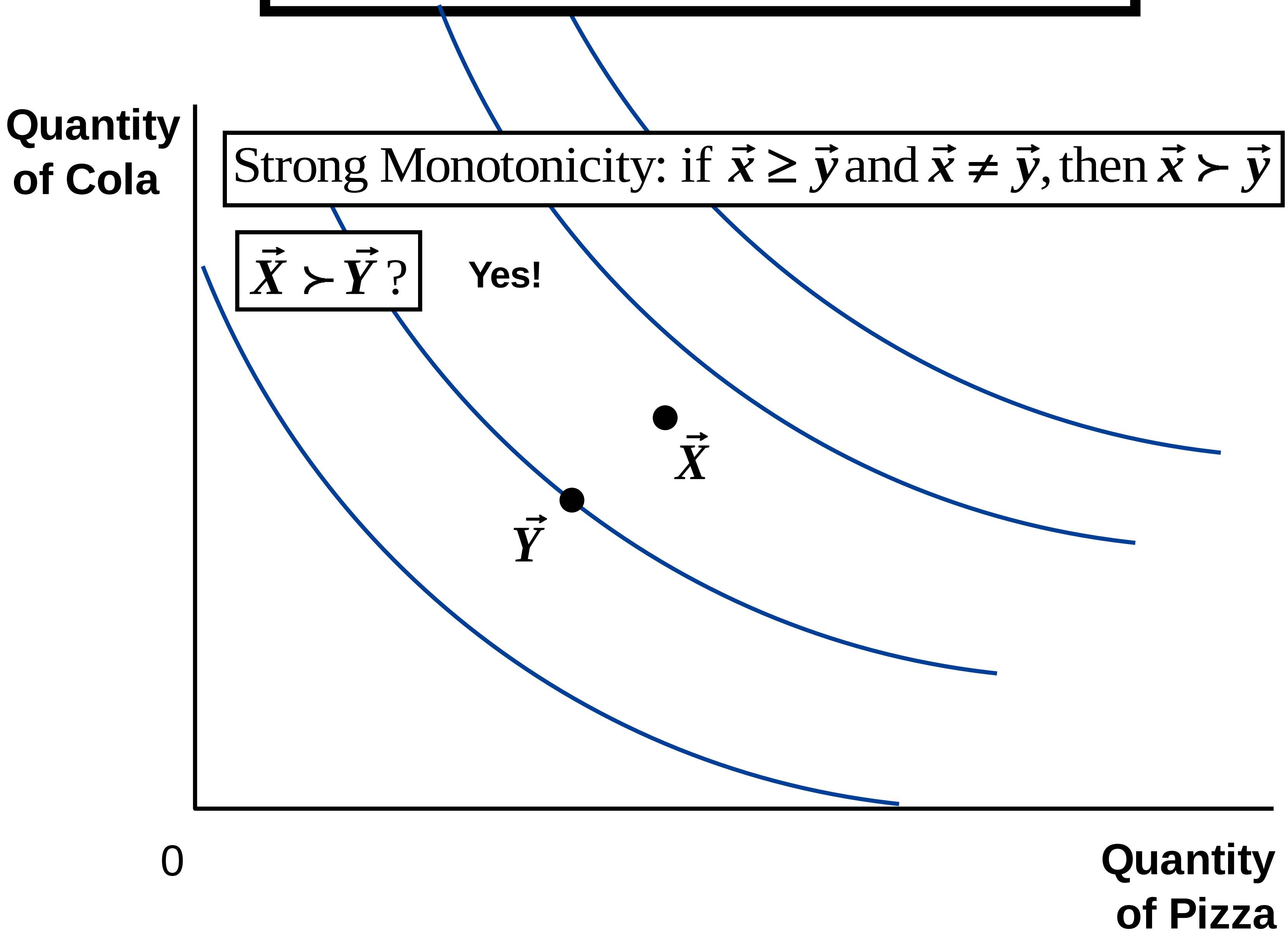
   3 variants:

   1. Strong monotonicity
      - if $\vec{\boldsymbol{x}} \geq \vec{\boldsymbol{y}}$ and $\vec{\boldsymbol{x}} \neq \vec{\boldsymbol{y}}$, then $\vec{\boldsymbol{x}} \succ \vec{\boldsymbol{y}}$

   2. Weak monotonicity
      - if $\vec{\boldsymbol{x}} \geq \vec{\boldsymbol{y}}$ then $\vec{\boldsymbol{x}} \succeq \vec{\boldsymbol{y}}$

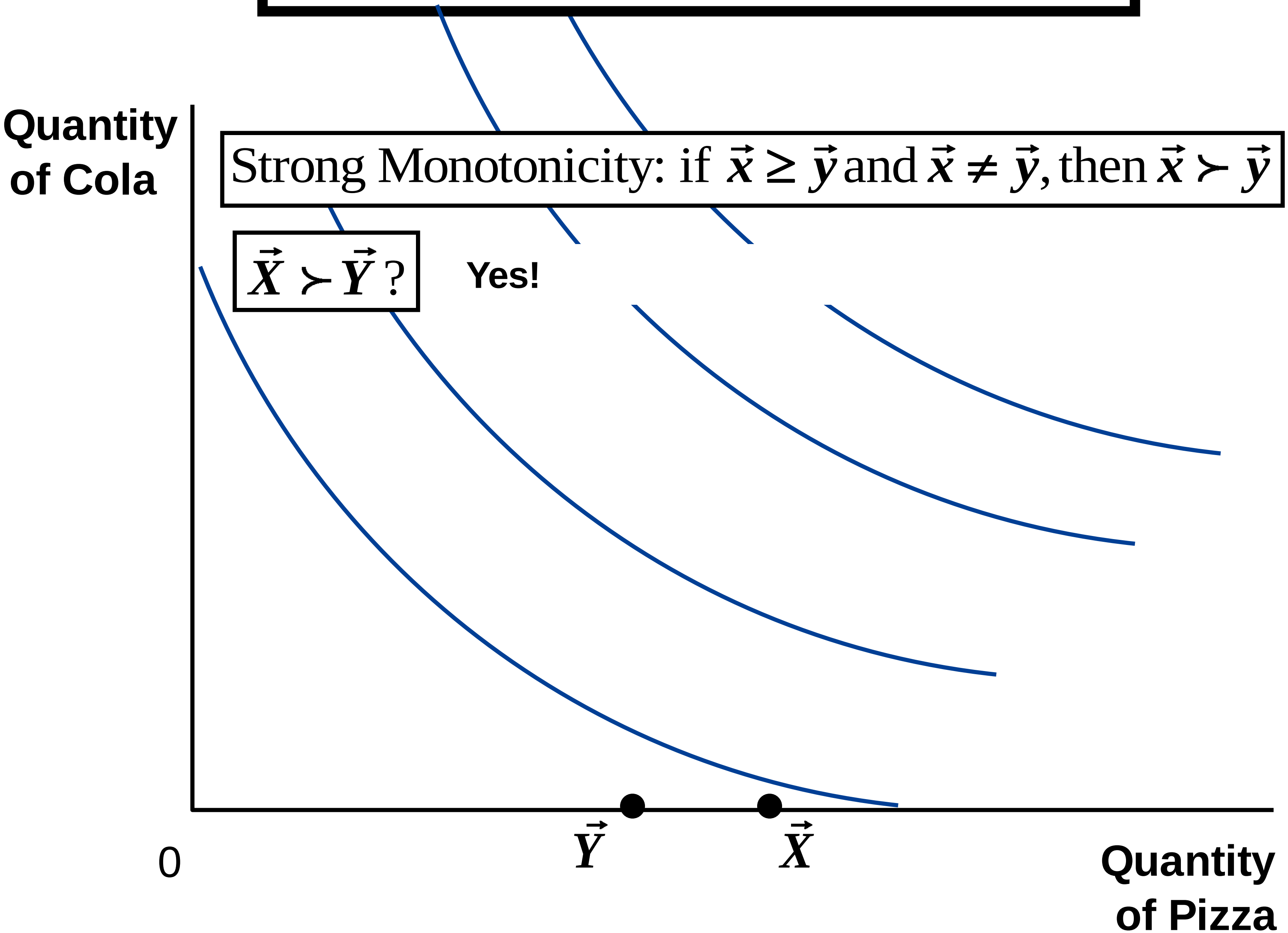
Indifference curves

Strong Monotonicity: if $\vec{x} \geq \vec{y}$ and $\vec{x} \neq \vec{y}$, then $\vec{x} \succ \vec{y}$

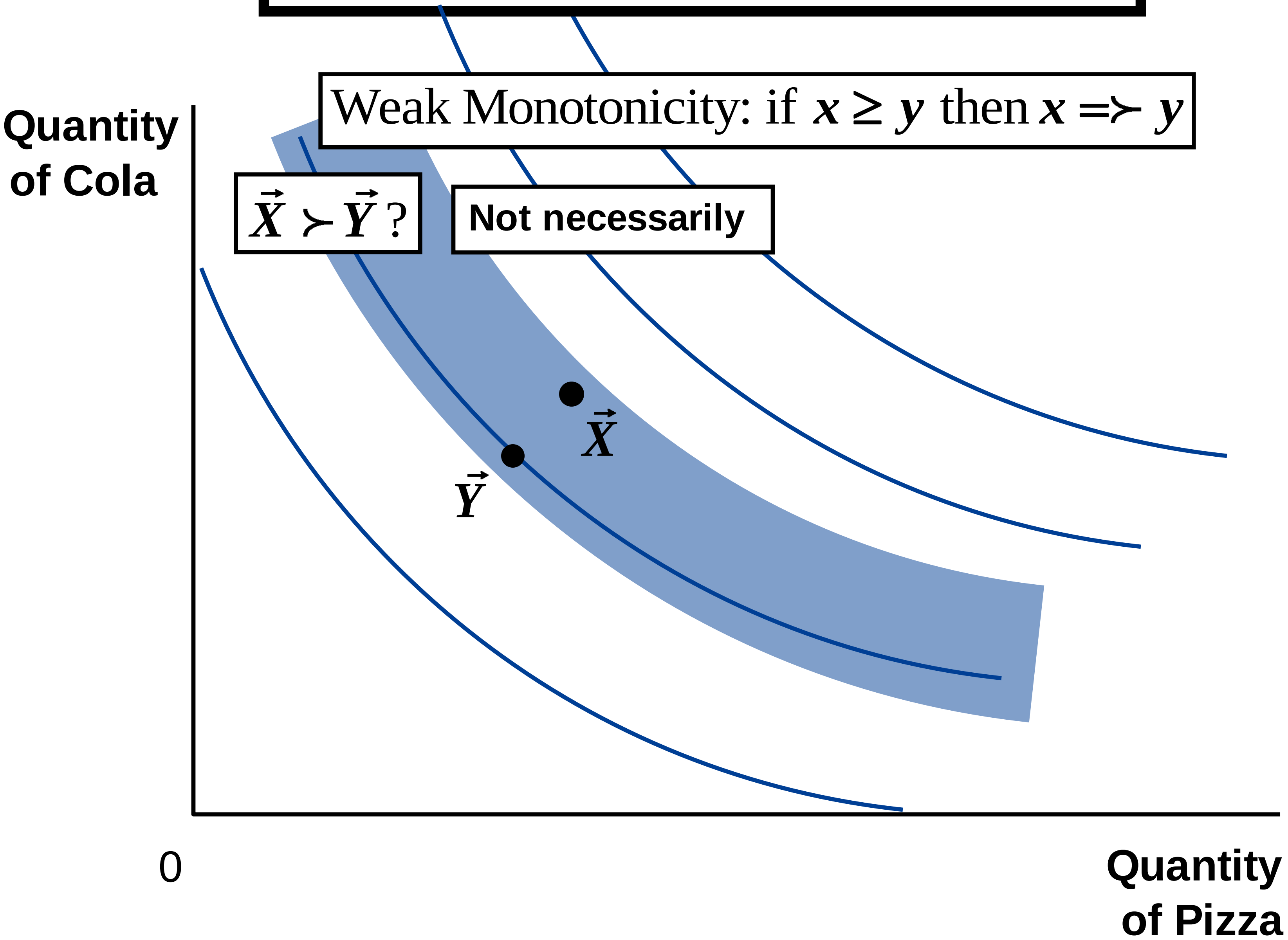


Indifference curves

Strong Monotonicity: if $\vec{x} \geq \vec{y}$ and $\vec{x} \neq \vec{y}$, then $\vec{x} \succ \vec{y}$



Indifference curves



Perfect Complements: are they strongly monotonic?

Strong Monotonicity: if $\vec{x} \geq \vec{y}$ and $\vec{x} \neq \vec{y}$, then $\vec{x} \succ \vec{y}$

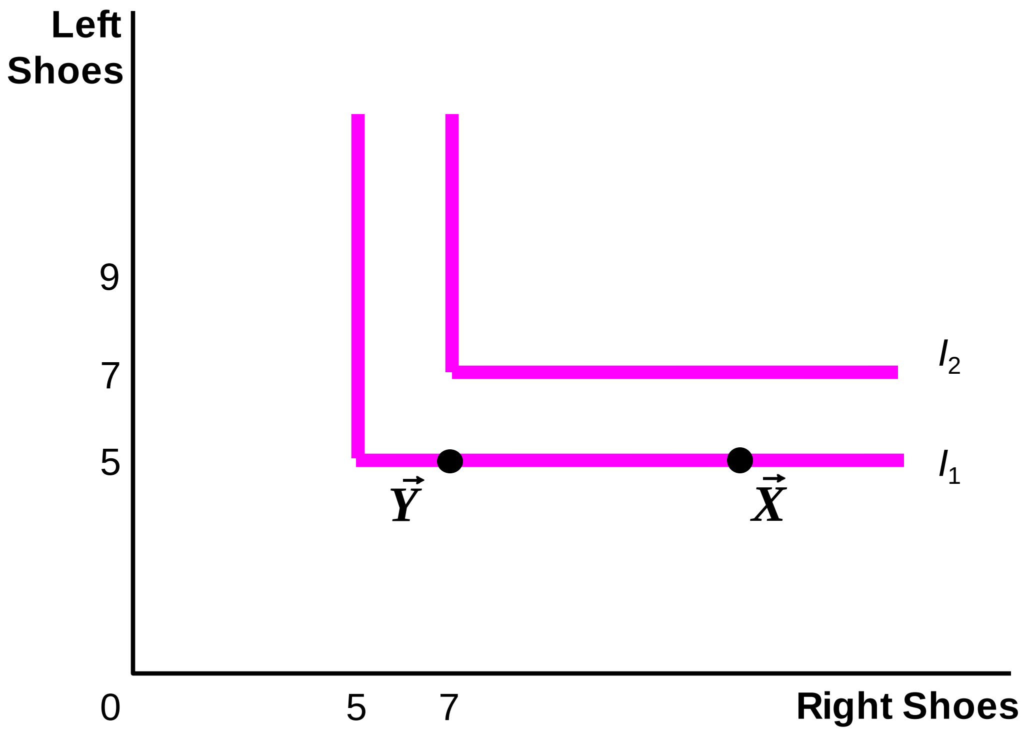
$\vec{X} \succ \vec{Y}$?

No! No strong monotonicity here

Weak Monotonicity: if $x \geq y$ then $x \succeq y$

$\vec{X} \succeq \vec{Y}$?

Yes! Weak monotonicity here

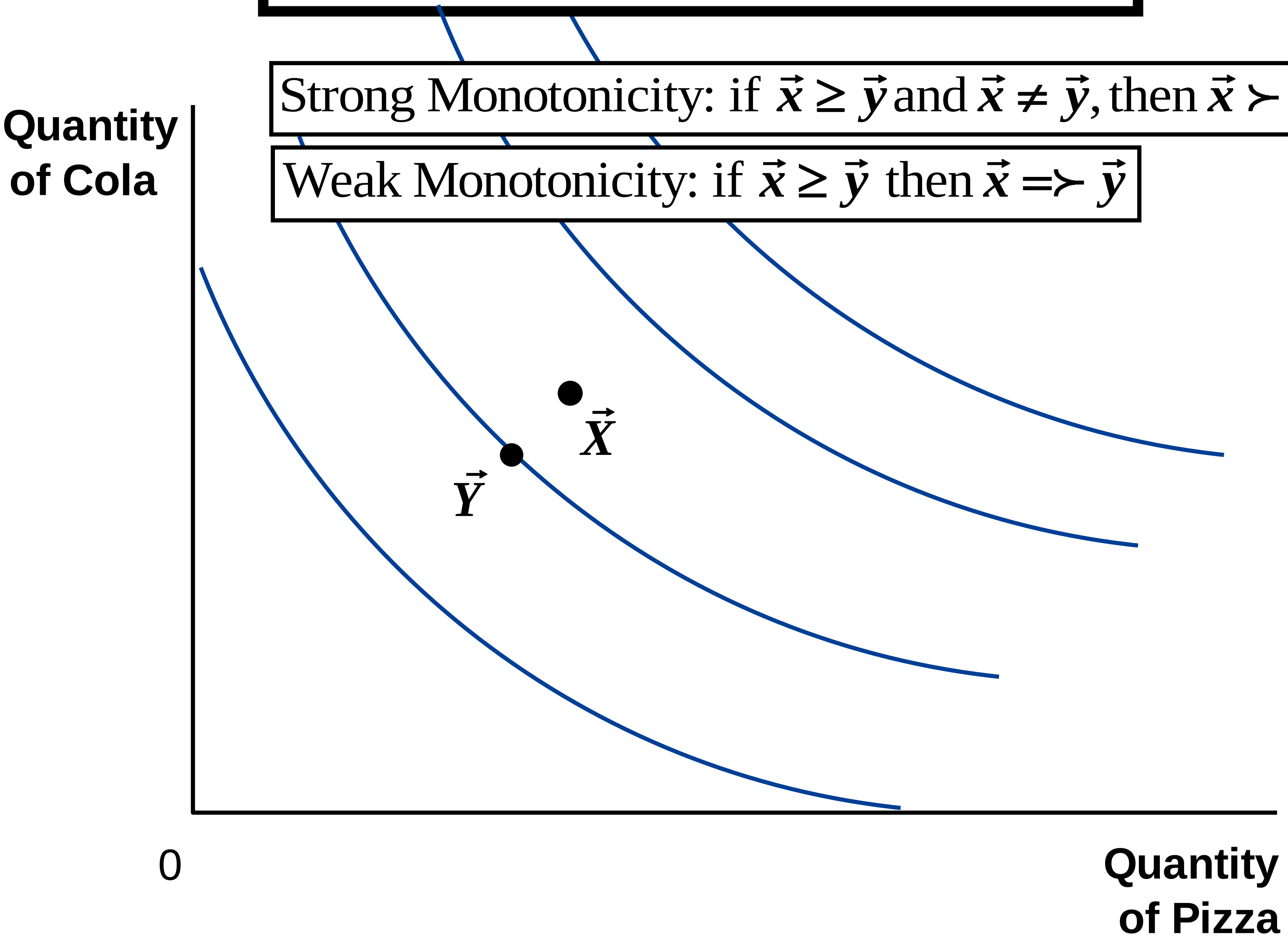


- Are indifference curves that are weakly monotonic necessarily strongly monotonic?

Indifference curves

Strong Monotonicity: if $\vec{x} \geq \vec{y}$ and $\vec{x} \neq \vec{y}$, then $\vec{x} \succ \vec{y}$

Weak Monotonicity: if $\vec{x} \geq \vec{y}$ then $\vec{x} \succeq \vec{y}$



Consumer preferences are:

4. More is better: Monotonicity

   3 variants:

   1. Strong monotonicity
      - if $\vec{x} \geq \vec{y}$ and $\vec{x} \neq \vec{y}$, then $\vec{x} \succ \vec{y}$

   2. Weak monotonicity
      - if $\vec{x} \geq \vec{y}$ then $\vec{x} \succeq \vec{y}$

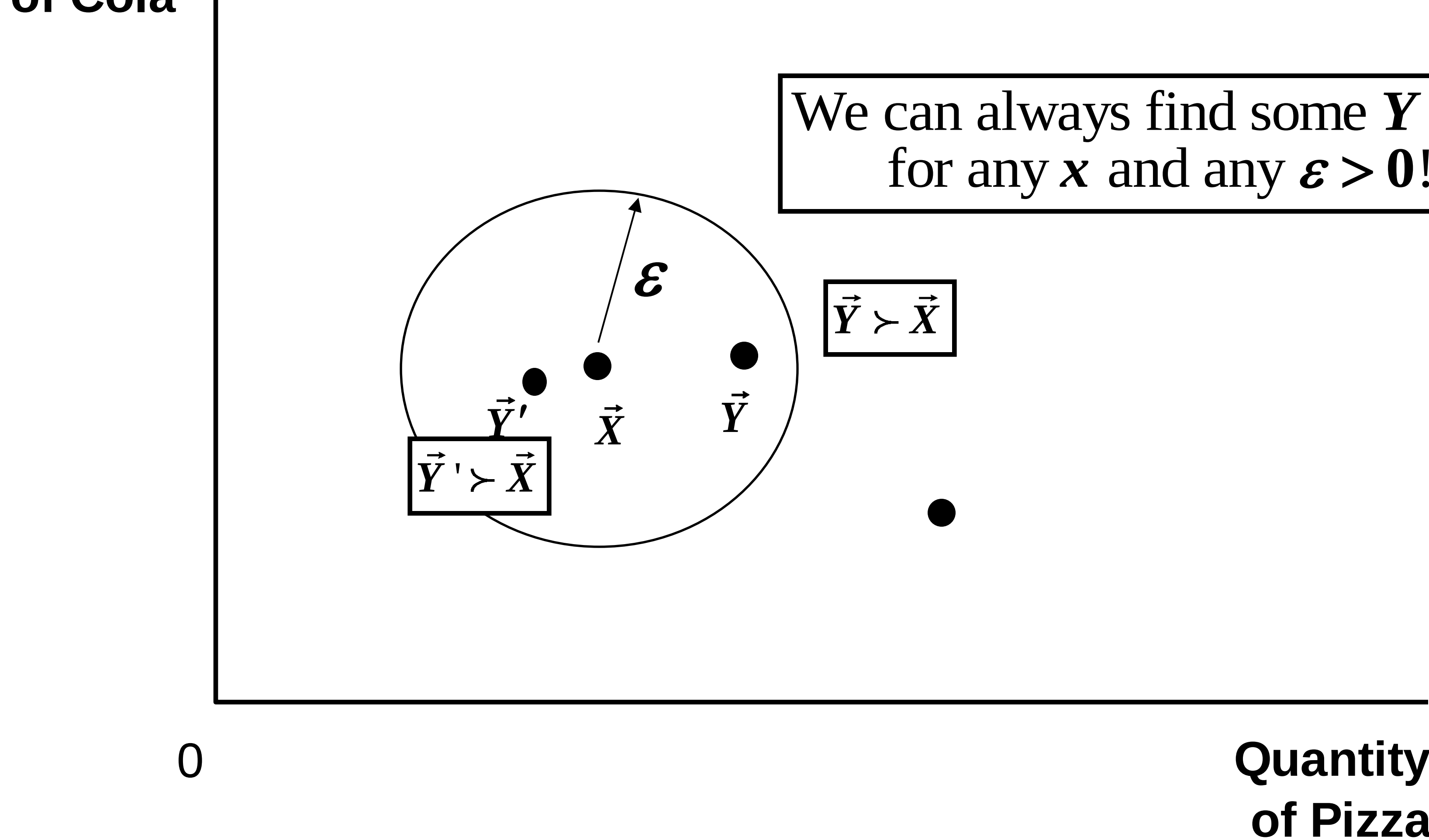
   3. Local non-satiation

      For any $\vec{x}$ and any $\varepsilon > 0$, there is always an $\vec{y}$ with $|\vec{x} - \vec{y}| < \varepsilon$ such that $\vec{y} \succ \vec{x}$

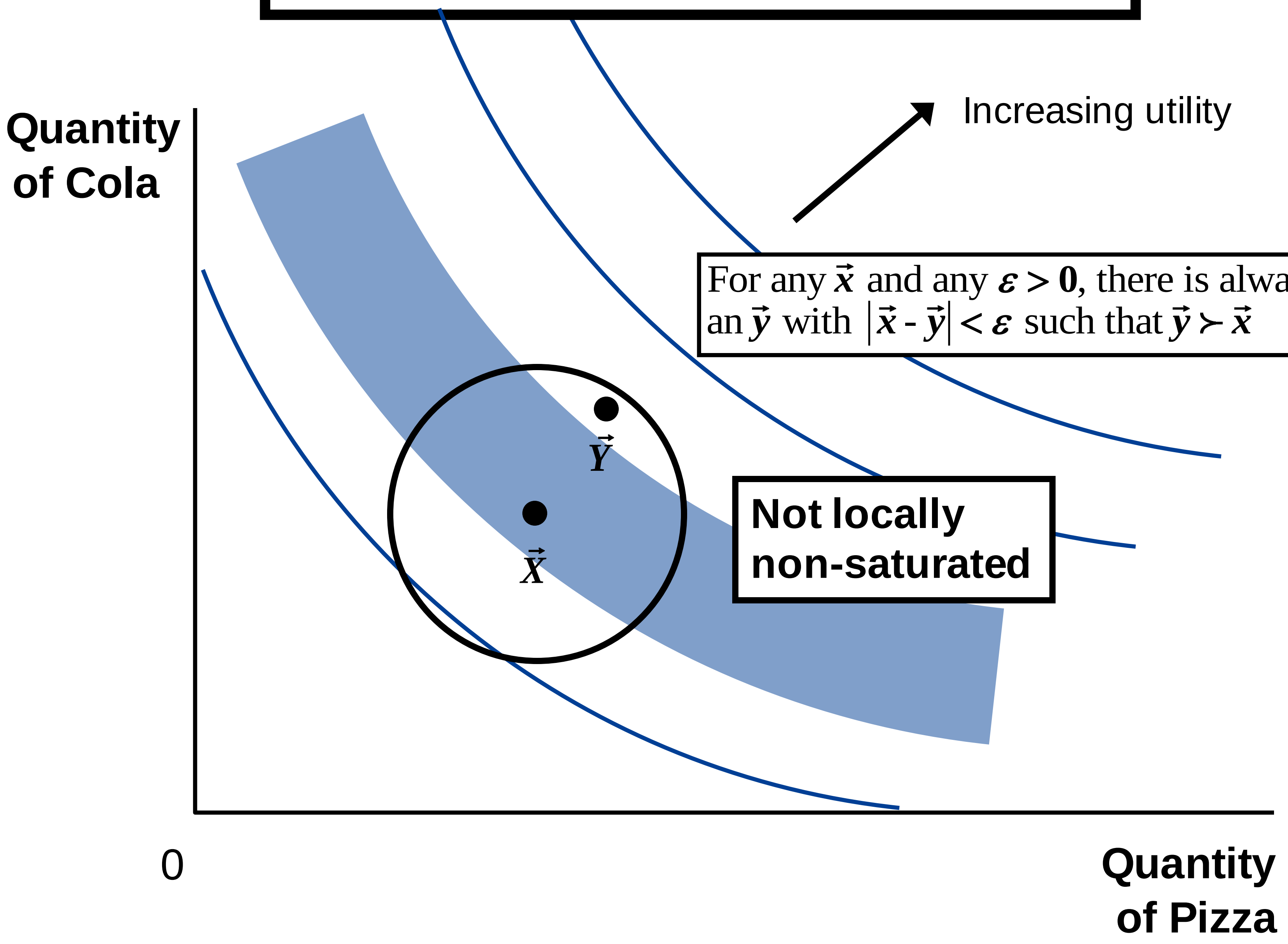
Indifference curves

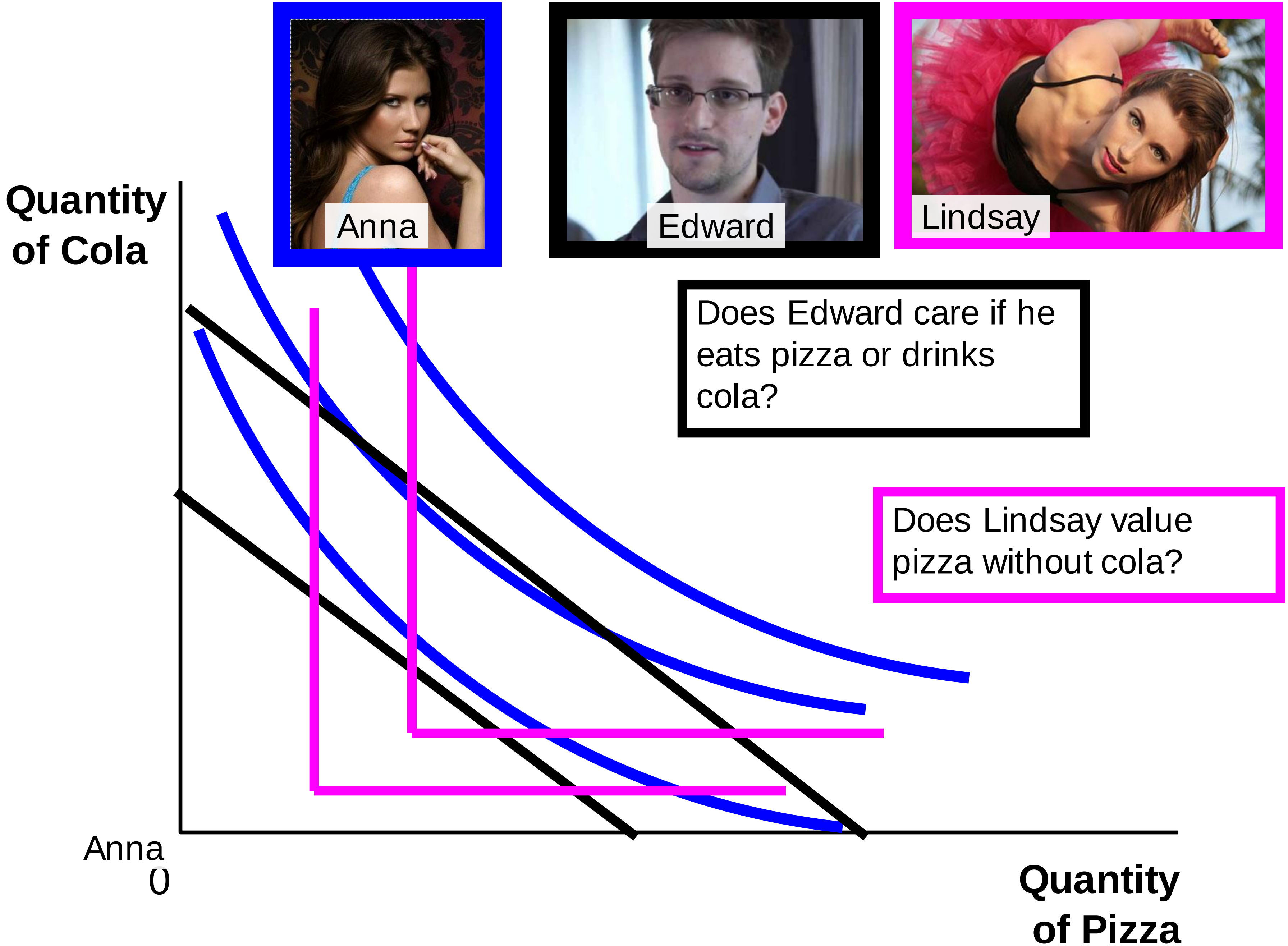
For any $\vec{x}$ and any $\varepsilon > 0$, there is always an $\vec{y}$ with $|\vec{x} - \vec{y}| < \varepsilon$ such that $\vec{y} \succ \vec{x}$

We can always find some $Y \succ X$ for any x and any $\varepsilon > 0$!

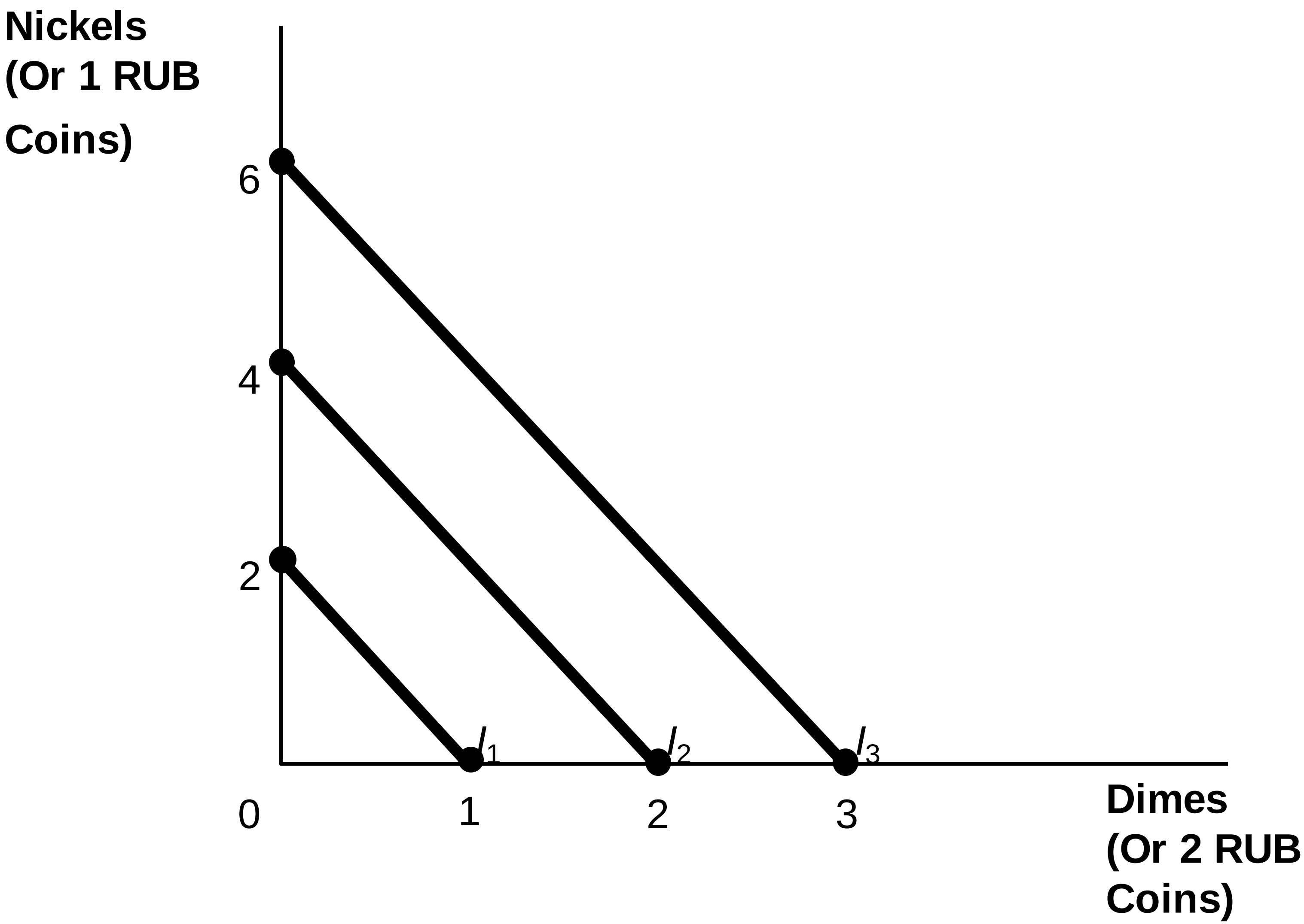


Indifference curves

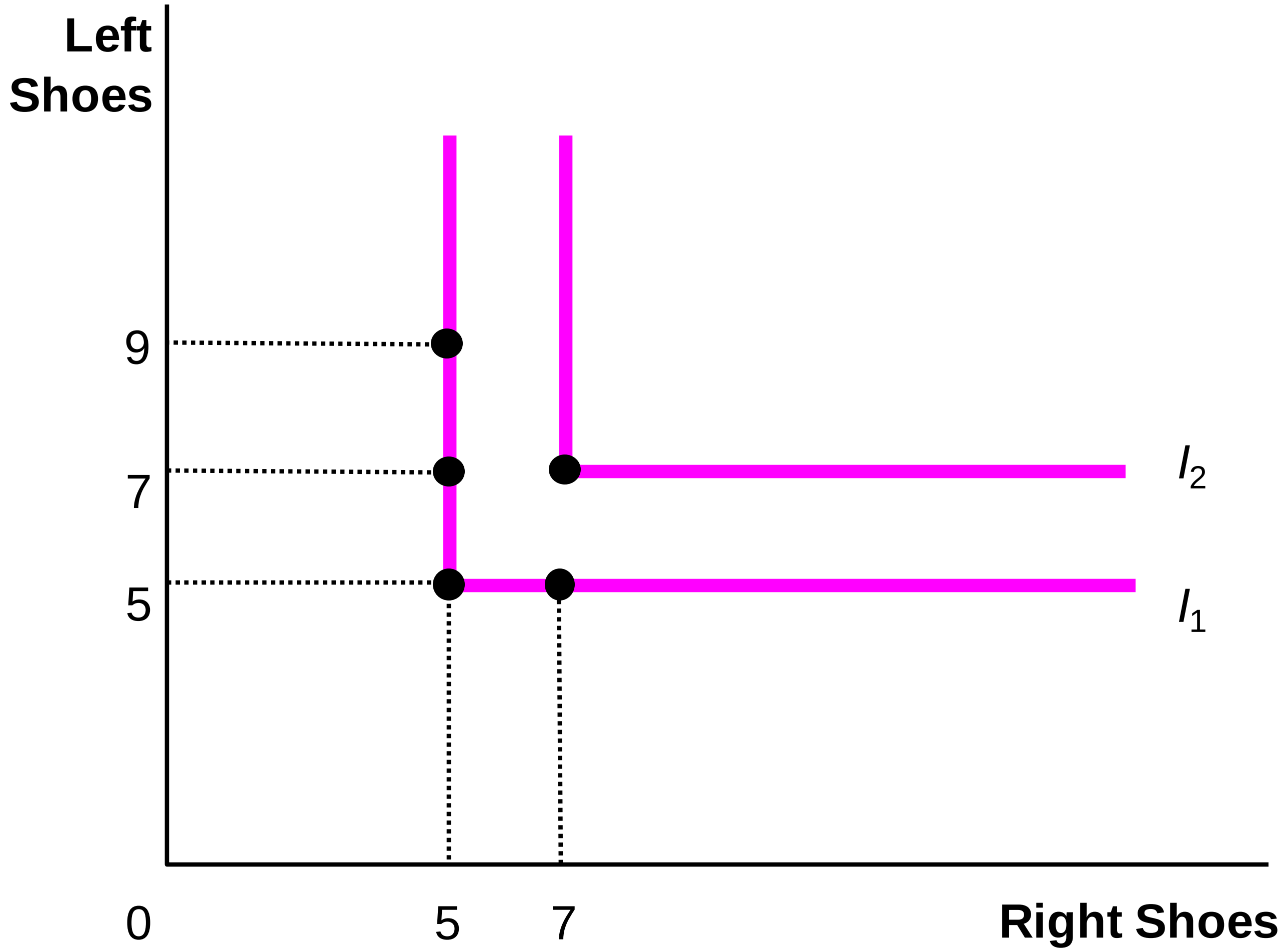


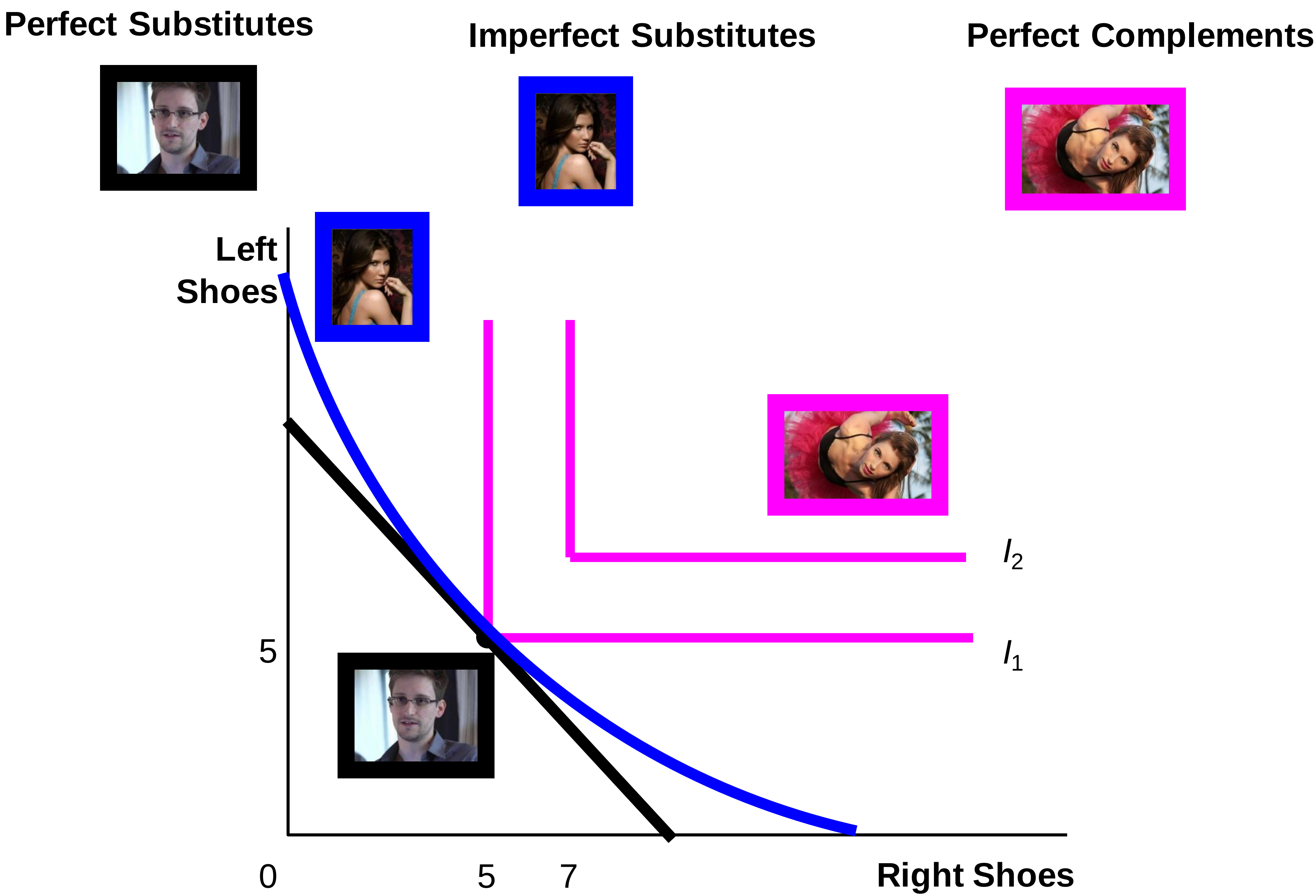

Anna
Edward
Lindsay
Quantity of Cola
Does Edward care if he eats pizza or drinks cola?
Does Lindsay value pizza without cola?
Anna
0
Quantity of Pizza

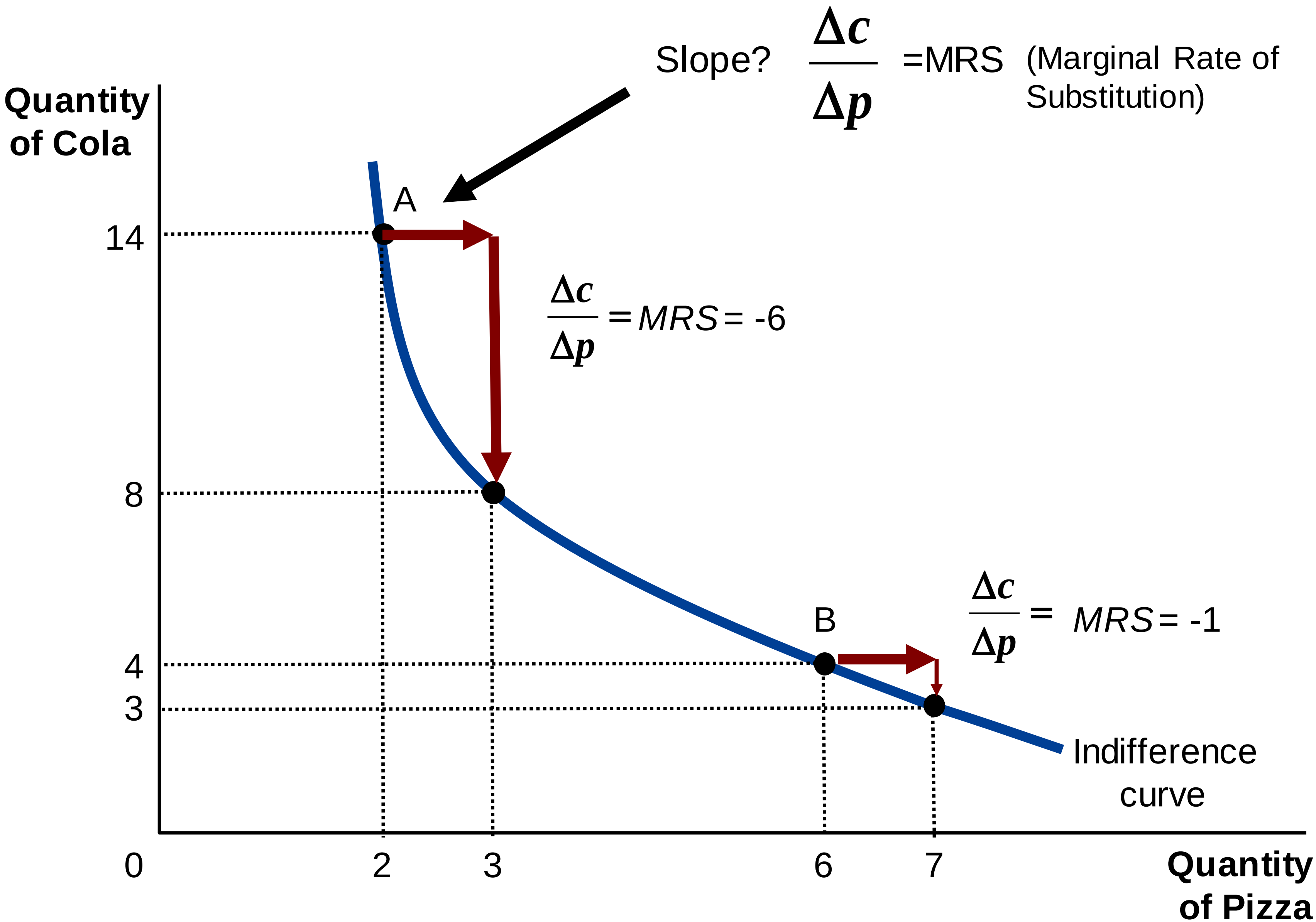
(a) Perfect Substitutes



(b) Perfect Complements




Perfect Substitutes
Imperfect Substitutes
Perfect Complements
Left Shoes
5
0
5
7
Right Shoes
I_2
I_1



Slope? $\frac{\Delta c}{\Delta p}$ =MRS (Marginal Rate of Substitution)
Quantity of Cola
A
14
$\frac{\Delta c}{\Delta p} = MRS = -6$
8
B
$\frac{\Delta c}{\Delta p} = MRS = -1$
4
3
Indifference curve
0
2
3
6
7
Quantity of Pizza

- **CONVEX*** preferences
  - – averages are preferred to extremes.

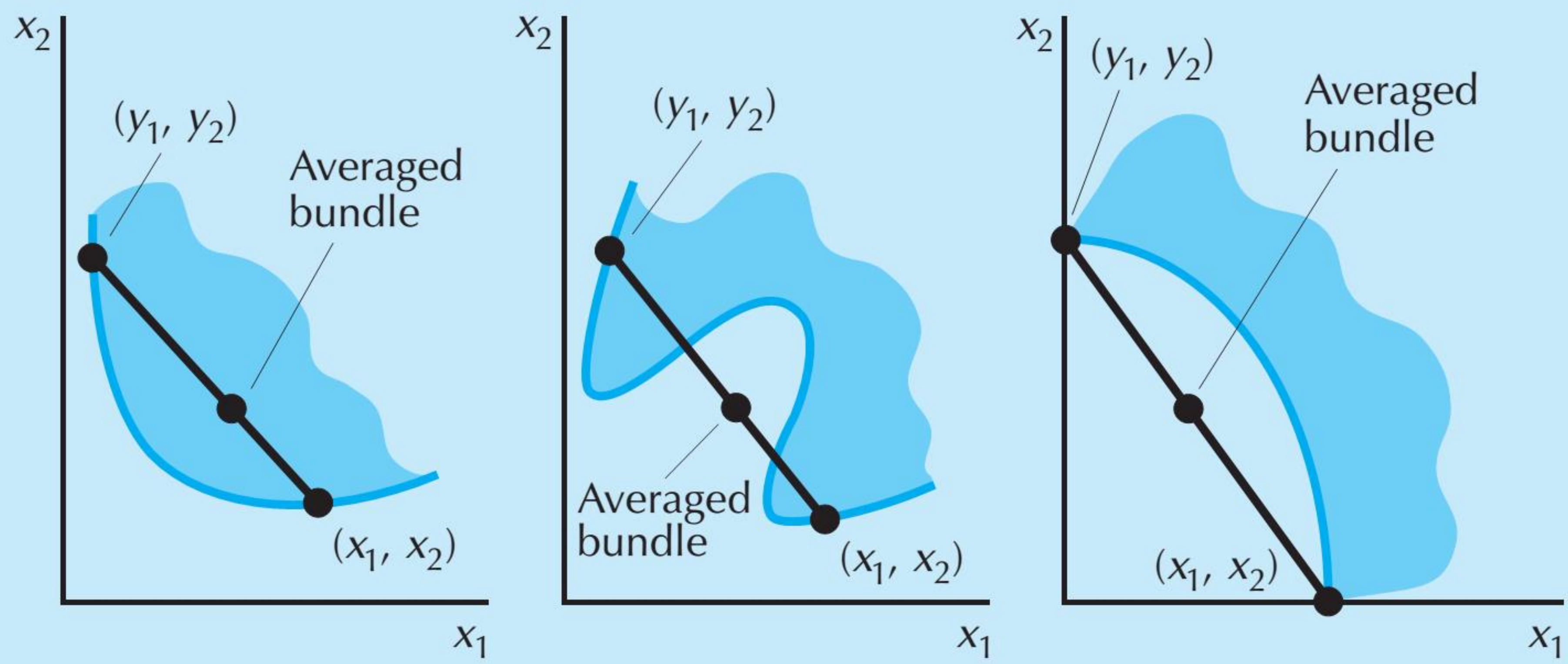
Second, we are going to assume that averages are preferred to extremes. That is, if we take two bundles of goods (x_1, x_2) and (y_1, y_2) on the same indifference curve and take a weighted average of the two bundles such as

$$\left(\frac{1}{2}x_1 + \frac{1}{2}y_1, \frac{1}{2}x_2 + \frac{1}{2}y_2\right),$$

then the average bundle will be at least as good as or strictly preferred to each of the two extreme bundles. This weighted-average bundle has

$$(tx_1 + (1-t)y_1, tx_2 + (1-t)y_2) \succeq (x_1, x_2)$$

for any t such that $0 \le t \le 1$.



A Convex preferences

B Nonconvex preferences

C Concave preferences

What does this assumption about preferences mean geometrically? It means that the set of bundles weakly preferred to (x_1, x_2) is a **convex set**. For suppose that (y_1, y_2) and (x_1, x_2) are indifferent bundles. Then, if averages are preferred to extremes, all of the weighted averages of (x_1, x_2) and (y_1, y_2) are weakly preferred to (x_1, x_2) and (y_1, y_2). A convex set has the property that if you take *any* two points in the set and draw the line segment connecting those two points, that line segment lies entirely in the set.

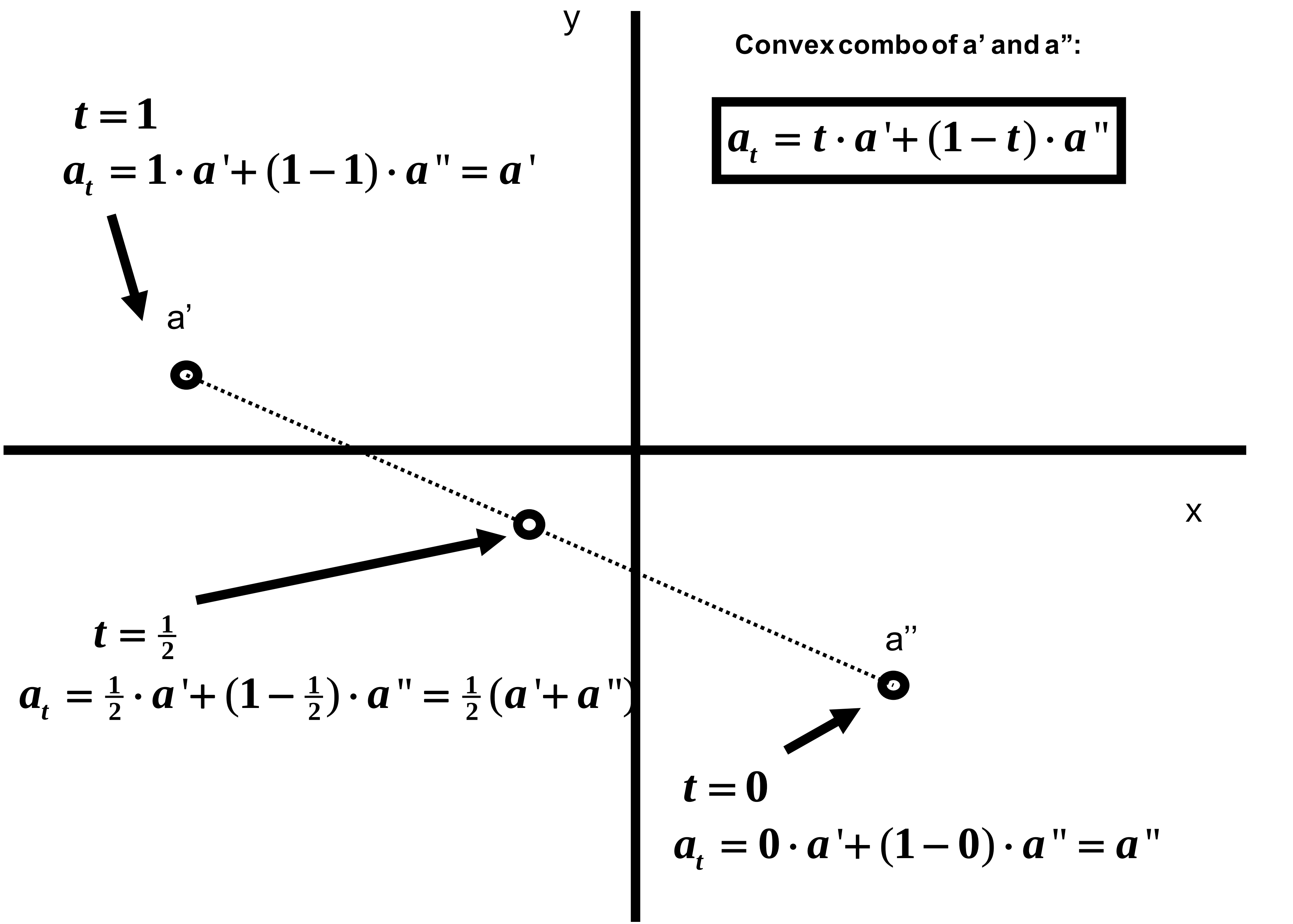
Define convexity

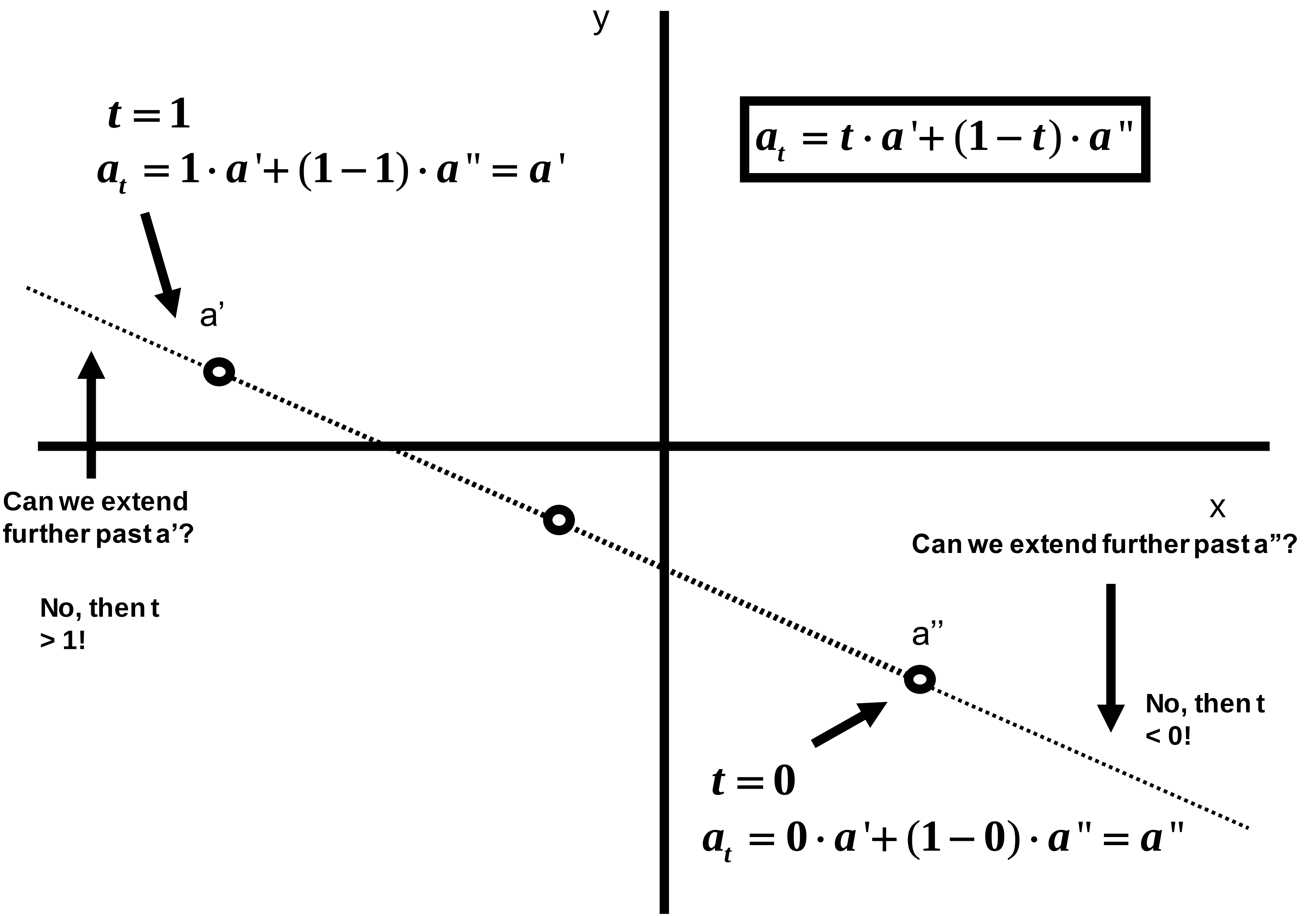
CONVEXITY

- V(y) is a convex set when:
  - x', x'' ϵ V(y), then (tx' + (1 - t)x'') ϵ V(y) for all 0 ≤ t ≤ 1

- Generally, define x_t = tx' + (1 - t)x''
  - Then x_t is the convex combination of x' and x''

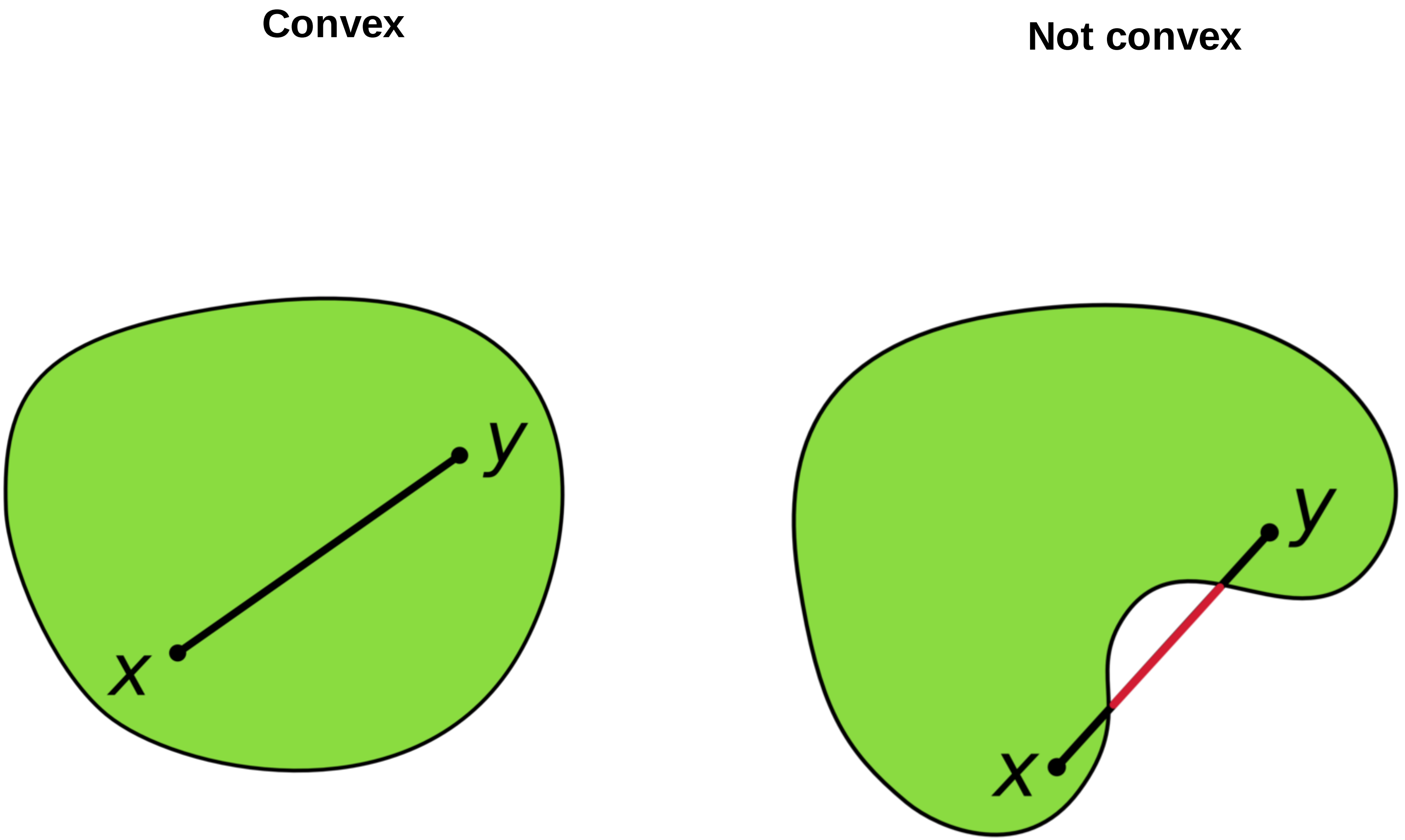
- More on the convex combo


Convex combo of a' and a":
$a_t = t \cdot a' + (1-t) \cdot a''$
y
x
$t = 1$
$a_t = 1 \cdot a' + (1-1) \cdot a'' = a'$
a'
$t = \frac{1}{2}$
$a_t = \frac{1}{2} \cdot a' + (1-\frac{1}{2}) \cdot a'' = \frac{1}{2}(a' + a'')$
a"
$t = 0$
$a_t = 0 \cdot a' + (1-0) \cdot a'' = a''$


y
x
$t = 1$
$a_t = 1 \cdot a' + (1-1) \cdot a'' = a'$
$a_t = t \cdot a' + (1-t) \cdot a''$
a'
Can we extend further past a'?
No, then t > 1!
Can we extend further past a''?
a''
No, then t < 0!
$t = 0$
$a_t = 0 \cdot a' + (1-0) \cdot a'' = a''$

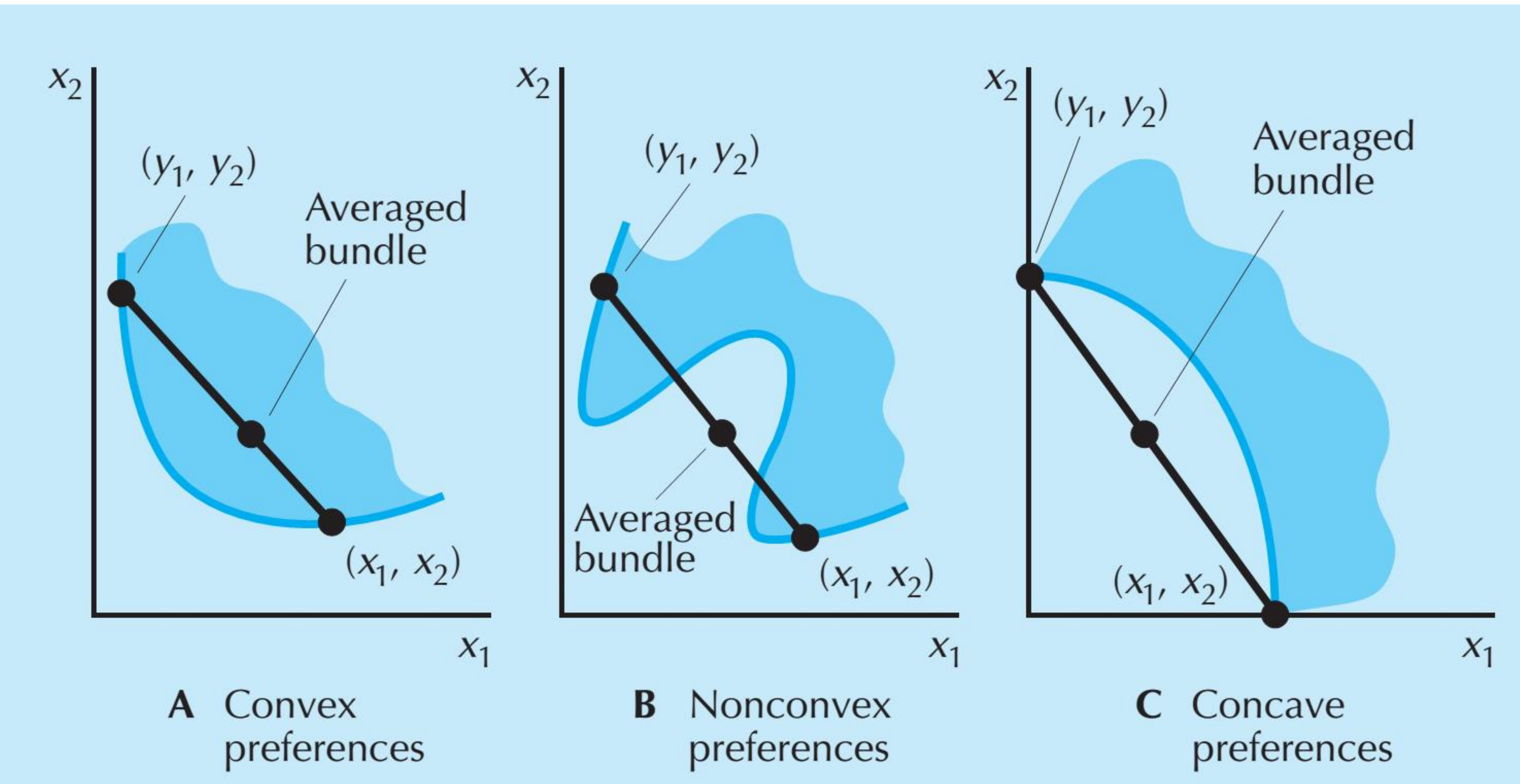
CONVEXITY

- V(y) is a convex set when:
  - x', x'' ϵ V(y), then $\mathbf{x_t}$ ϵ V(y) for all $0 \leq t \leq 1$


Convex
Not convex
y
x
y
x

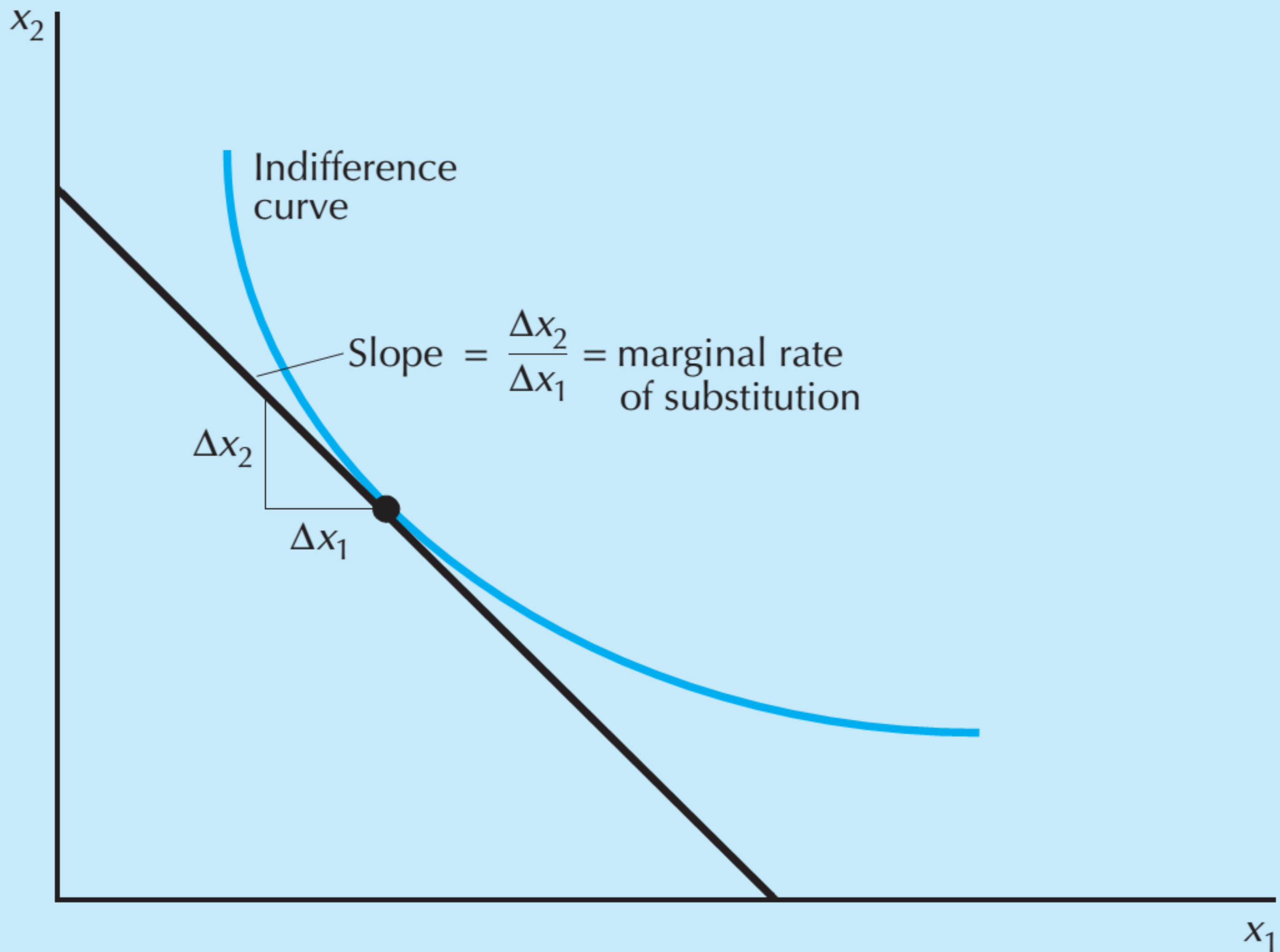
$$(tx_1 + (1-t)y_1, tx_2 + (1-t)y_2) \succeq (x_1, x_2)$$

for any t such that $0 \leq t \leq 1$.



- Can you think of preferences that are not convex?
  - preferences for ice cream and olives?

- strict convexity versus weak convexity



The marginal rate of substitution (MRS). The marginal rate of substitution measures the slope of the indifference curve.

The marginal rate of substitution measures an interesting aspect of the consumer’s behavior. Suppose that the consumer has well-behaved preferences, that is, preferences that are monotonic and convex, and that he is currently consuming some bundle $(x1,x2)$.

We now will offer him a trade: he can exchange good 1 for 2, or good 2 for 1, in any amount at a “rate of exchange” of E.

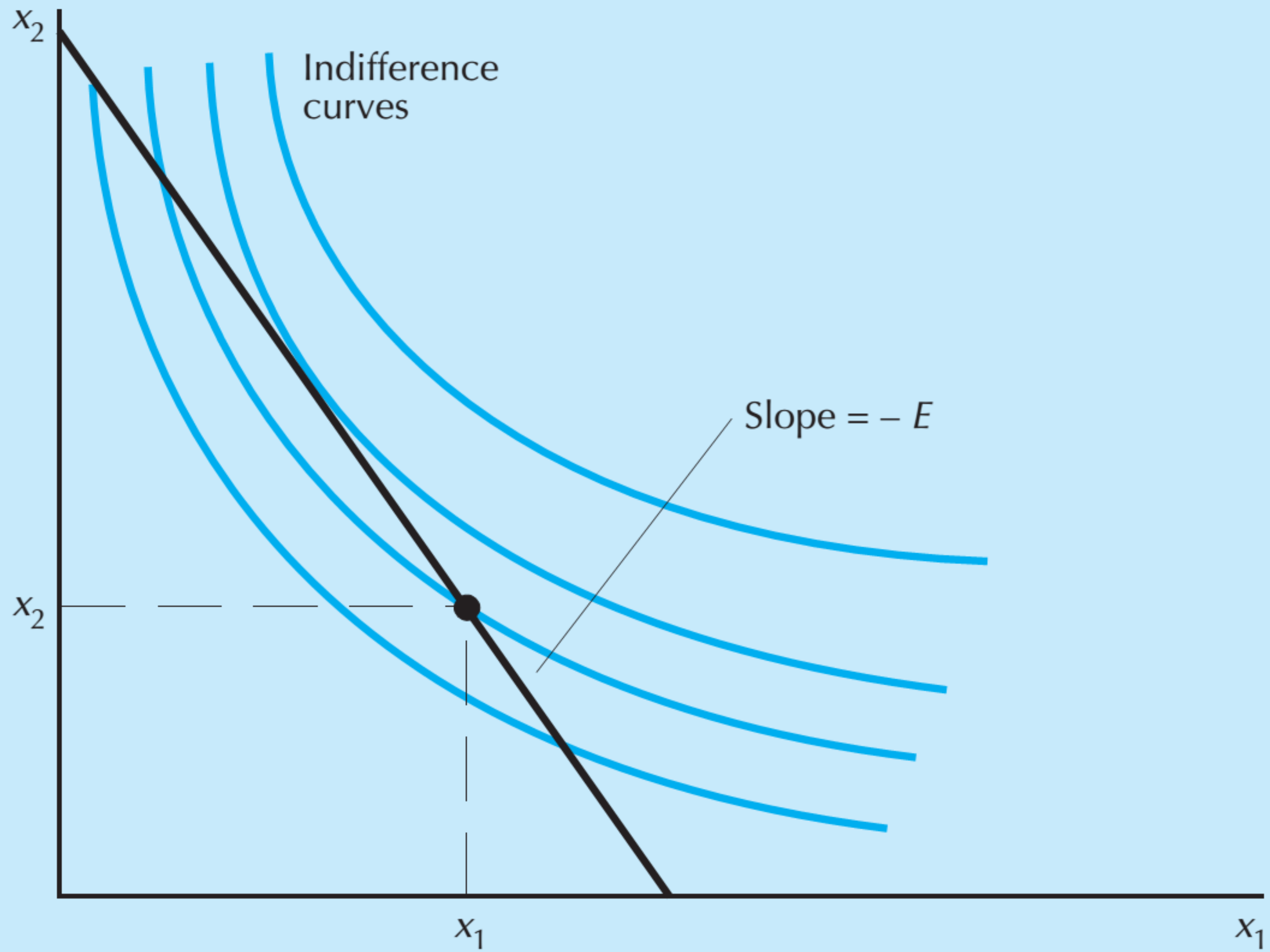
That is, if the consumer gives up $\Delta x1$ units of good 1, he can get $E\Delta x1$ units of good 2 in exchange. Or, conversely, if he gives up $\Delta x2$ units of good 2, he can get $\Delta x2/E$ units of good 1. Geometrically, we are offering the consumer an opportunity to move to any point along a line with slope -E that passes through $(x1,x2)$, as depicted in Figure 3.12.

Moving up and to the left from $(x1,x2)$ involves exchanging good 1 for good 2, and moving down and to the right involves exchanging good 2 for good 1. In either movement, the exchange rate is E. Since exchange always involves giving up one good in exchange for another, the exchange rate E corresponds to a slope of $-E$.

We can now ask what would the rate of exchange have to be in order for the consumer to want to stay put at (x1,x2)?

To answer this question, we simply note that any time the exchange line crosses the indifference curve, there will be some points on that line that are preferred to (x1,x2)—that lie above the indifference curve. Thus, if there is to be no movement from (x1,x2), the exchange line must be tangent to the indifference curve.

That is, the slope of the exchange line, −E, must be the slope of the indifference curve at (x1,x2). At any other rate of exchange, the exchange line would cut the indifference curve and thus allow the consumer to move to a more preferred point.

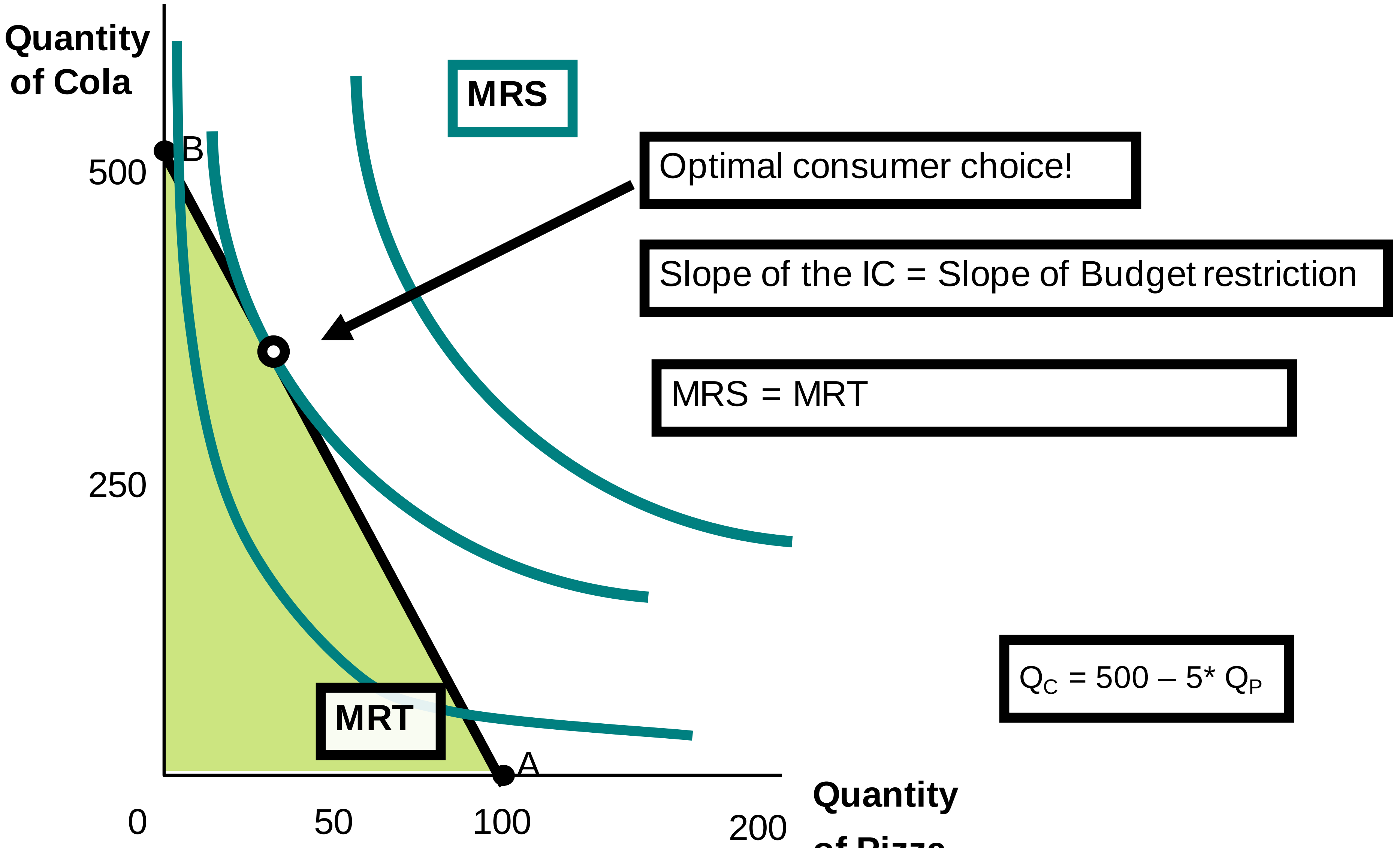


Trading at an exchange rate. Here we are allowing the consumer to trade the goods at an exchange rate E, which implies that the consumer can move along a line with slope $-E$.

We have said that the MRS measures the rate at which the consumer is just on the margin of being willing to substitute good 1 for good 2. We could also say that the consumer is just on the margin of being willing to "pay" some of good 1 in order to buy some more of good 2. So sometimes

- Other way of looking at it (not looking at the slope)

Consumer Choice



We've already pointed out that the assumption of monotonicity implies that indifference curves must have a negative slope, so the MRS always involves reducing the consumption of one good in order to get more of another for monotonic preferences.

The case of convex indifference curves exhibits yet another kind of behavior for the MRS. For strictly convex indifference curves, the MRS—the slope of the indifference curve—decreases (in absolute value) as we increase x1.

Thus the indifference curves exhibit a diminishing marginal rate of substitution. This means that the amount of good 1 that the person is willing to give up for an additional amount of good 2 increases the amount of good 1 increases.

Stated in this way, convexity of indifference curves seems very natural: it says that the more you have of one good, the more willing you are to give some of it up in exchange for the other good. (But remember the ice cream and olives example—for some pairs of goods this assumption might not hold!)

- Exercises

1. If we observe a consumer choosing (x_1, x_2) when (y_1, y_2) is available one time, are we justified in concluding that $(x_1, x_2) \succ (y_1, y_2)$?

3.1. No. It might be that the consumer was indifferent between the two bundles. All we are justified in concluding is that $(x_1, x_2) \succeq (y_1, y_2)$.

2. Consider a group of people A, B, C and the relation "at least as tall as," as in "A is at least as tall as B." Is this relation transitive? Is it complete?

3.2. Yes to both.

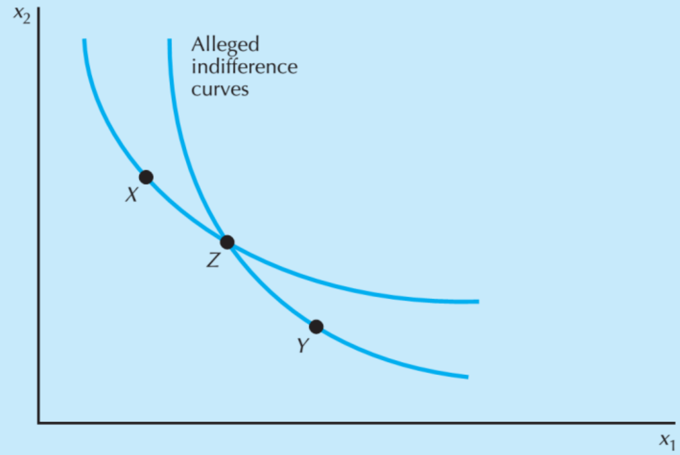
- Exercises

3. Take the same group of people and consider the relation "strictly taller than." Is this relation transitive? Is it reflexive? Is it complete?

3.3. It is transitive, but it is not complete—two people might be the same height. It is not reflexive since it is false that a person is strictly taller than himself.

4. A college football coach says that given any two linemen A and B, he always prefers the one who is bigger and faster. Is this preference relation transitive? Is it complete?

3.4. It is transitive, but not complete. What if A were bigger but slower than B? Which one would he prefer?



Indifference curves cannot cross. If they did, X, Y, and Z would all have to be indifferent to each other and thus could not lie on distinct indifference curves.

5. Can an indifference curve cross itself? For example, could Figure 3.2 depict a single indifference curve?

3.5. Yes. An indifference curve can cross itself, it just can't cross another distinct indifference curve.

6. Could Figure 3.2 be a single indifference curve if preferences are monotonic?

3.6. No, because there are bundles on the indifference curve that have strictly more of both goods than other bundles on the (alleged) indifference curve.

7. If both pepperoni and anchovies are bads, will the indifference curve have a positive or a negative slope?

3.7. A negative slope. If you give the consumer more anchovies, you've made him worse off, so you have to take away some pepperoni to get him back on his indifference curve. In this case the direction of increasing utility is *toward* the origin.

8. Explain why convex preferences means that "averages are preferred to extremes."

3.8. Because the consumer weakly prefers the weighted average of two bundles to either bundle.

9. What is your marginal rate of substitution of \$1 bills for \$5 bills?

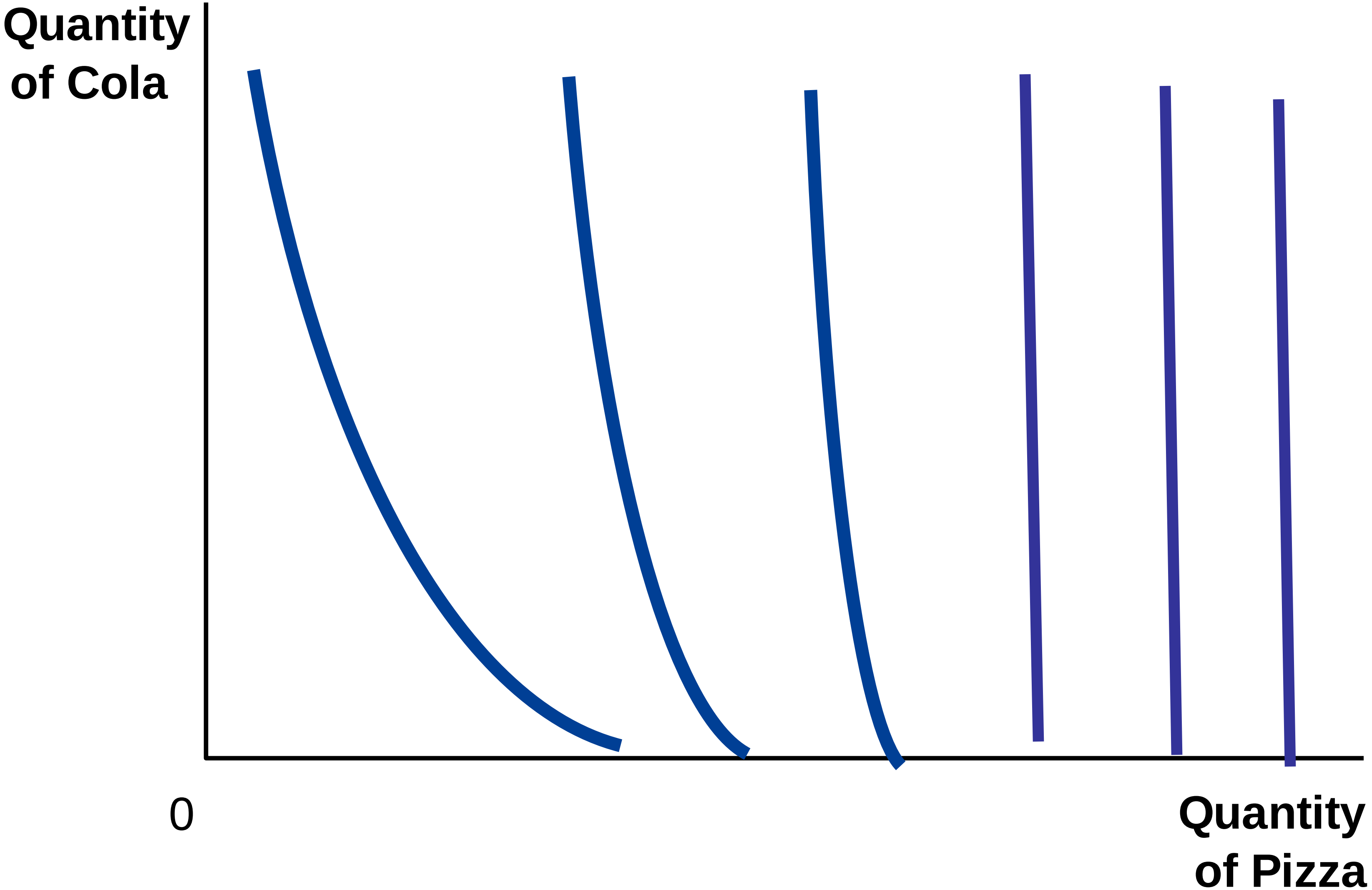
3.9. If you give up one \$5 bill, how many \$1 bills do you need to compensate you? Five \$1 bills will do nicely. Hence the answer is -5 or $-1/5$, depending on which good you put on the horizontal axis.

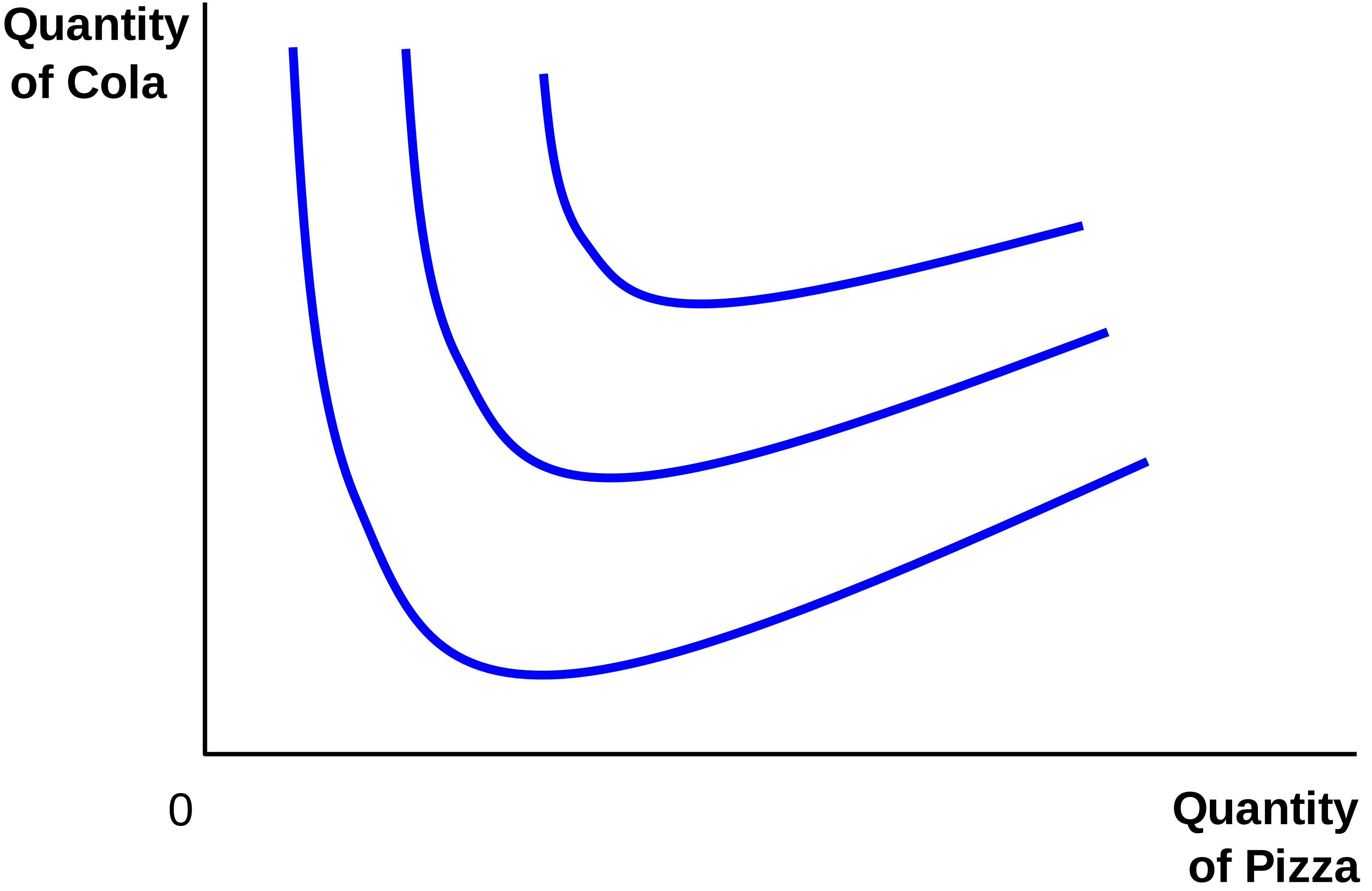
10. If good 1 is a “neutral,” what is its marginal rate of substitution for good 2?

3.10. Zero—if you take away some of good 1, the consumer needs zero units of good 2 to compensate him for his loss.

11. Think of some other goods for which your preferences might be concave.

3.11. Anchovies and peanut butter, scotch and Kool Aid, and other similar repulsive combinations.


Quantity
of Cola
0
Quantity
of Pizza


Quantity
of Cola
0
Quantity
of Pizza

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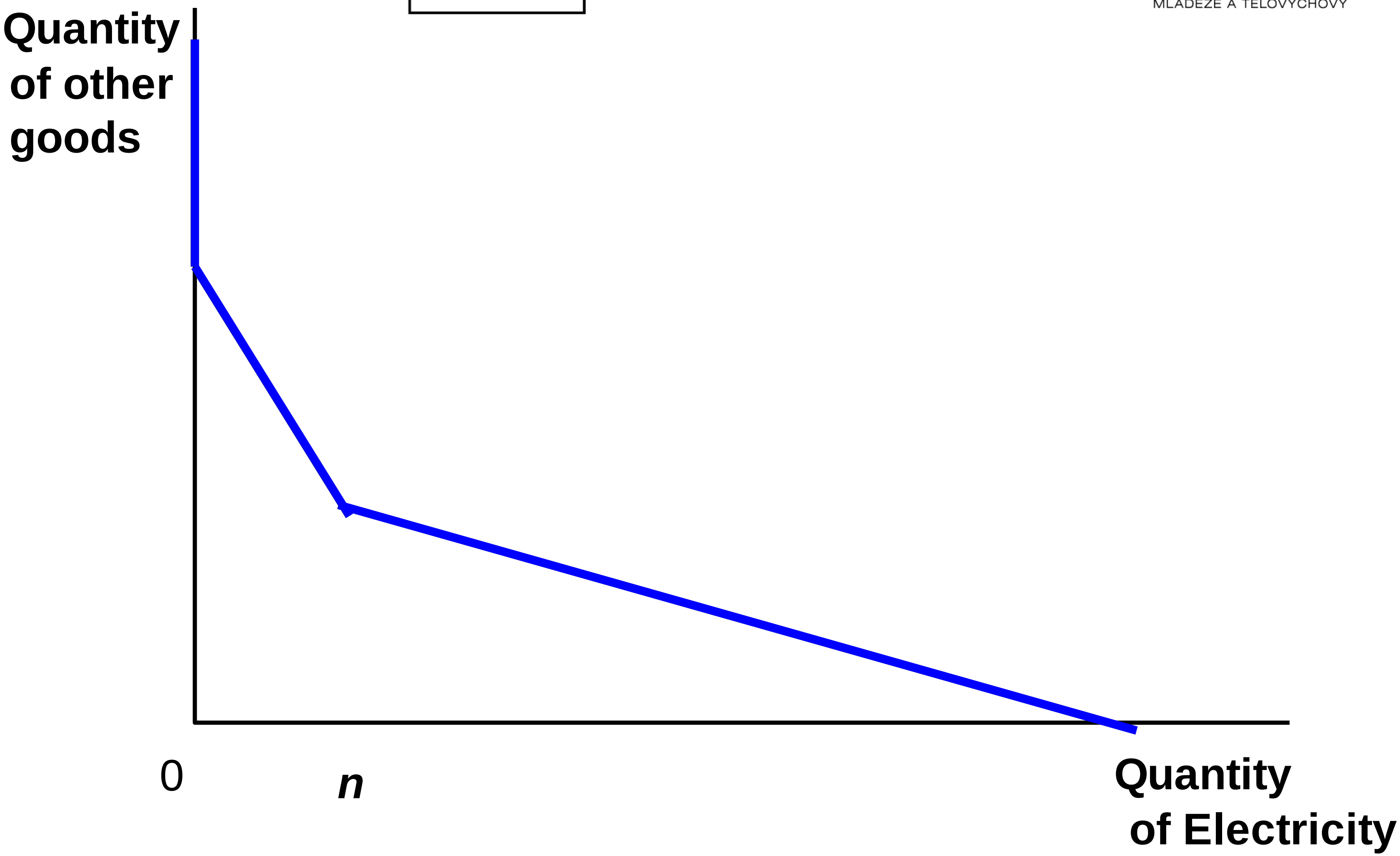

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