1506
UNIVERSITÀ DEGLI STUDI DI URBINO CARLO BO

Basic concepts of microeconomics and industrial organization: Consumer and producer behaviour

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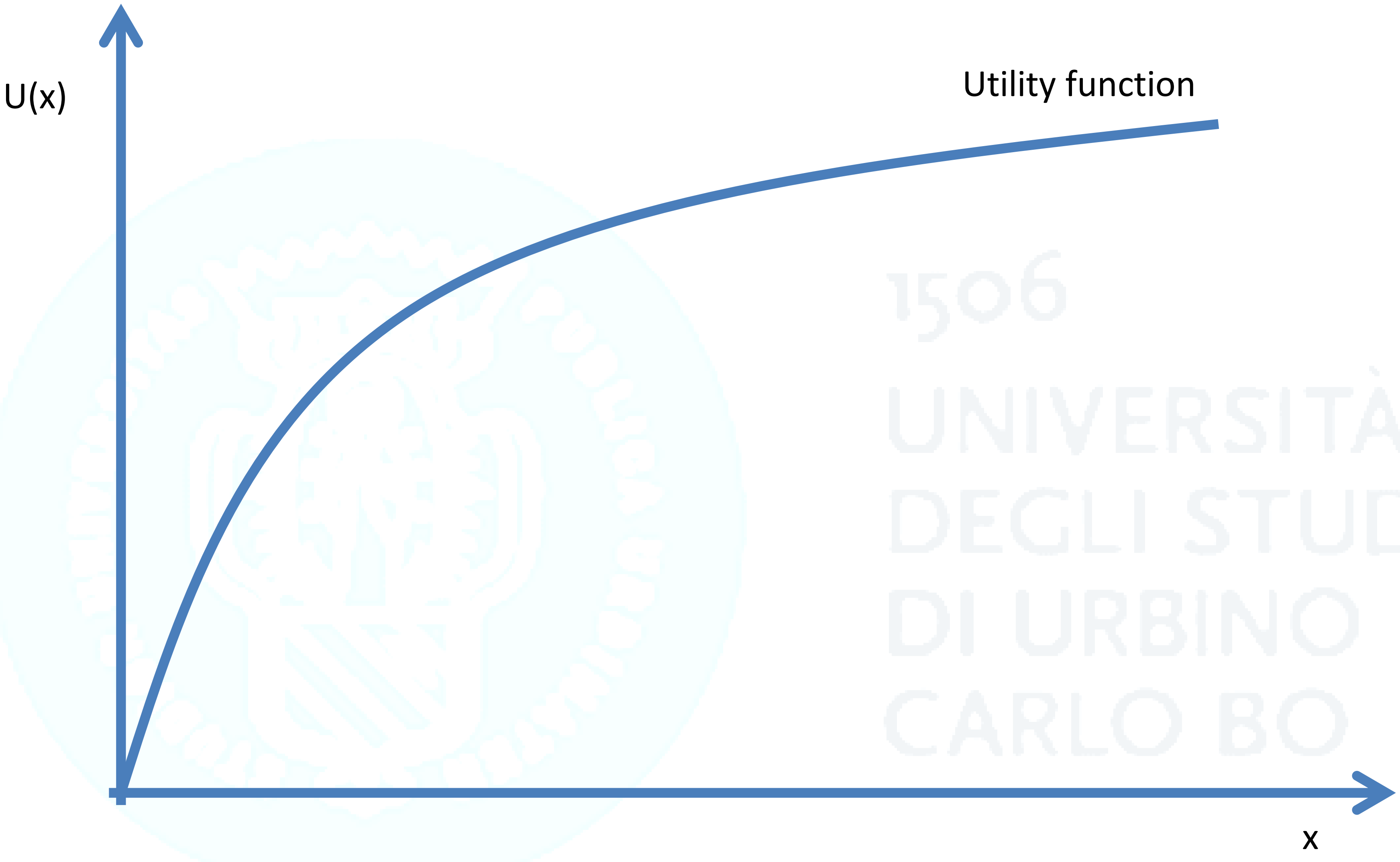
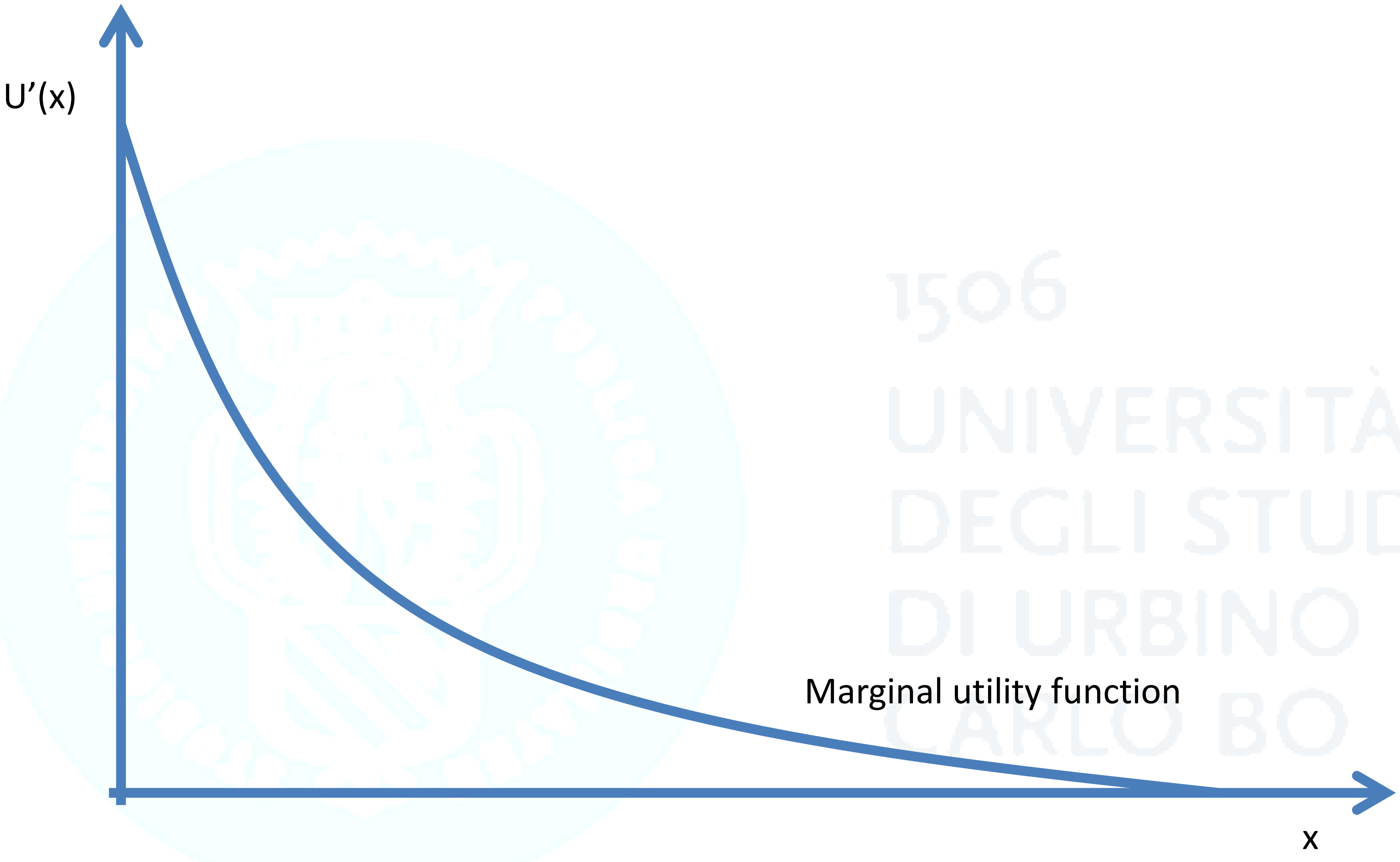
Utility function

- **Utility** can be defined as the **satisfaction** a **consumer** derives from the **consumption** of commodities
- Utility is an **'ordinal' concept**
  - U(2 beers)>U(1 beer)
  - Is the U(2 beers) = 2 x U(1 beer)? 3x? 10x? **Cardinal** differences **cannot** be **measured**

Utility function

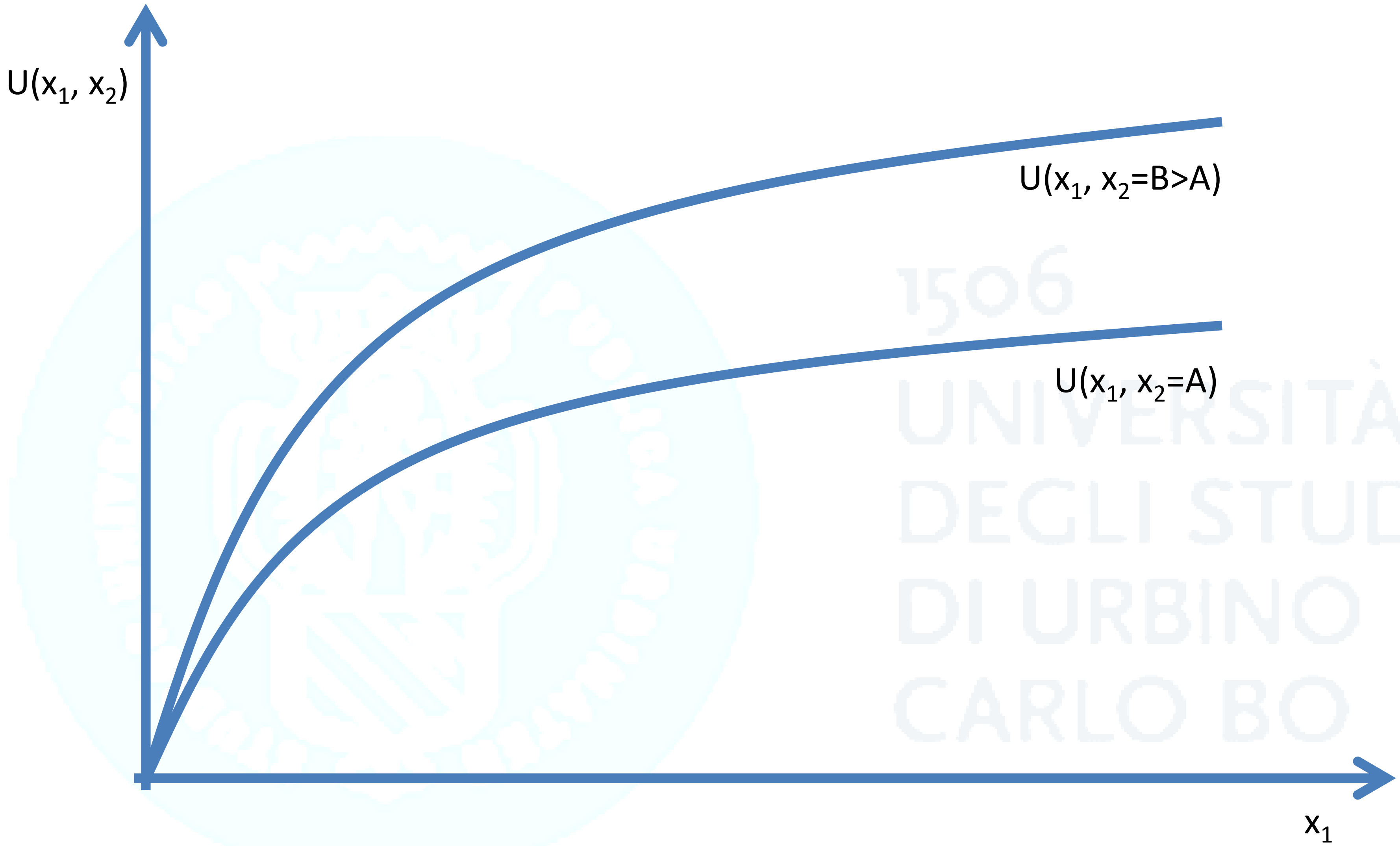
- ‘**Well behaved**’ utility functions:
  - Utility is **increasing** in **consumption**
  - Utility is increasing at a **decreasing rate** ➔ **marginal utility** of consumption is **decreasing**


U(x)
Utility function
x

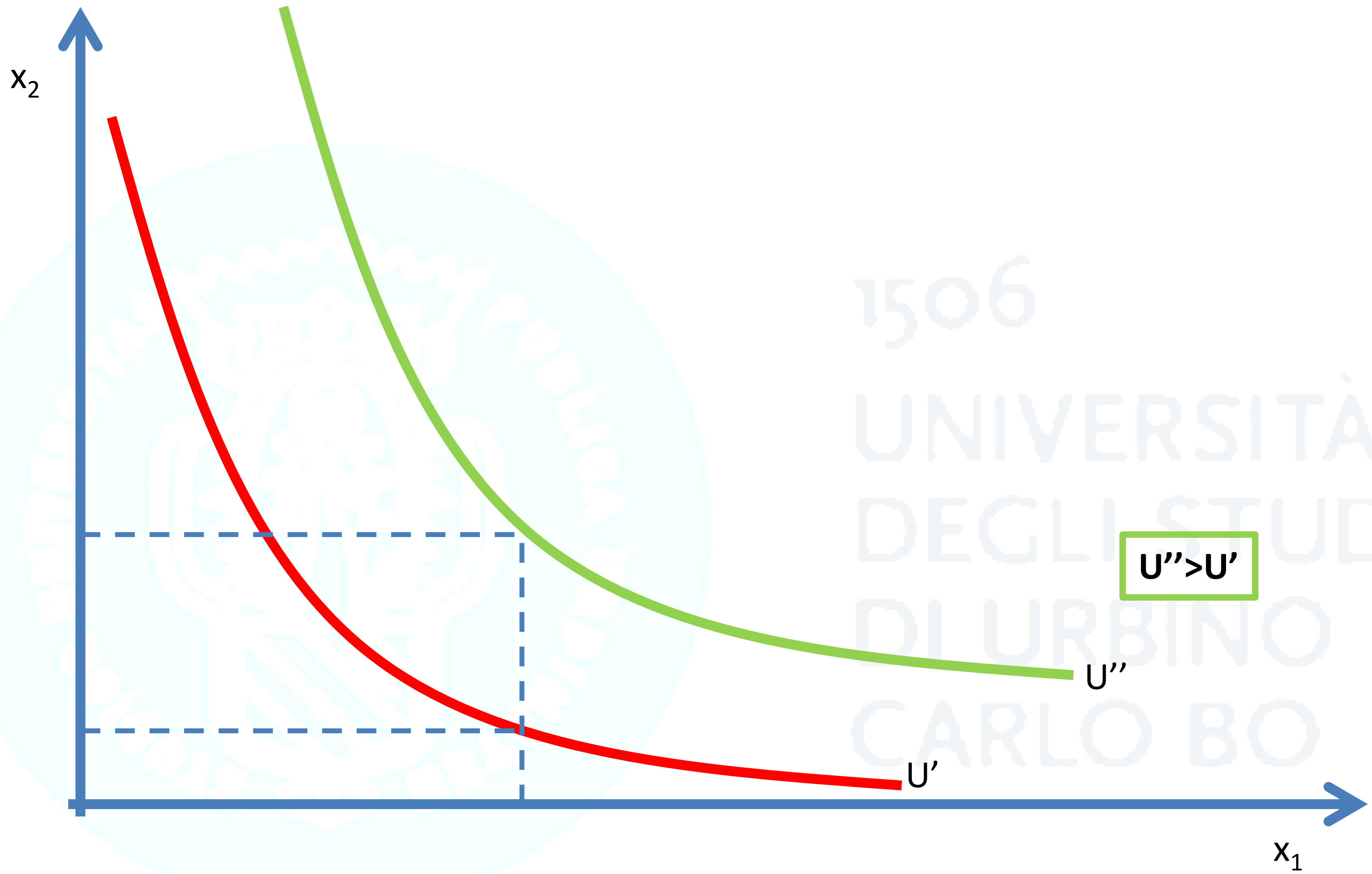

U’(x)
Marginal utility function
x

Utility function with two goods

- We derive utility from the consumption of a **bundle of goods**
- Assume we can consume **two goods**: x_1 and x_2
- $U=U(x_1,x_2)$
  - $dU/dx_1>0$; $ddU/ddx_1<0$
  - $dU/dx_2>0$; $ddU/ddx_2<0$


U(x1, x2)
U(x1, x2=B>A)
U(x1, x2=A)
x1

Indifference curves



Marginal rate of utility substitution

- The **same** level of **utility** can be attained by consuming **different bundles** of goods x_1 and x_2 (i.e. along the **indifference curve**)
- The **Marginal Rate of Utility Substitution** (MRUS) is the rate at which x_1 can be substituted for x_2 at the margin while maintaining the same level of utility
- This measures **how much** of $\mathbf{x_1}$ the individual is willing to **give up** for a **marginal increase** in $\mathbf{x_2}$ in order to attain the **same** level of **utility**

$$MRUS = \frac{dU(x_1, x_2)/dx_1}{dU(x_1, x_2)/dx_2}$$

- The MRUS represents the **slope** of the **indifference curve**

Equilibrium of the consumer

- When **choosing** the amount of $\mathbf{x_1}$ and $\mathbf{x_2}$ to consume, the individual is subject to the **budget constraint**

$$p_1 x_1 + p_2 x_2 \leq w$$

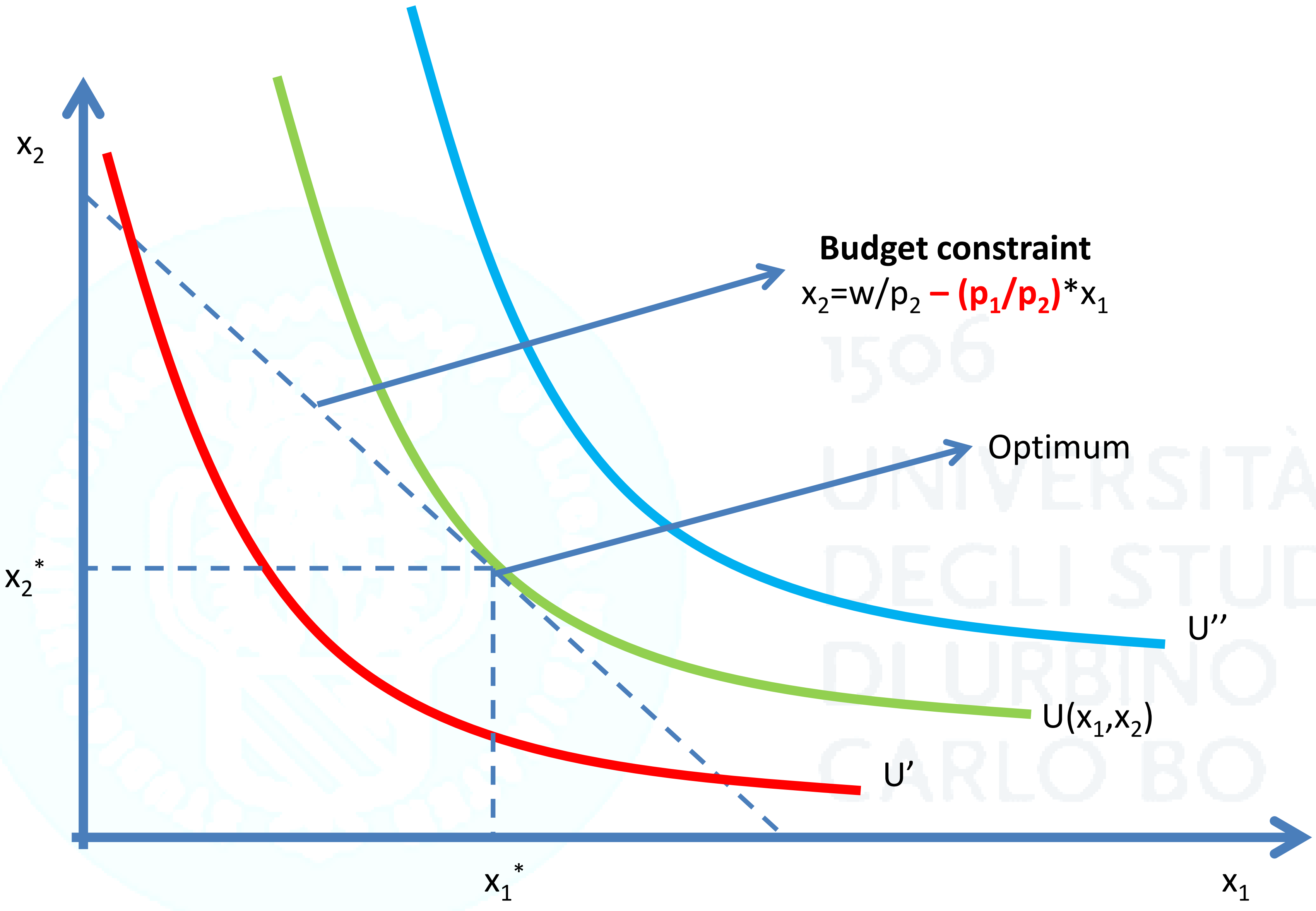
- The individual can spend at most *w* (its **disopsable wealth**) in the consumption of x_1 and x_2 taking goods' **prices** as **given**

Utility maximization

- The individual **maximizes** its **utility** subject to the **budget constraint**:

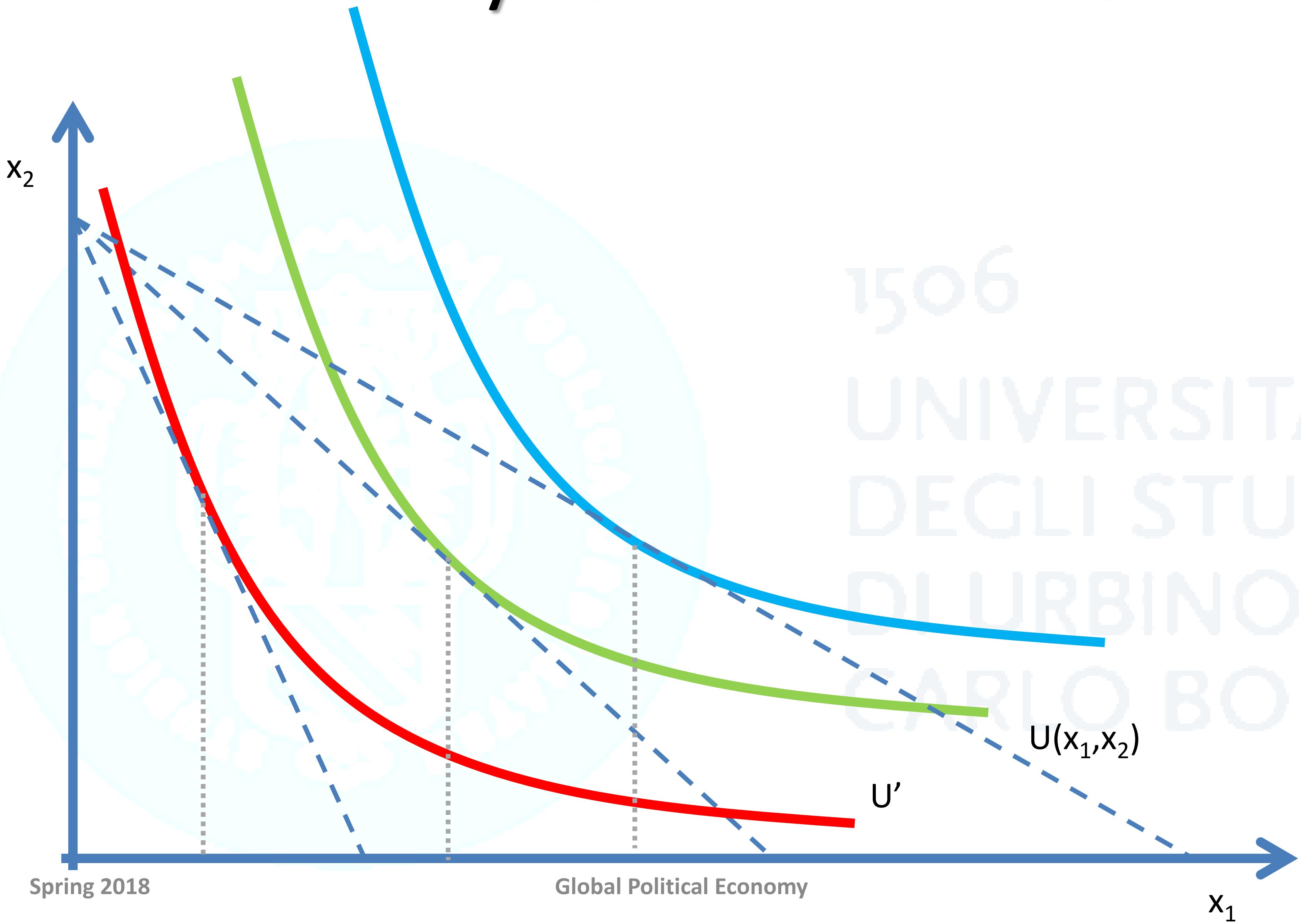
$$\max_{\{x_1, x_2\}} U(x_1, x_2) = f(x_1, x_2)$$
$$s.t.$$
$$p_1 x_1 + p_2 x_2 \leq w$$

- Utility is maximized when the **marginal rate of utility substitution** is **equal** to the **ratio** between **prices**
- **Rationale** ➔ the rate at which the individual is willing to renounce to a marginal amount of good x_1 in exchange of a marginal increase in the consumption of good x_2 is equal to the relative price of good x_2 in with respect to good x_1



x_2
Budget constraint
$x_2 = w/p_2 - (p_1/p_2) * x_1$
Optimum
U''
$U(x_1, x_2)$
U'
x_2^*
x_1^*
x_1

From utility to demand function



Production with a single input

- **Technology** describes how the **input X** (in quantity) is transformed into the **output Y** (in quantity)
  - Total product (**<u>production function</u>**) ➔ Y=Y(X)
- **Marginal product**
  - It is the **increase** in **output** Y that is produced by a **marginal increase** in **input** X

$$MP=dY(X)/dX$$

Production costs

- The **cost** of producing a certain level of Y depends on:
  - The **quantity of input X** that is needed to produce Y
  - The **price** of input **X**
- $Y=Y(X) \Rightarrow X=Y^{-1}(Y) \Rightarrow$ is the **amount** of **input** needed to **produce Y** (and is the **inverse** function of the **total product function**)
- **Total costs** of production as a **function of Y**:

  $TC(Y)=P_X*Y^{-1}(Y) = f(Y)$

Average and marginal costs

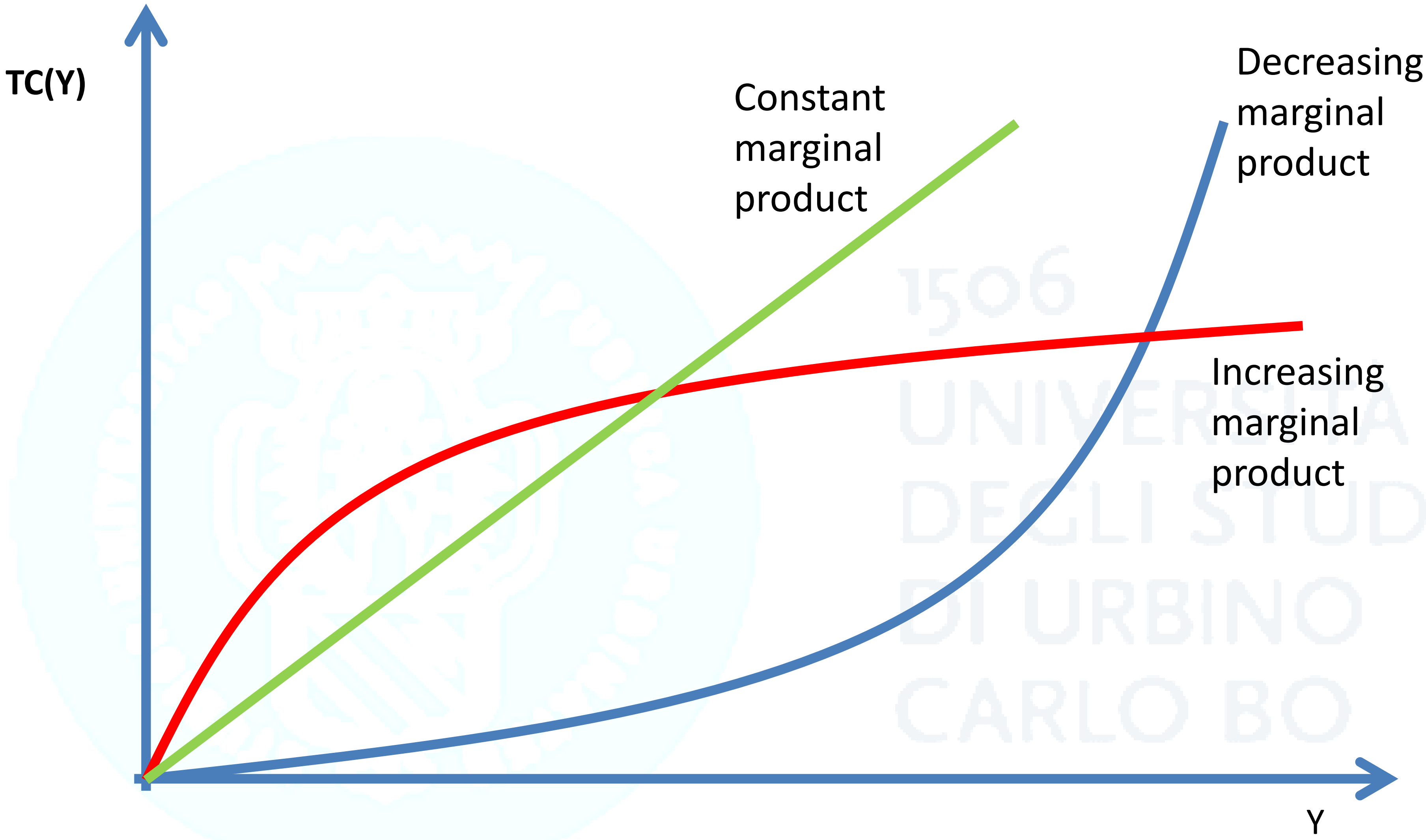
- **Average costs** are defined as the **unitary cost** of producing a **certain output** Y

  AC(Y)=TC(Y)/Y

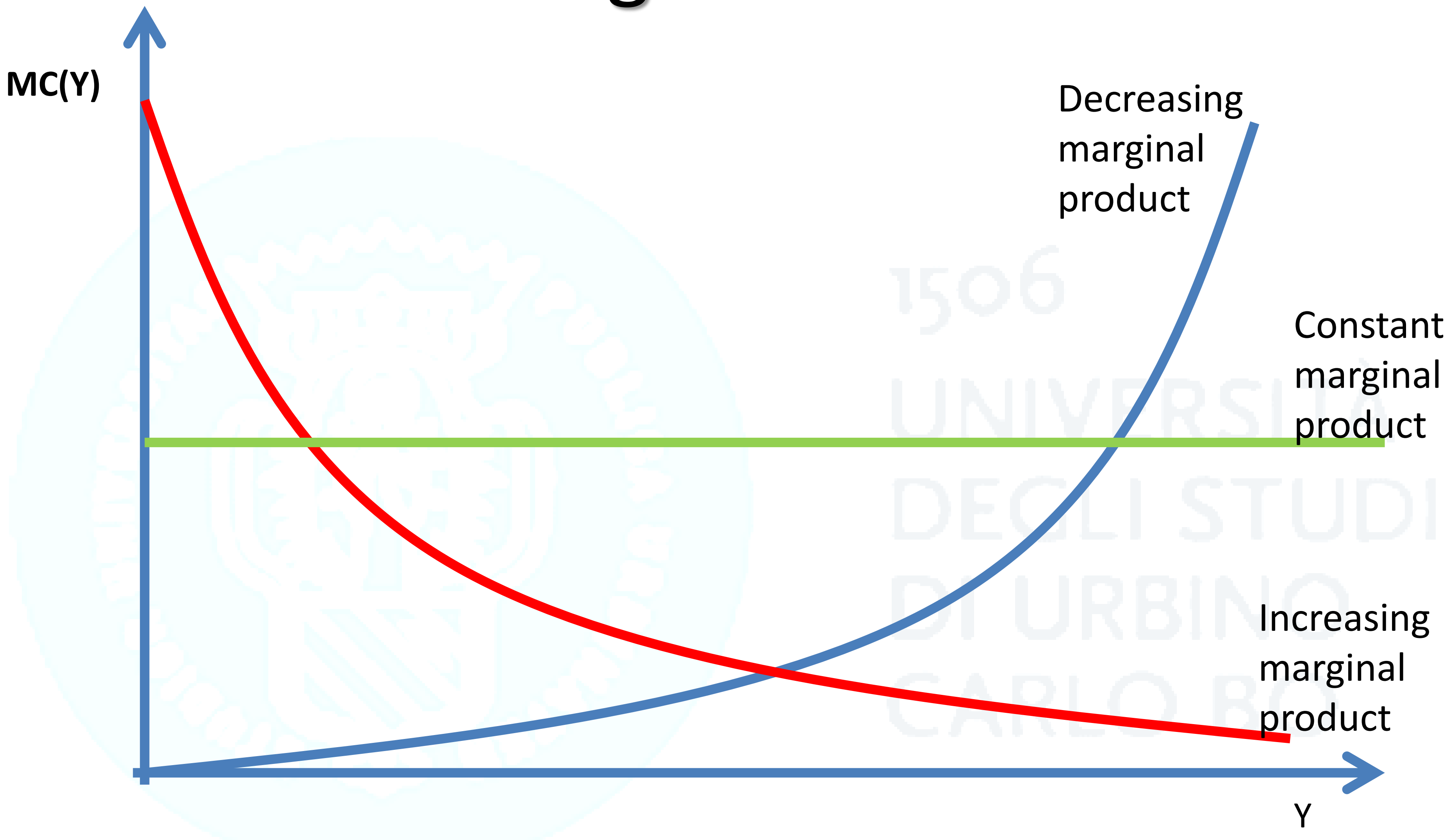
- **Marginal costs** are defined as the **cost** of producing an **additional unit** of Y

  MC(Y)=dTC(Y)/Y

Total cost


TC(Y)
Constant marginal product
Decreasing marginal product
Increasing marginal product
Y

Marginal costs



Costs and marginal product

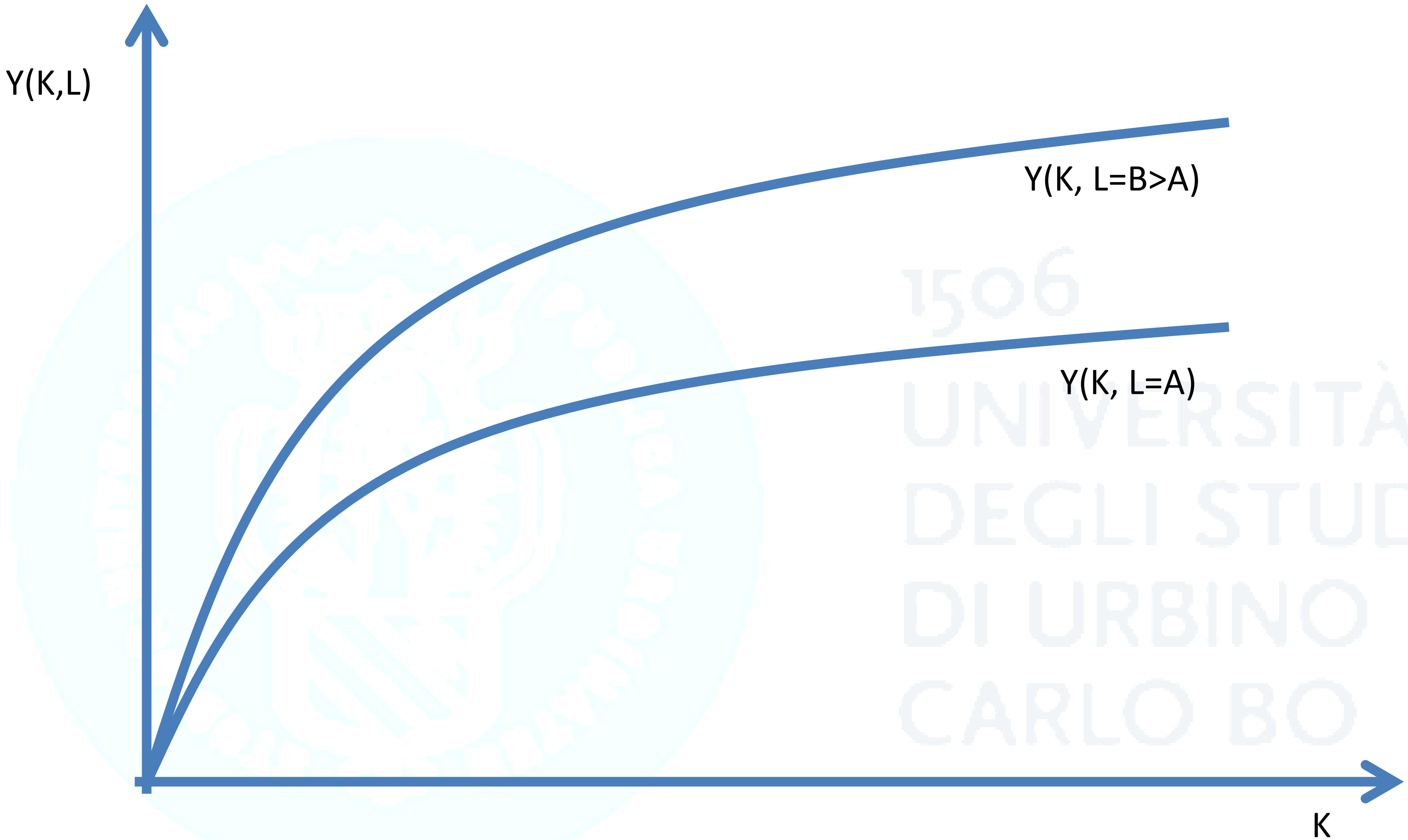
- **Decreasing marginal products** => convex total costs => increasing marginal costs

- **Constant marginal product** => linear total costs => constant marginal costs

- **Increasing marginal product** => concave total costs => decreasing marginal costs

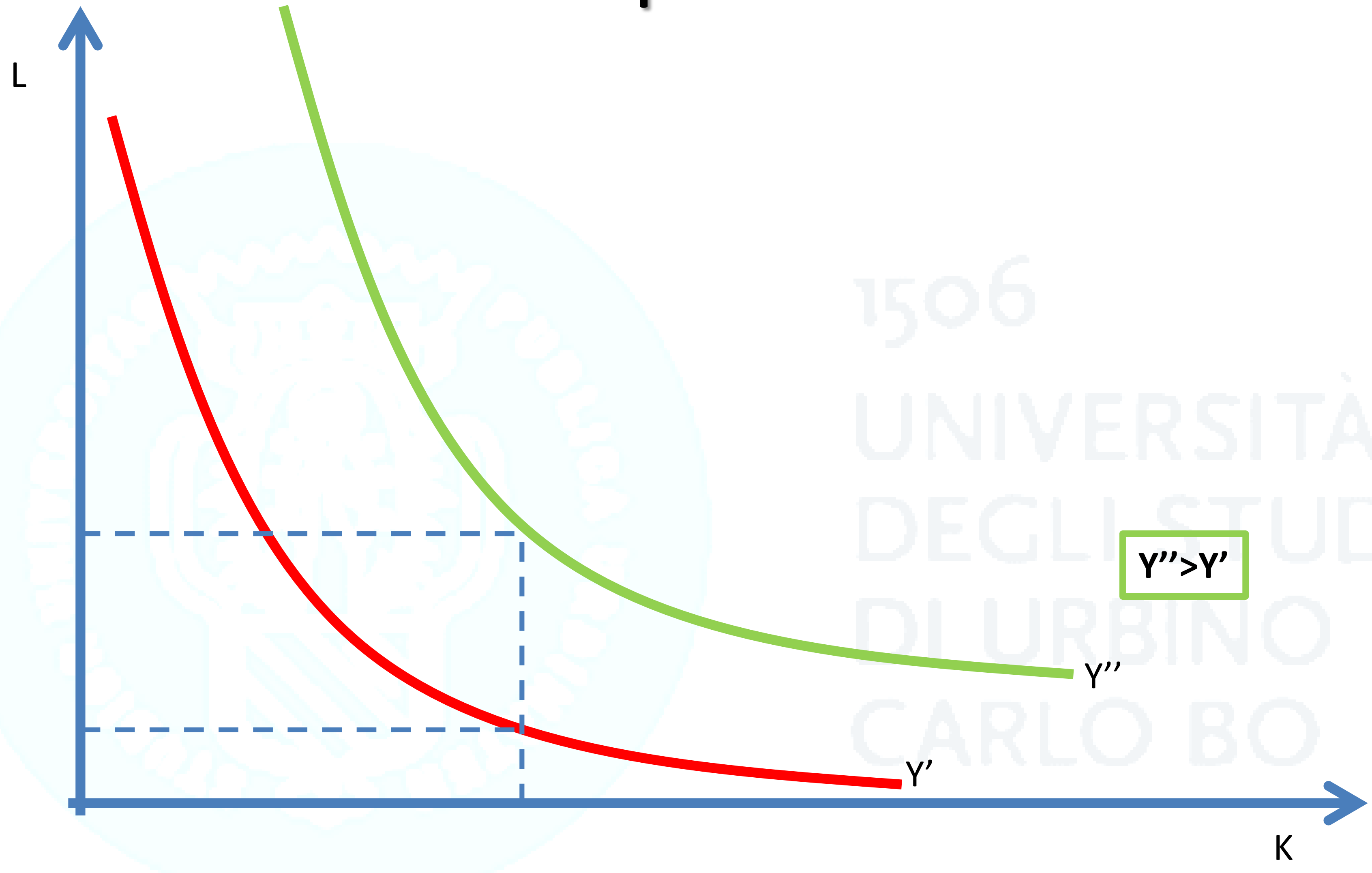
Production with two inputs

- Assume that production of Y requires **two** different **inputs**
  - Labour (L)
  - Capital (K)
- **Production function**
  - $Y=Y(K,L)$
  - A sort of **recipe** => a certain combination of K and L generates a certain amount of Y
  - The production function describes the **production technology**



Y(K,L)
Y(K, L=B>A)
Y(K, L=A)
K

Isoquants



Marginal rate of technical substitution

- The **same** level of **output** can be produced by using different **bundles** of **inputs** L and K (i.e. along the **isoquant**)
- The **Marginal Rate of Technical Substitution** (MRTS) is the rate at which L can be substituted for K at the margin while maintaining the same level of production
- This measures **how much** of **K** the firm can **reduce** for a **marginal increase** in **L** in order to obtain the **same** level of **production**

$$MRTS = \frac{dY(K,L)/dK}{dY(K,L)/dL}$$

- The MRTS represents the **slope** of the **isoquant**

Properties of the production function

- The production function is **strictly increasing** in the level of **inputs** => dY/dL>0; dY/dK>0
- **Constant returns to scale** => Y(2K,2L)=2*Y(K,L)
- **Marginal production** of inputs is **decreasing**
  - For a given level of L, a marginal increase in K also increases output, but at an ever decreasing rate (same for K and L) => ddY/ddK<0; ddY/ddL<0

Equilibrium of the producer

- When choosing the **amount of K and L** to use in production, the producer should also consider the total **cost of production** associated with a **given bundle** of inputs:

$$C(K,L) = p_L L + p_K K$$

Cost minimization

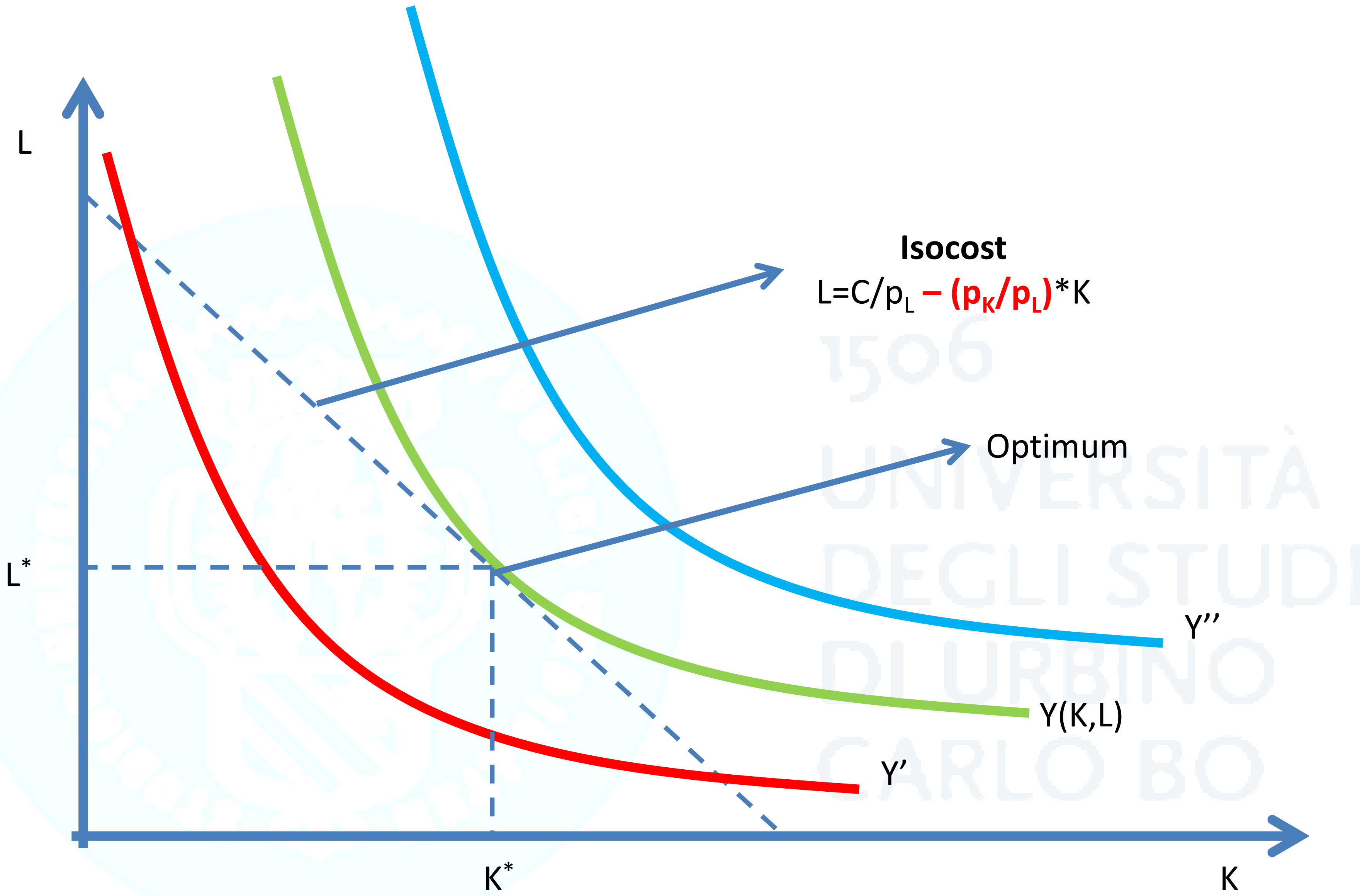
- The firm **minimize** its **costs** provided the (monetary) **output remains** at a **certain level** (**isoquant**)

$$\min_{\{K,\mathrm{L}\}} C(K,L) = p_L L + p_K K$$

$$s.t.$$

$$p_Y Y(K,L) \geq p_Y \overline{Y}$$

- Costs are minimized when the **marginal rate of technical substitution** is equal to the **ratio** between **prices** of **inputs**
- Rationale ➔ the **value of marginal product** (i.e. price times the marginal quantity produced with a small increase in one input given the other input) of each input should **equal** the **price** of that **input**


L
Isocost
$L = C/p_L - (p_K/p_L) * K$
Optimum
L*
Y''
Y(K,L)
Y'
K*
K

Structure of production costs

- **<u>Fixed costs</u>** (FC)
  - They do **not vary** with the **quantity** of output that is produced
  - The producer will incur fixed costs **even** with **no production**
  - **Average fixed costs** per unity of output decrease as output grows ➔ FC/Q
- **<u>Variable costs</u>** (VC)
  - Variable costs are **function** of the **quantity** of output produced ➔ VC(Q)
  - As output grows, total variable costs **grow**
  - VC(Q=0)=0

Structure of production costs

- **<u>Marginal costs</u>** (MC)
  - Marginal costs represent the **change** in **total costs** when **output changes** marginally
    - **Fixed costs** are **constant**
    - **Variable costs** depend on **Q**

    $dTC/dQ=dFC/dQ+dVC(Q)/dQ=0+dVC(Q)/dQ$

  - They are (usually) **function of output → MC(Q)**
- **<u>Average costs</u>** (AC)
  - Average costs represent the **average total cost** of producing a certain quantity **Q**

  $AC(Q)=FC/Q+VC(Q)/Q$

Q	FC	VC(Q)/Q	VC(Q)	MC(Q)	AC(Q)	TC(Q)	Average FC
0	2	0	0	-	-	2	-
1	2	1.00	1.00	1.00	3.00	3.00	2.00
2	2	1.10	2.20	1.20	2.10	4.20	1.00
3	2	1.11	3.34	1.14	1.78	5.34	0.67
4	2	1.13	4.51	1.17	1.63	6.51	0.50
5	2	1.14	5.72	1.21	1.54	7.72	0.40
6	2	1.16	6.97	1.25	1.50	8.97	0.33
7	2	1.18	8.28	1.31	1.47	10.28	0.29
8	2	1.21	9.66	1.38	1.46	11.66	0.25
9	2	1.23	11.11	1.46	1.46	13.11	0.22
10	2	1.27	12.66	1.55	1.47	14.66	0.20
11	2	1.30	14.33	1.67	1.48	16.33	0.18
12	2	1.34	16.13	1.81	1.51	18.13	0.17
13	2	1.39	18.11	1.98	1.55	20.11	0.15
14	2	1.45	20.30	2.18	1.59	22.30	0.14
15	2	1.52	22.74	2.44	1.65	24.74	0.13

Q	FC	VC(Q)/Q	VC(Q)	MC(Q)	AC(Q)	TC(Q)	Average FC
0	2	0	0	-	-	2	-
1	2	1.00	1.00	1.00	3.00	3.00	2.00
2	2	1.10	2.20	1.20	2.10	4.20	1.00
3	2	1.11	3.34	1.14	1.78	5.34	0.67
4	2	1.13	4.51	1.17	1.63	6.51	0.50
5	2	1.14	5.72	1.21	1.54	7.72	0.40
6	2	1.16	6.97	1.25	1.50	8.97	0.33
7	2	1.18	[illegible]	[illegible]	[illegible]	10.28	0.29
8	2	1.21	[illegible]	[illegible]	[illegible]	11.66	0.25
9	2	1.23	[illegible]	[illegible]	[illegible]	13.11	0.22
10	2	1.27	12.66	1.55	1.47	14.66	0.20
11	2	1.30	14.33	1.67	1.48	16.33	0.18
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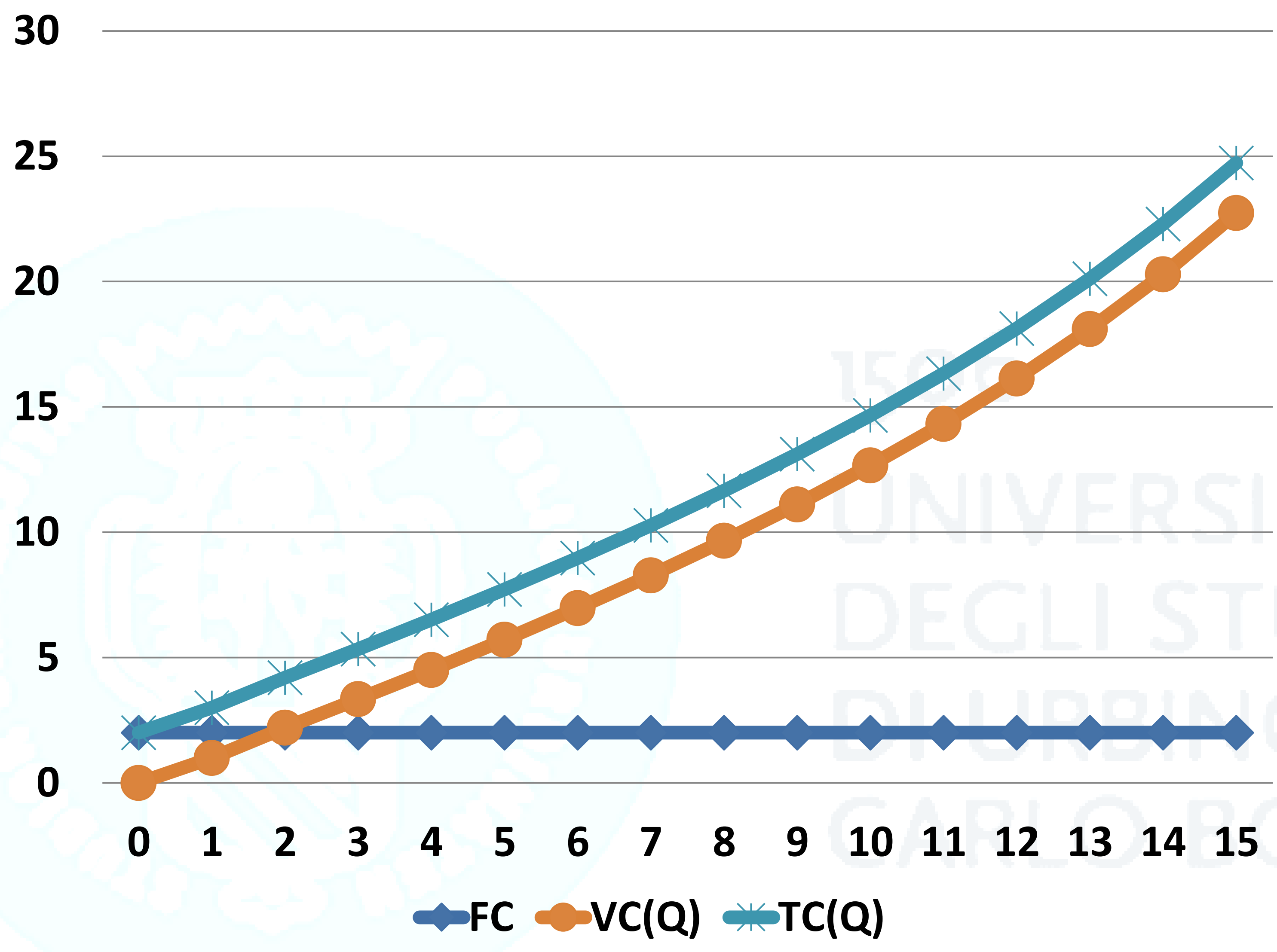
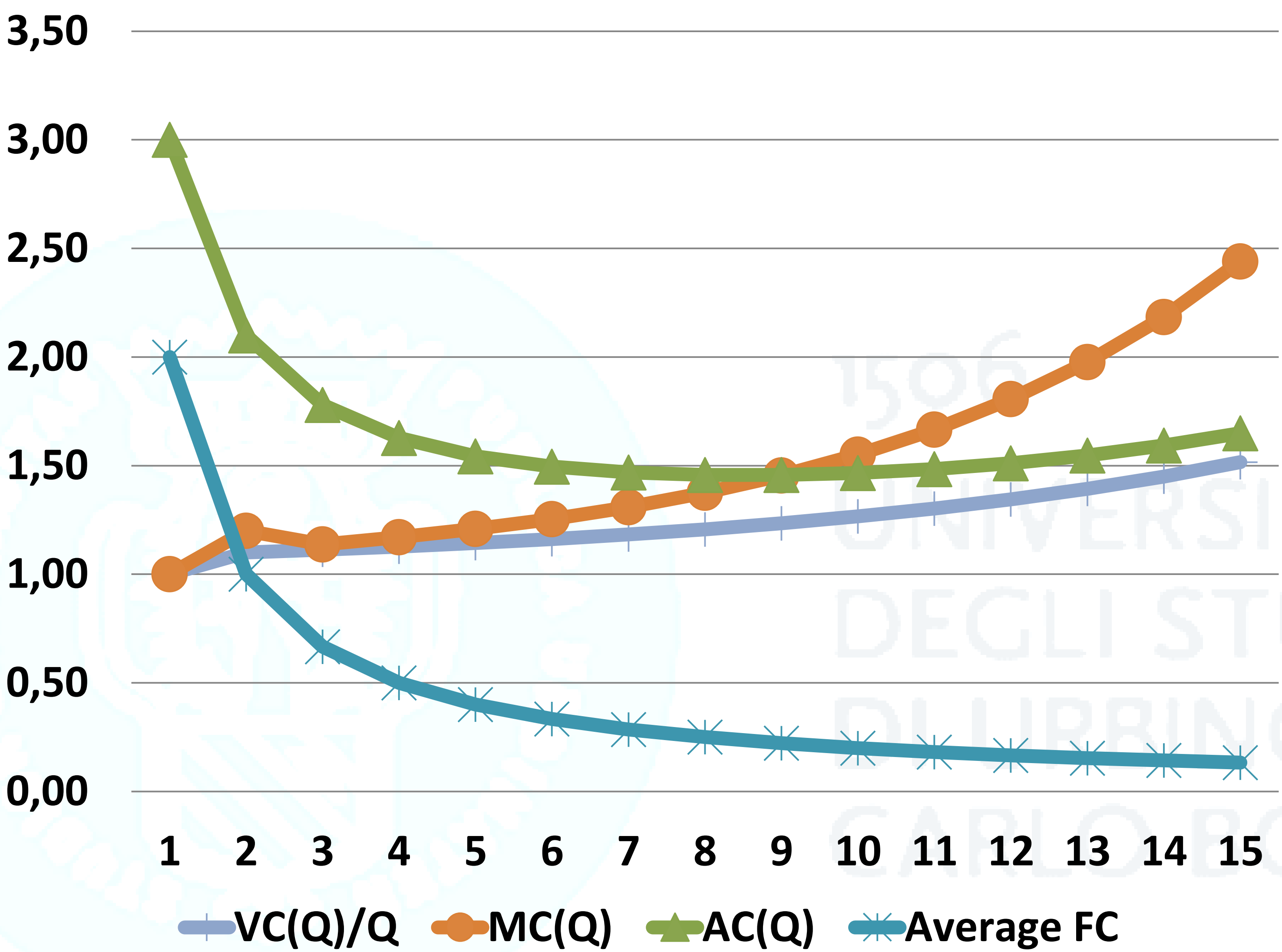
13	2	1.39	18.11	1.98	1.55	20.11	0.15
14	2	1.45	20.30	2.18	1.59	22.30	0.14
15	2	1.52	22.74	2.44	1.65	24.74	0.13

$$MC(Q)=TC(Q)-TC(Q-1)=$$
$$=VC(Q)-VC(Q-1)$$

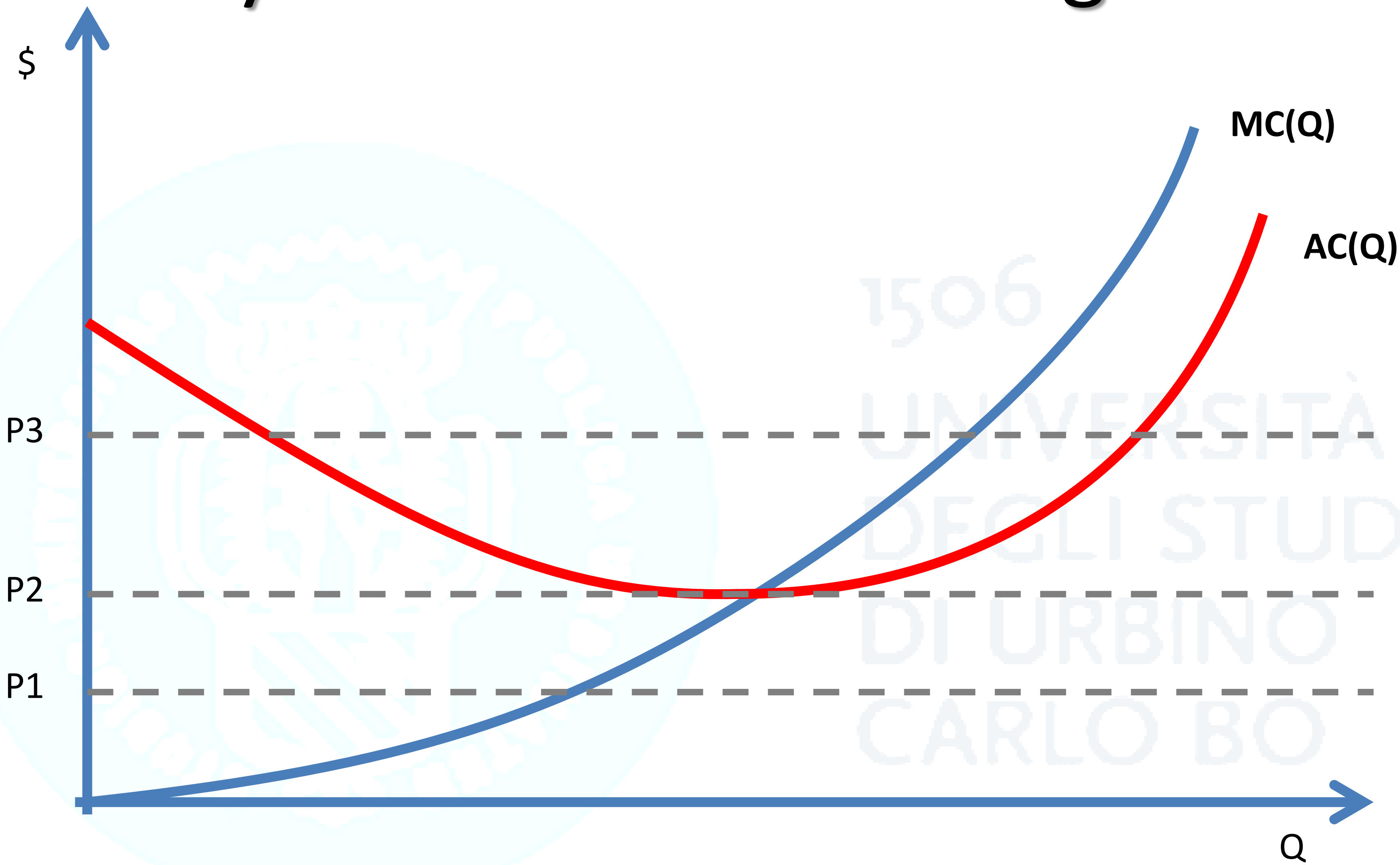

30
25
20
15
10
5
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
FC
VC(Q)
TC(Q)


3,50
3,00
2,50
2,00
1,50
1,00
0,50
0,00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
VC(Q)/Q
MC(Q)
AC(Q)
Average FC

Short run vs long run

- In the **short run** some **inputs** are **fixed**
  - A factory cannot be phased out easily
  - In the very short run even labour could be fixed (notice period for firing workers)
  - Other inputs are variable even in the very short run (e.g. you can decide to fill the tank of your truck at any time)
- In the **long run** all **inputs** are **variable**
  - Factories can be built or dismantled
  - Workers can be hired or fired
  - …

Stay or exit? Short vs long run



Marginal costs and supply function

- **Marginal cost** are equivalent, ultimately, to the **supply curve**
  – In the **short run**, the producer is willing to **accept any price greater** or equal to the **marginal cost** to produce a certain quantity Q
  – **Even if** prices are **below average costs** and thus the company will experience a negative profit due to too high fixed costs, it will produce Q anyways to **cover as much fixed costs as possible**
  – **Marginal profits** (P-MC(Q)) are **positive** as long as P>MC(Q)

Market structure

- The market structure ➔ how **prices** and **quantity** are set on the **market**
- The market structure **depends on** (among other things):
  - The **number** of **consumers** and **producers**
  - The **bargaining power** of each producer and consumers
- These factors **ultimately** depend on:
  - **Cost** structure
  - Shape of **demand**
  - **Institutional** setting (e.g. strength of the antitrust)

Market structures

- **Perfect competition**
  - Large number of (atomistic) consumers and producers
  - Each consumer and producer is price taker (i.e. has no direct influence on prices)
- **Monopoly**
  - One single producer and multiple consumers
  - Consumers are price takers, the producer is price maker
- **Monopsony**
  - One single consumer and multiple producers
  - The consumer is price maker

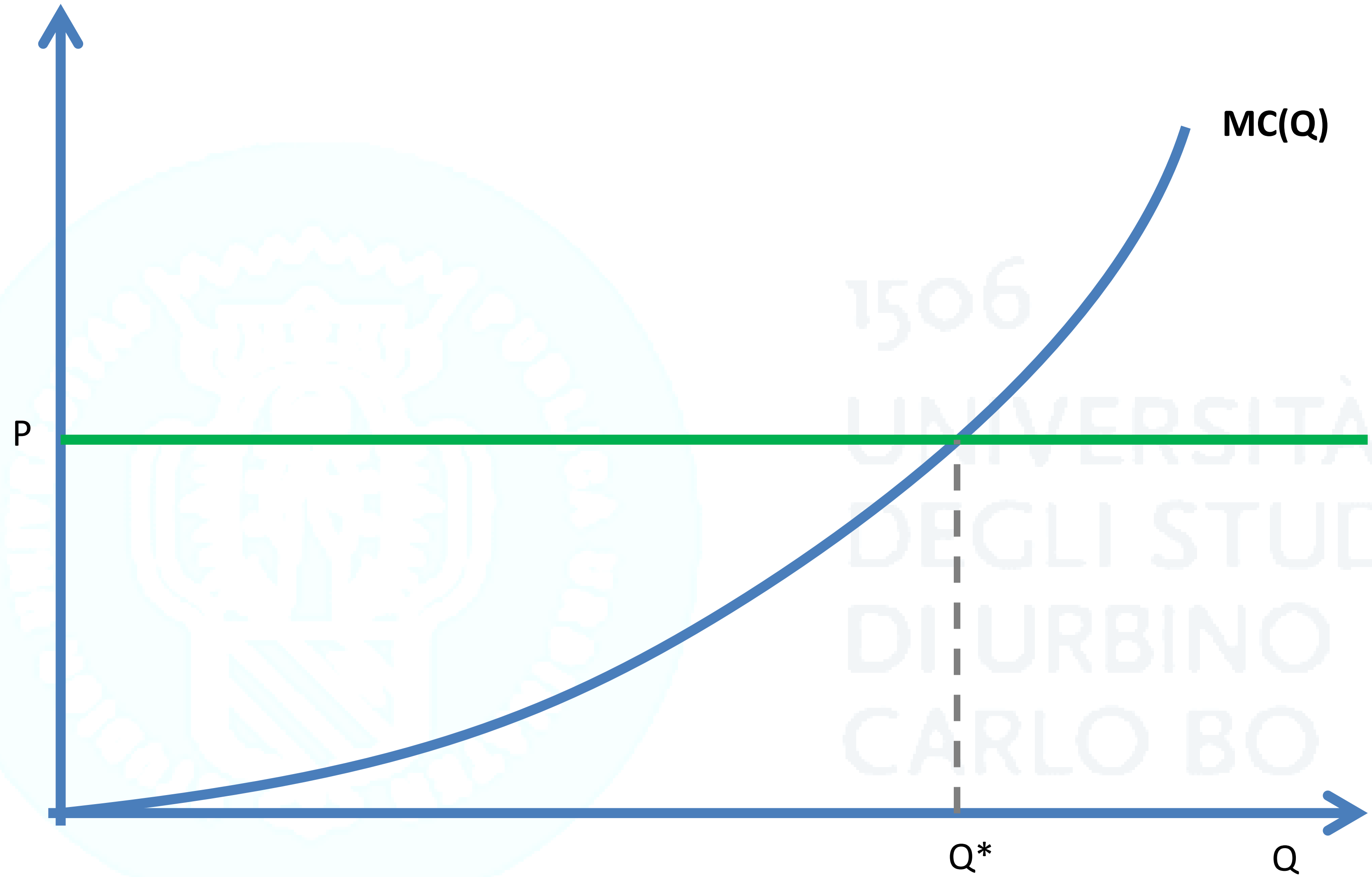
Market structures

- **Oligopoly**
  – Few producers and multiple consumers
  – Consumers are price takers
  – Producers have some influence on prices, that also depends on the behaviour of other producers
- **Monopolistic competition**
  – Many consumers with preferences over variety of goods (that are substitute)
  – Each producer is the monopolist for the production of a certain variety
  – Varieties compete on the market

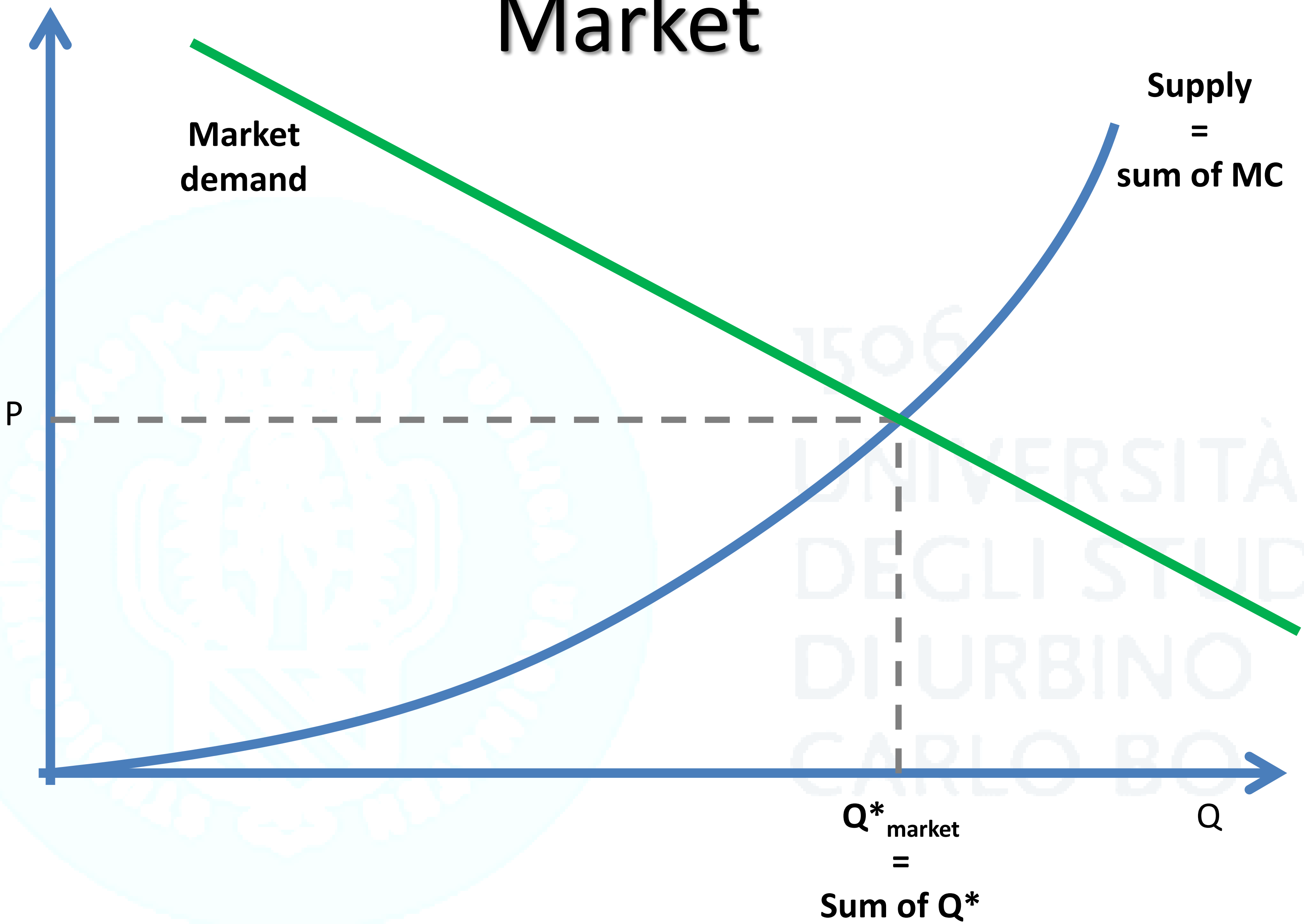
Perfect competition

- **Many** firms
- **Identical** and **homegenous product**
- Each firm is a **small part** of the **market**
- Each firm in the market takes the market **price** as being **predetermined** ➔ firms are **price takers**
- Firms **only** decide **how much** to **produce** for a given price
- Each **firm** faces a **'flat' demand** curve

Firm



Market



Entry and exit in perfect competition

- In the **short run**, firms will **produce** as long as **marginal costs** are **below** the market **price** (even if average costs are larger than market prices)
- **New firms** will enter the market if their **expected marginal cost** is **below** the prevailing market **price**
- In the **long run**, firms with **average costs larger** than the market **price** will **exit** the market

Monopoly

- Only **one producer** is on the market
- This happens for a **number of reasons** that generate **barrier to entry** for potential competitors:
  - High **fixed or sunk costs** prevent potential entrants from entry => **natural monopoly**
    - Building a **railway infrastructure**
    - Building an **electricity transmission** network
  - **Strategic behaviour** of the **incumbent** that deter entry
    - **Predatory prices**
    - Large expenditure in **advertising**
  - Government **regulation**
    - **Gambling** and casino (in Italy)

Monopoly

- **Differently** from firms in **perfectly competitive** markets, the **monopolist** faces a **downward sloping demand** function
- The monopolist is **not price-taker**
- The **price** is **set** by the **monopolist**

Profit maximization in monopoly

- The monopolist will **maximize** the following **profit function**:

$$\max_{\{Q\}} \pi = Q * P(Q) - C(Q)$$

- Where **Q*P(Q)** are **total revenues** and **C(Q)** are **total costs**
- Recall that **revenues** in **perfectly competitive** markets **were Q*P** and not Q*P(Q)

Profit maximization in monopoly

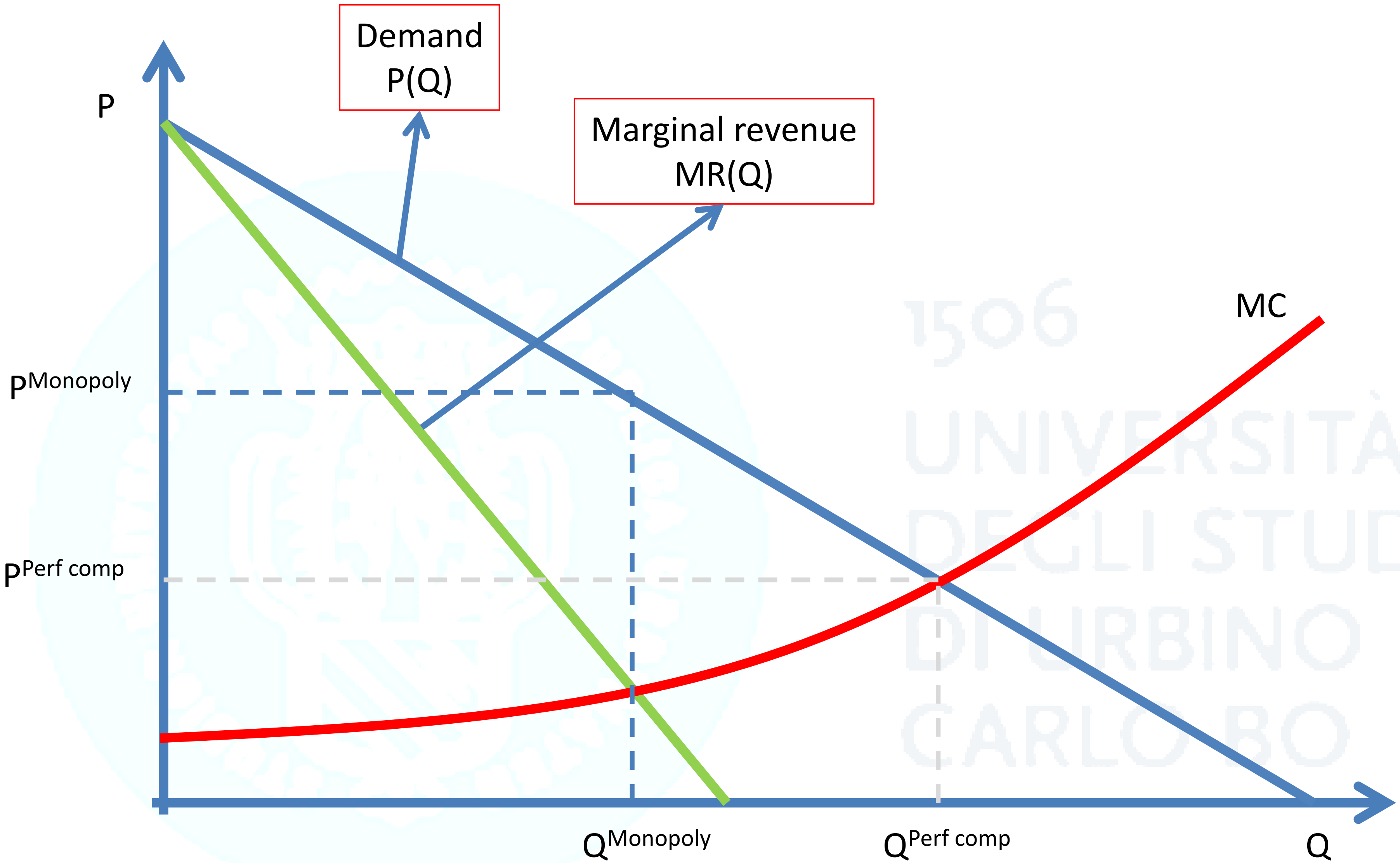
- Profits are **maximized** when:

$$MR(Q) = MC(Q)$$

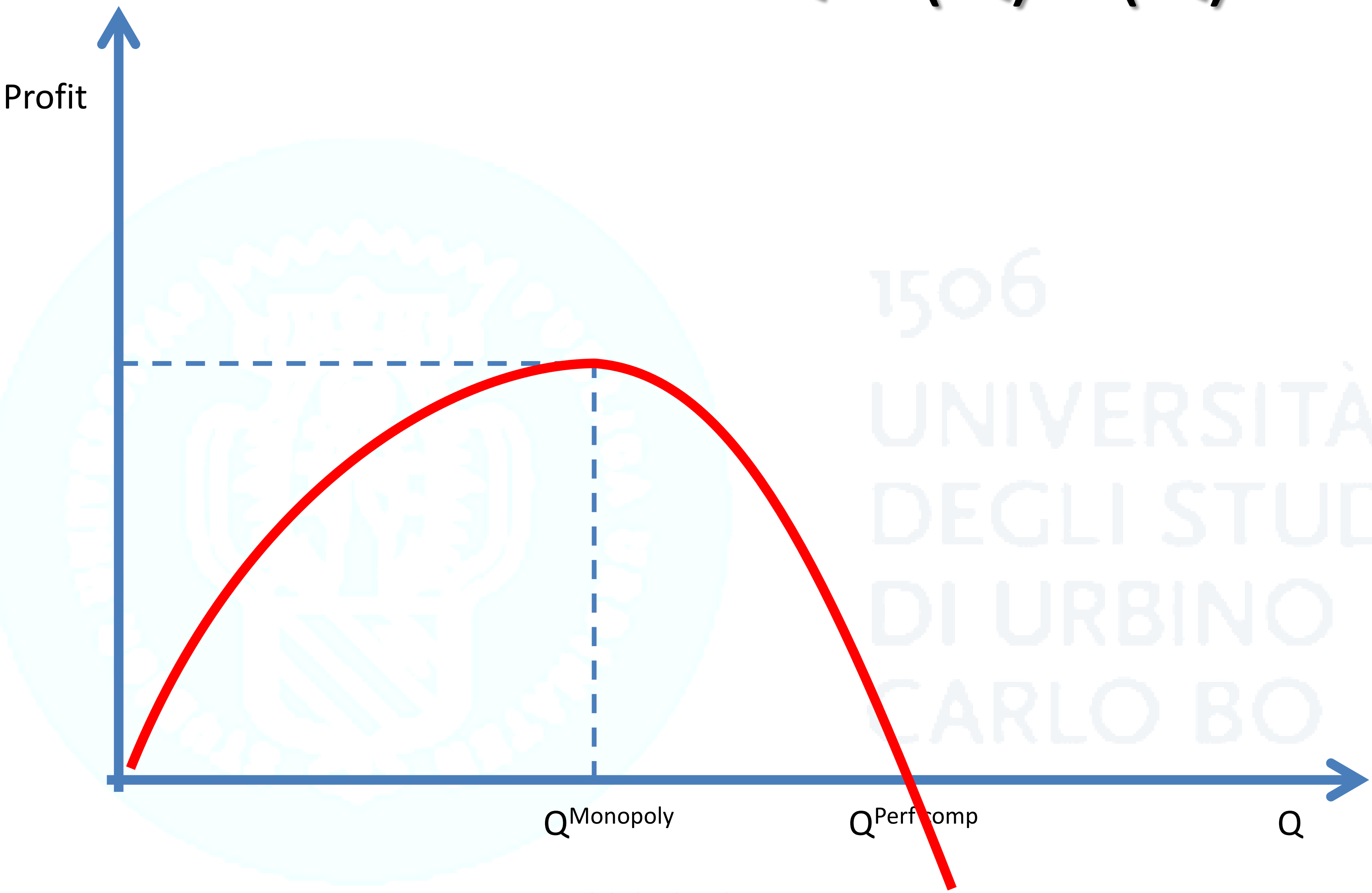
- **where:**

$$MR(Q) = d[Q * P(Q)] / dQ = P(Q) + dP(Q) / dQ$$

$$MC(Q) = dC(Q) / dQ$$


Demand
P(Q)
Marginal revenue
MR(Q)
P
MC
P^Monopoly
P^Perf comp
Q^Monopoly
Q^Perf comp
Q

Profit function=Q*P(Q)-C(Q)



Oligopoly

- **Few firms** operate on the market
- Firms interact **strategically** to **maximize** their **profits**
- A firm decides **either prices** or **quantities**, taking into **account** the **behaviour** of **other firms** ➔ optimal response function

Competition on prices (Bertrand)

- **Two firms** on the market with the **same marginal cost** function and **no fixed costs**
- Firms **decide** the **price**
- The firm that sets the **lowest price** on the market will serve the **whole market**
- Firms choose their price **'given' the price** set by **other firms**
- Firms choose prices **simultaneously**

Competition on prices (Bertrand)

- Firm 1 **maximizes profits**
- Profits of firm 1 will be
  - 0 if $P_1>P_2$
  - $P_1*Q(P_1)/2-C(Q/2)$ if $P_1=P_2$ ➔ the two firms split equally the market
  - $P_1*Q(P_1)-C(Q)$ if $P_1<P_2$ ➔ firm 1 becomes the monopoly
- Firm 2 does the same
- As long as $P_1*Q(P_1)-C(Q)>0$ (positive profits), firm 1 will set $P_1<P_2$

Competition on prices (Bertrand)

- In the end, firms will choose a **price such that profits** of each firm are **zero** ➔ $MC_1=MC_2=P_1=P_2$
- **No** firm has **incentive** to **deviate**
  - **Increasing** the **price** leads to **null production**
  - **Reducing** the **price** leads to **negative profits**
- **Same** result as in **perfect competition**!

Competition on quantity (Cournot)

- Each firm will set its level of **production given** the **expected production** of the **other** firm(s)
- All firms decide their quantity **simultaneously**
- Firms **maximize** their **profits** for **given quantities** produced by **other firms**

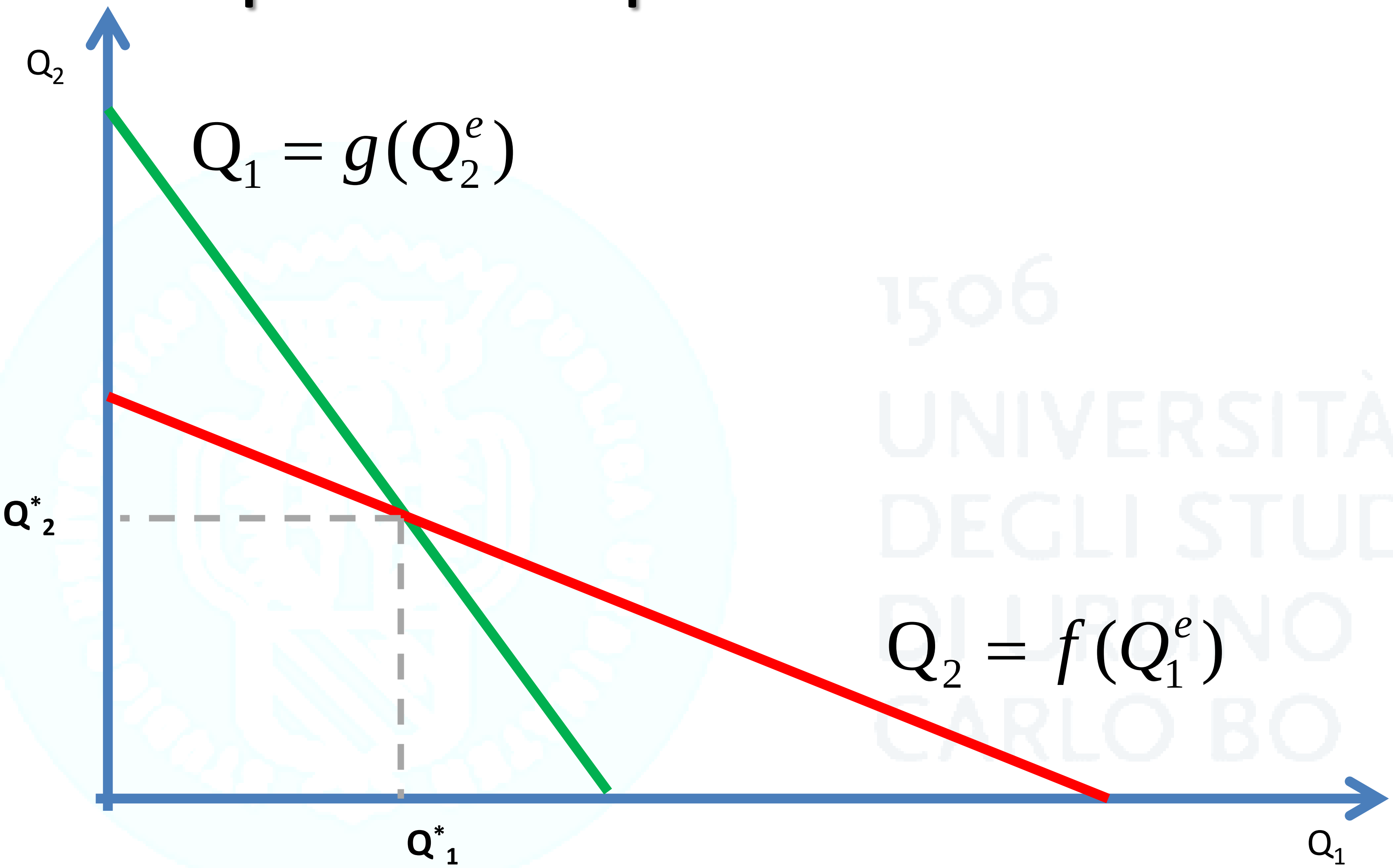
Competition on quantity (Cournot)

- Assume that **two firms** operate in the market
- **Firm 1 maximizes** its **profits given** the **expected output** produced by **firm 2**

$$\max_{\{Q_1\}} Q_1 P(Q_1 + Q_2^e) - C(Q_1)$$

- **Firm 2** will do the **same**
- The **optimal** solution for **firm 1** is a decreasing **function** of the **expected quantity** produced by **firm 2**
- The **larger** the **quantity** produced by **firm 2**, the **lower** the '**residual demand**' for **firm 1** (or alternatively, the lower the expected price)

Optimal response functions



Oligopoly and collusion

- The **Cournot** model results in
  - **Prices higher** than in perfect **competition** (and Bertrand oligopoly) and **lower** than in **monopoly**
  - **Quantity lower** than in perfect **competition** (and Bertrand oligopoly) and **higher** than in **monopoly**
- Firms could **potentially increase** their **profits** (i.e. total profits earned by producers) by producing the **same quantity** as the **monopolist** at the **monopoly price** → **collusion**
- Firms have great **incentive** to **deviate** from **collusion** as, at the **margin**, they will earn **additional profits** from **deviating**