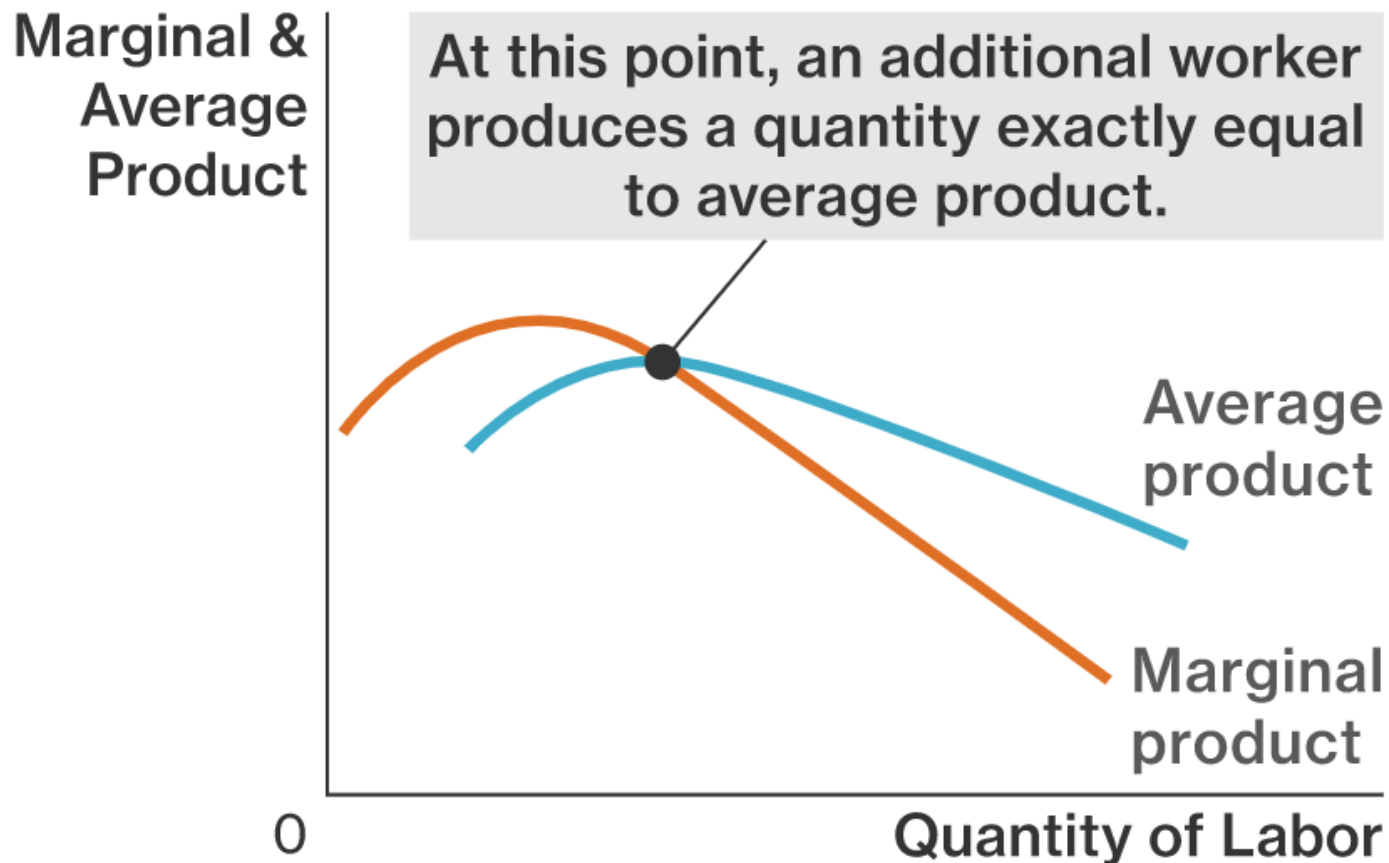


WHERE DO WE STAND?



The typical relation between average and marginal product: an example

L	TP	AP	MP
0	0	0	0
1	4	4	4
2	14	7	10
3	30	10	16
4	48	12	18
5	67	13.4	19
6	85	14.17	18
7	101	14.42	16
8	113	14.12	12
9	121	13.44	8
10	125	12.5	4
11	127	11.55	2
12	128	10.67	1

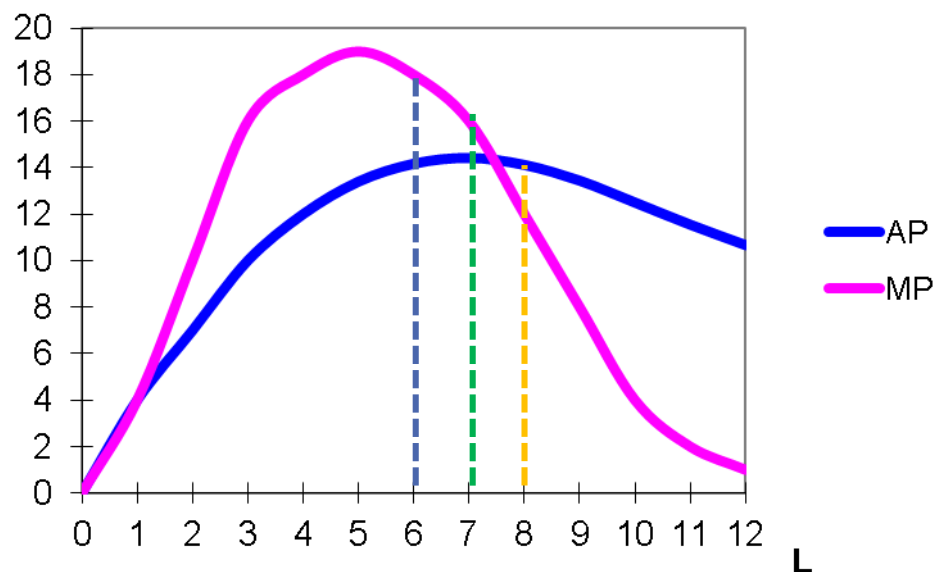
-1 = loss in MP passing from 5 to 6 workers
BUT the last worker contributes to the average product by $18:6=3$
GAIN HIGHER THAN LOSS: AVERAGE PRODUCT INCREASES

-2 = loss in MP passing from 6 to 7 workers
BUT the last worker contributes to the average product by $16:7=2.28$

GAIN HIGHER THAN LOSS: AVERAGE PRODUCT **STILL** INCREASES

-4 = loss in MP passing from 7 to 8 workers AND the last worker contributes to the average product by $12:8=1.5$

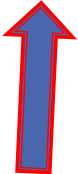
GAIN LOWER THAN LOSS: AVERAGE PRODUCT **ALSO STARTS DECREASING**



The maximum average product is between 7 and 8 units of labour.

1) Cost minimisation: costs

Once clarified how the output varies according to the quantity of inputs used, we introduce the cost of inputs in order to be able to calculate the total costs of production (which have to be minimized).

$$\Pi = (p * q) - (\textcircled{c} * q)$$


Costs in the short run

Before starting to consider the evolution of costs that derives from marginal and average products, it has to be specified that we are here talking about **opportunity costs**. The opportunity cost of a certain good / decision does not include only the amount of money needed, but is instead calculated in terms of everything I have to give up to if I decide to buy the good or to take the decision. This means that costs do not include only monetary payments, but also the «rewards» for inputs whose supply does not involve monetary transactions. For example, the return that the owners could have achieved had they invested their financial resources elsewhere (that the firms need to cover in order to remain in business).

In the light of this definition, **normal profits** are those covering all the **opportunity costs**, but nothing more. Any additional return over and above the normal profit is called **abnormal profit**.

Opportunity cost. Example 1

What is the total cost of studying at the university (5 years)?

- Fees:	$1,500\text{€} \times 5 = 7,500\text{€}$	} Monetary cost
- Books and material:	$600\text{€} \times 5 = 3,000\text{€}$	
- Transport	$300\text{€} \times 5 = 1,500\text{€}$	
- Board and lodging	$2,000\text{€} \times 5 = 10,000\text{€}$	
Total	$= 22,000\text{€}$	

Missed salary: 1,000€ per 60 months $= 60,000\text{€}$

Total opportunity cost $= 82,000\text{€}$

Opportunity cost. Example 2

Is monetary cost the main driver of your decisions?



Option 1:

A pizza out with your best friend
(shared bill).



Option 2:

A pizza out with the girl/boy you like
(same pizzeria, but you pay for her too).

Which one would you choose?

Opportunity cost. Example 2

Is monetary cost the main driver of your decisions?

If monetary cost were the main driver of your decisions, you would always choose option 1.

Reality is, that you will end choosing option 2.

Why? Are you irrational?

NO, you are taking your decisions according to the opportunity cost and not to the monetary costs.

It will «cost» you more to give up to the pizza with the person you like than to the meeting out with your best friend.

Opportunity cost. Example 3

Why are opportunity costs important for firms?

I own a company where I work as CEO, together with my partner, who is the General Director, in a building that I inherited from my parents. Occasionally my daughter comes to help as part time assistant. I also have two employees: a worker and a secretary.

Year 1

Total revenues:	150,000€
Total costs:	
Raw material =	50,000€
1 worker salary	20,000€
1 secretary salary	20,000€
No other monetary costs	
Total profit	60,000€

Opportunity cost. Example 3

Why are opportunity costs important for firms?



Year 2

Total revenues: 150,000€

Total costs:

Raw material =	50,000€
1 worker salary	20,000€
1 secretary salary	20,000€
1 CEO salary	80,000€
1 General Manager	80,000€
1 part time secretary	10,000€
Building rent	60,000€

Total loss 170,000€

Costs in the short run

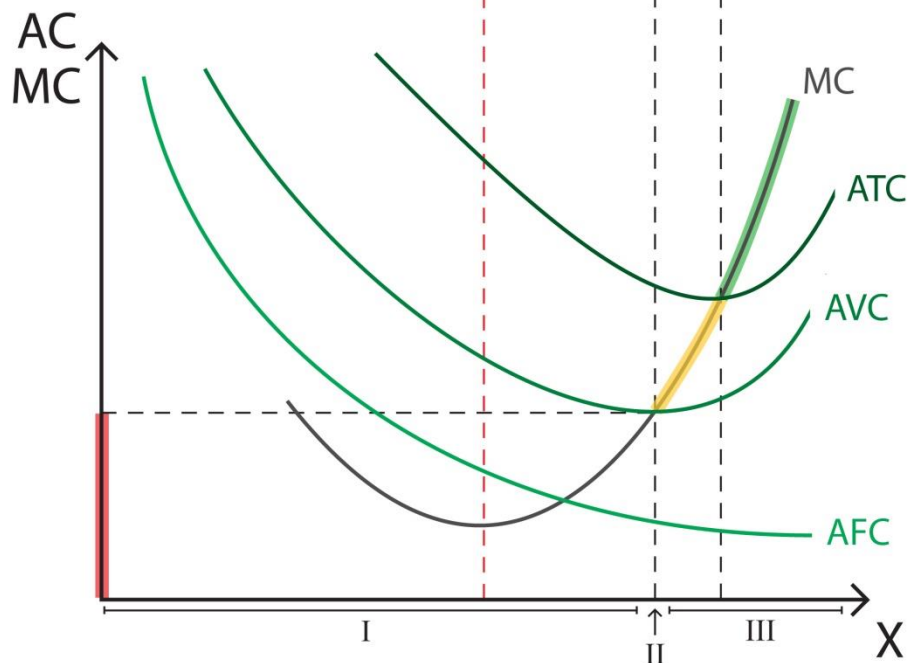
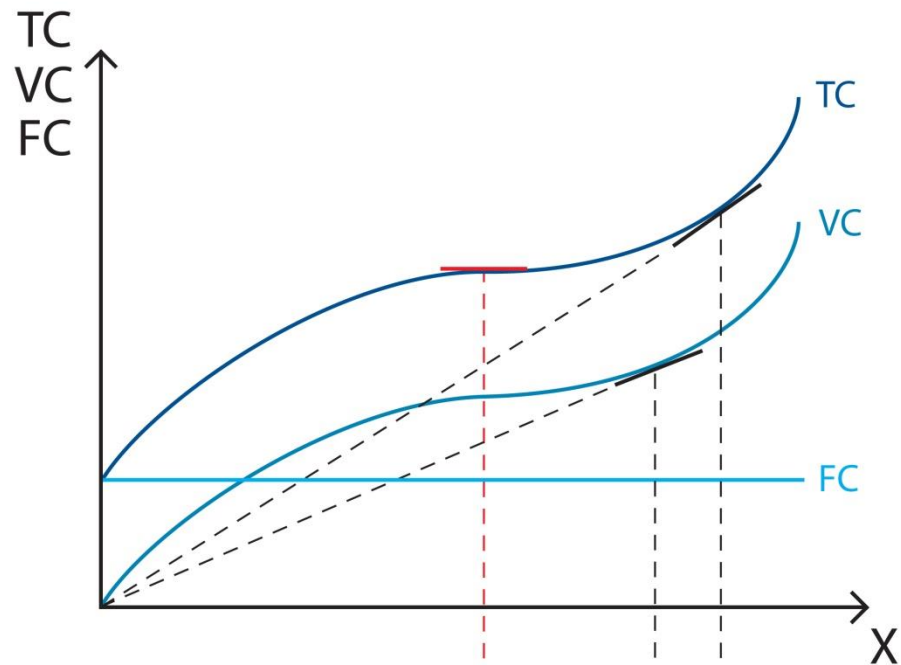
- ▶ **Total cost (TC):** cost incurred to produce a certain amount of output in a certain period of time.
 - **Fixed costs (FC):** costs that do not vary with the variation of the produced output
 - **Variable costs (C):** costs that vary according to the produced output

Average and marginal cost

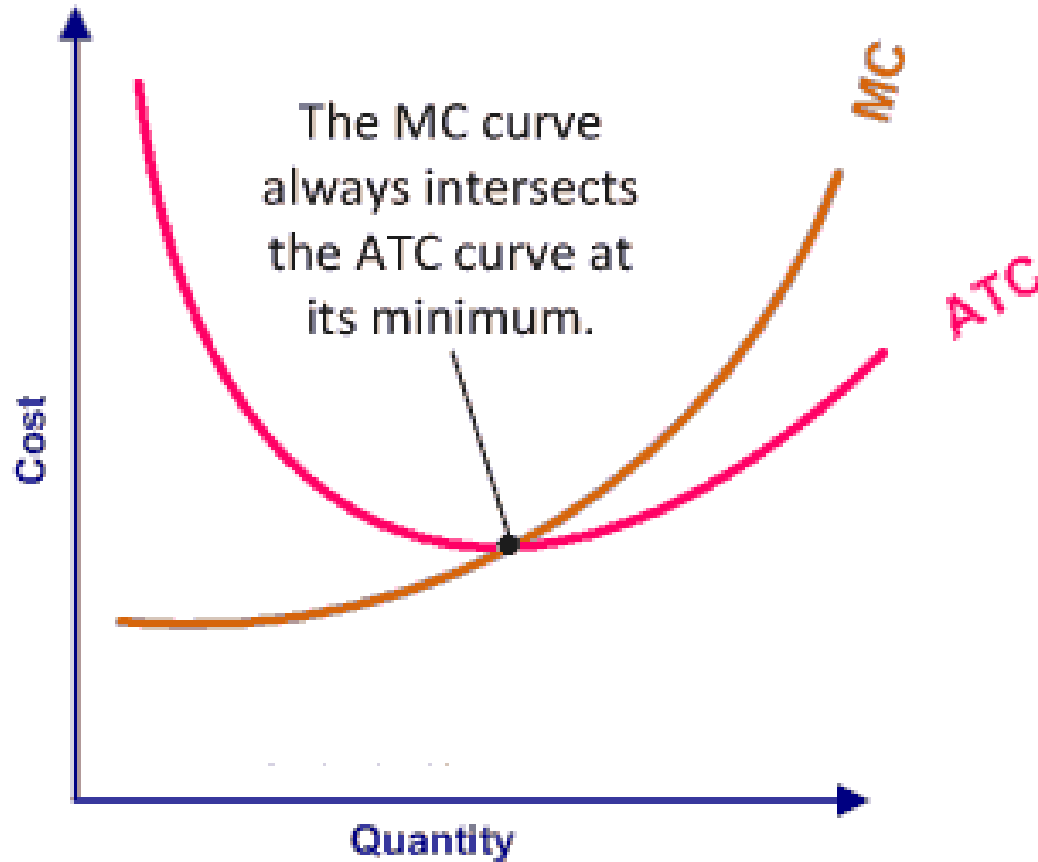
- ▶ **Average total cost (ATC)** = total cost to produce a certain amount of output per unit of output (*unit cost*). It can be divided in average fixed cost (AFC) and average variable cost (AVC)
- ▶ **Marginal Cost (MC)** = increase in costs deriving from the increase by one unit of output (*incremental cost*).

1	2	3	4	5	6	7 (col. 4 / col. 3)	8 (col. 5 / col. 3)	9 (col. 6 / col. 3) OR (col. 7 + col. 8)	10 (var. col. 6 / var. col. 3)
Inputs		Total out.	Total cost			Average Cost			MC
K	L		Fixed	Varia b.	Tot.	Fixed	Variab.	Tot.	
10	1	43	100	20	120	2.326 <i>(100/43)</i>	0.465 <i>(20/43)</i>	2.791	0.465 <i>(120-100)/(43-0)</i>
10	2	160	100	40	140	0.625 <i>(100/160)</i>	0.250 <i>(40/160)</i>	0.875	0.171 <i>(140-120)/(160-43)</i>
10	3	351	100	60	160	0.285	0.171	0.456	0.105
10	4	600	100	80	180	0.167	0.133	0.300	0.080
10	5	875	100	100	200	0.114	0.114	0.228	0.073
10	6	1152	100	120	220	0.087	0.104	0.191	0.072
10	7	1372	100	140	240	0.073	0.102	0.175	0.091
10	8	1536	100	160	260	0.065	0.104	0.169	0.122
10	9	1656	100	180	280	0.060	0.108	0.169	0.167
10	10	1750	100	200	300	0.057	0.114	0.171	0.213
10	11	1815	100	220	320	0.055	0.121	0.176	0.308
10	12	1860	100	240	340	0.054	0.129	0.183	0.444

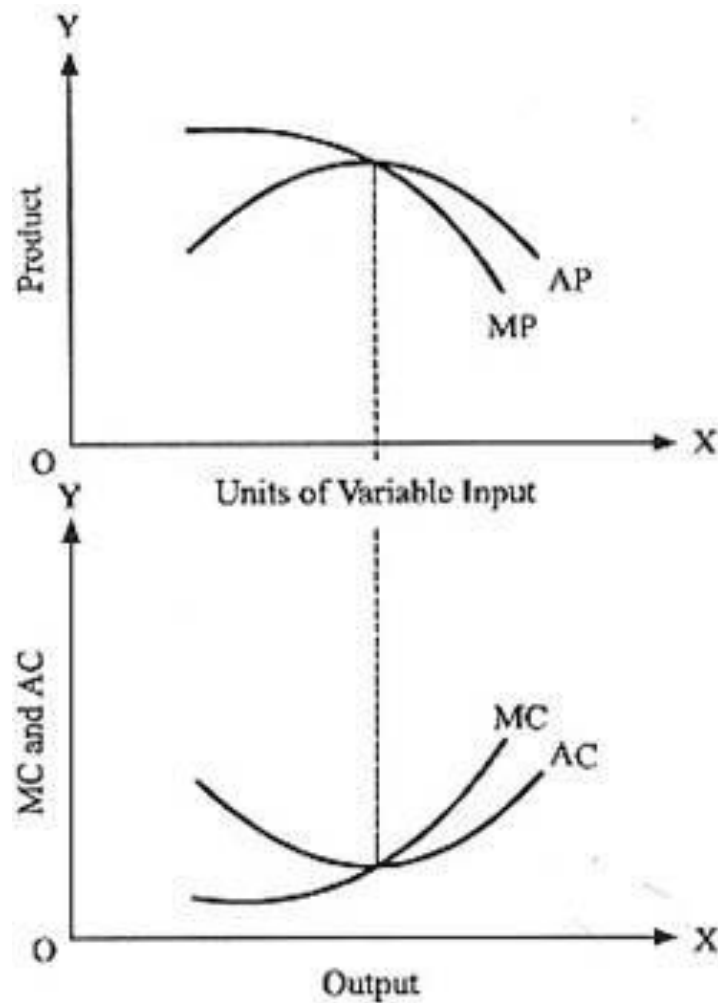
Total, average and marginal cost curves



The relation between marginal and average total cost curves



Relation between marginal and average product and marginal and average costs



Optimal productive capacity in the short run.

It is the level of production corresponding to the level of minimum short run average total cost.

N.B.: Therefore it is **NOT** the maximum quantity that it is possible to produce, but the production level that minimises costs.

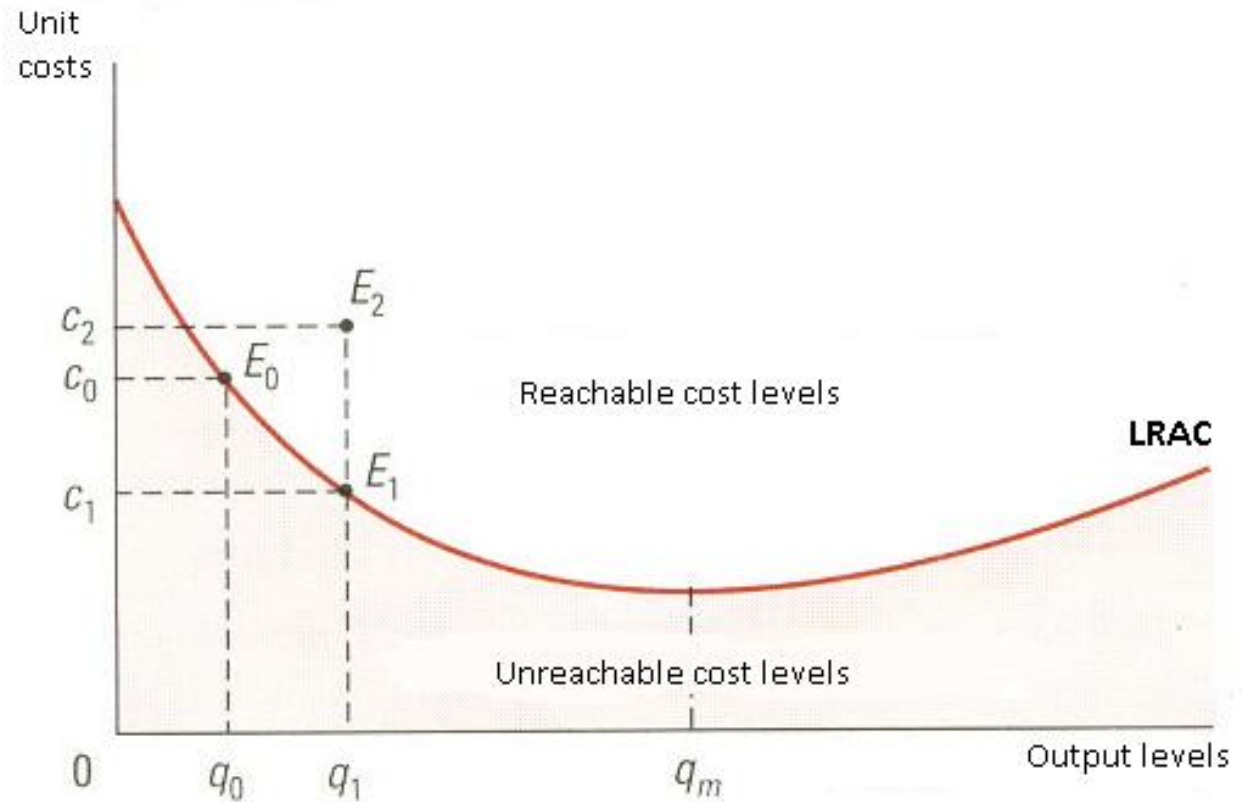
For each amount of the fixed factor there **are different short run cost curves**: the cost curve for a very small plant is of course very different from the cost curve of a large plant.

Production, costs and profit maximisation

The long run

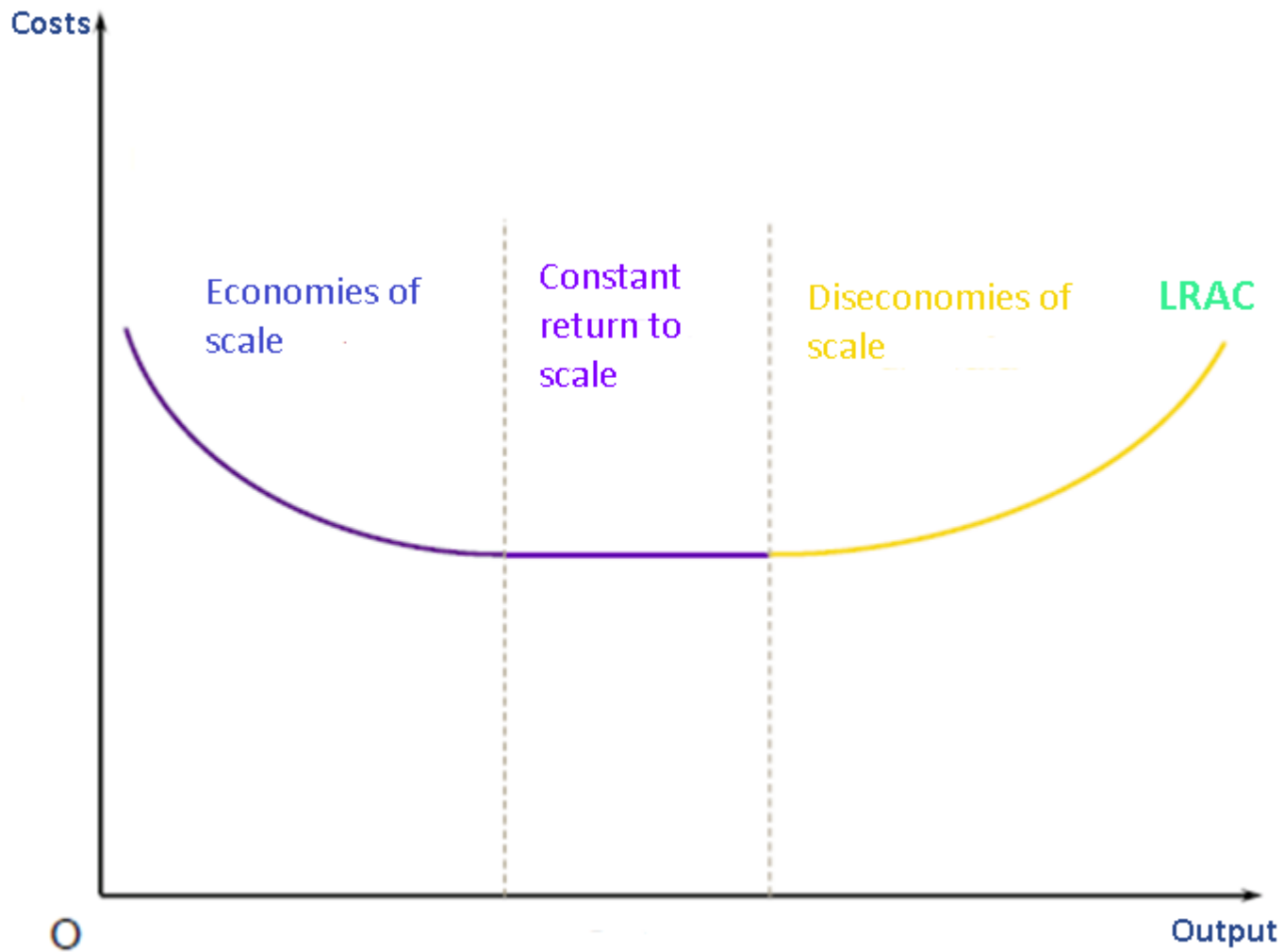
The long run average cost (LRAC) curve

All inputs are variable: it is possible to identify a production method minimising the long run average cost (LRAC).



N.B.

The long run average cost (LRAC) curve



The LRAC curve shape

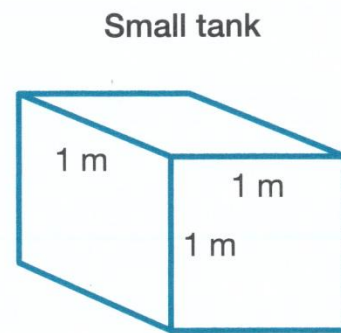
1. Decreasing costs: from 0 to q_m an increase in output causes a decrease in unit costs. The production increases more than proportionally than input costs $\Rightarrow$ **increasing returns to scale or ECONOMIES OF SCALE**
2. Constant costs: around q_m , output increases at the same pace of costs $\Rightarrow$ **CONSTANT RETURNS TO SCALE**
3. Increasing costs: from q_m onwards, output increases less proportionally than input costs $\Rightarrow$ **decreasing return to scale or DISECONOMIES OF SCALE**

Economies of scale typologies

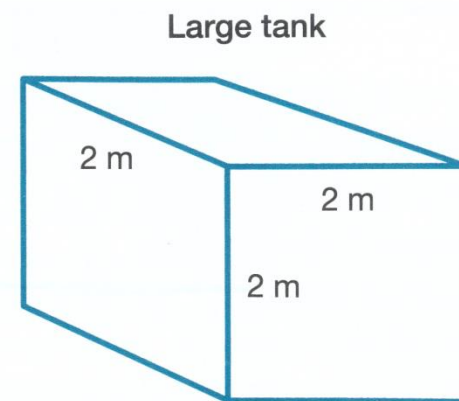
1. REAL: savings in average costs due to changes in the quantities of physical inputs
2. PECUNIARY: savings in average costs due to changes in the prices paid by the firm for inputs

1) Real economies of scale

1. **Input indivisibilities and *una tantum* costs:** economies are caused by the fact that there are inputs that are indivisible and do not depend from the produced quantity. Therefore their unit cost decreases if output increases because they are spread over a higher number of produced items. Ex. Advertisement or R&D.
2. **Geometric relations between inputs and outputs:** sometimes costs are proportional to surface but output is proportional to volume



Surface area = 6 m^2
Volume = 1 m^3



Surface area = 24 m^2
Volume = 8 m^3

1) Real economies of scale (cont.)

3. **Specialisation or division of labour:** individual workers can perform specialized tasks, with an increase in their knowledge and skills and in their productivity (learning economies). The time of production decreases, less time is wasted in switching from one task to another and it is easier to mechanise production. It is often associated to mass production techniques (fordism).

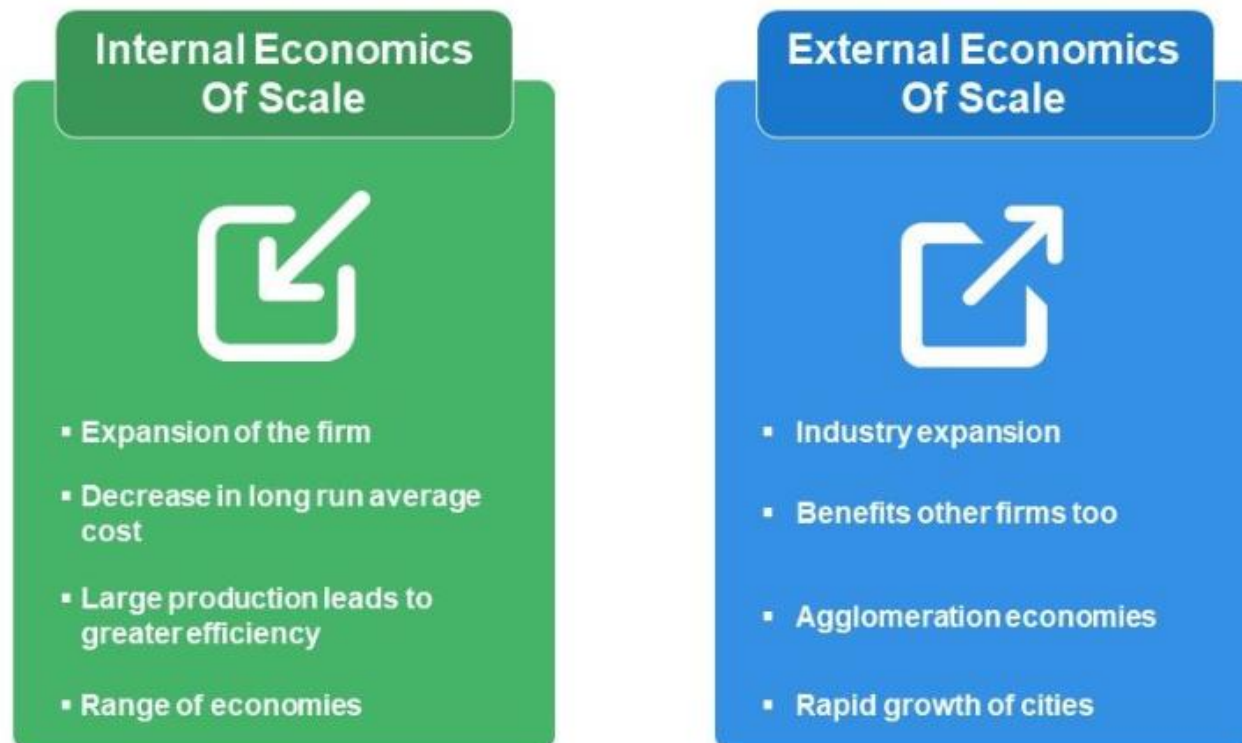
2) Pecuniary economies of scale

- 1) Large firms may find it easier than small firms to raise **finance**.
- 2) Large firms can buy **in bulk** (purchasing economies) and sell in bulk (marketing economies).
- 3) Large firms servicing a national market may be able to realise **transport economies**, by operating several plants producing and selling in different regions.

Internal and external economies of scale

INTERNAL: Originate from the decision of the firm to increase the scale of production.

EXTERNAL: the arise as a consequence of the expansion of the industry as a whole, not of the single industry (ex. availability of specialised labour, of support services, of specialised funding, etc.).



Consequences of scale economies

The presence of economies of scale in an industrial sector induces a **concentration** of production in the hands of a few, large producers.

Once the product is affirmed on the market, in fact, the average costs decrease and small competitors find it more and more difficult to enter the market at the same cost levels.

Economies of scale measurement: the minimum efficient scale (MES)

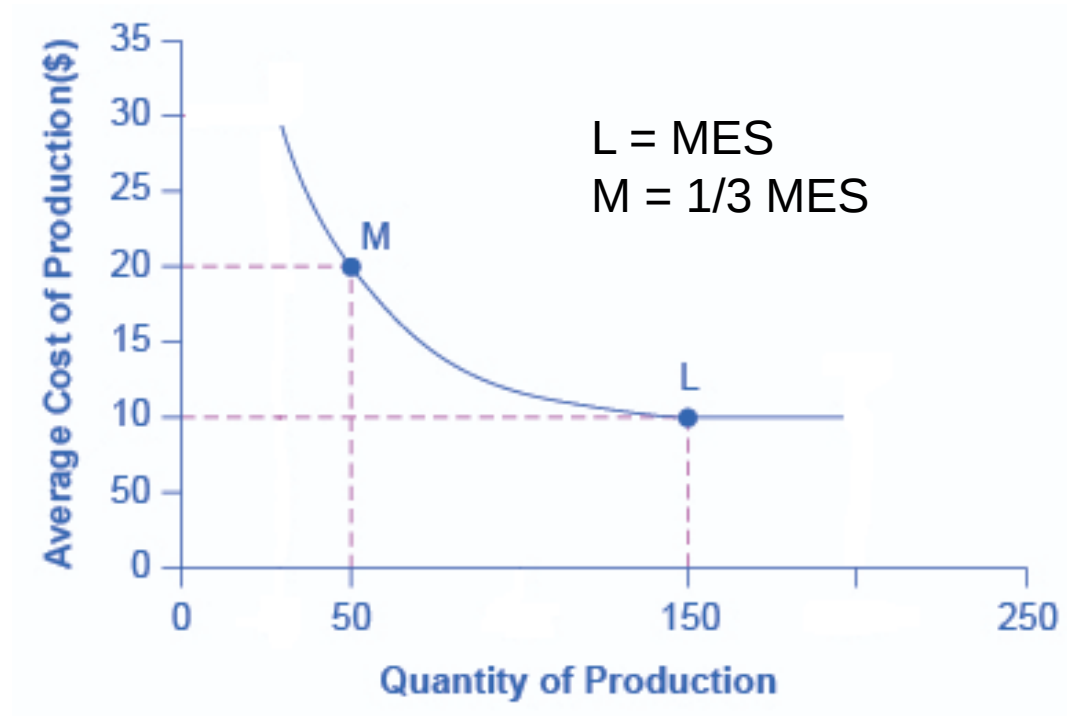
Economists have tried to measure the **MINIMUM EFFICIENT SCALE (MES) OF PRODUCTION**, i.e. the quantity of output that minimises the long run average cost.

The used measure is the **economies of scale index**, representing the exceeding average cost of a firm producing one third of the minimum efficient scale.

Sector	MES of plants as % of the US demand	% increase in unit cost at 1/3 of MES
Beer	3.4%	5.0%
Cigarettes	6.6%	2.2%
Textiles	0.2%	7.6%
Oil refineries	1.9%	4.8%
Shoes	0.2%	1.5%
Glass bottles	1.5%	11.0%
Cement	1.7%	26.0%
Steel	2.6%	11.0%
Bearings	1.4%	8.0%
Refrigerators	14.1%	6.5%
Accumulators	1.9%	4.6%

Source: Scherer F.M. et al. (1975), *The Economics of Multi-Plant Operation: An International Comparisons Study*, Harvard University Press

Economies of scale index (example)



Economies of scale index:

$$20 - 10 = 10$$

$$(20-10)/10 \times 100 = \mathbf{100\%}$$

Why are economies of scale not always fully exploited?

- Product differentiation



Customers sometimes prefer to pay more for a more differentiated product

- Flexibility



In some cases flexible labour and machinery, even if not highly specialised, can more easily adjust to external changes

- Motivation and coordination problems



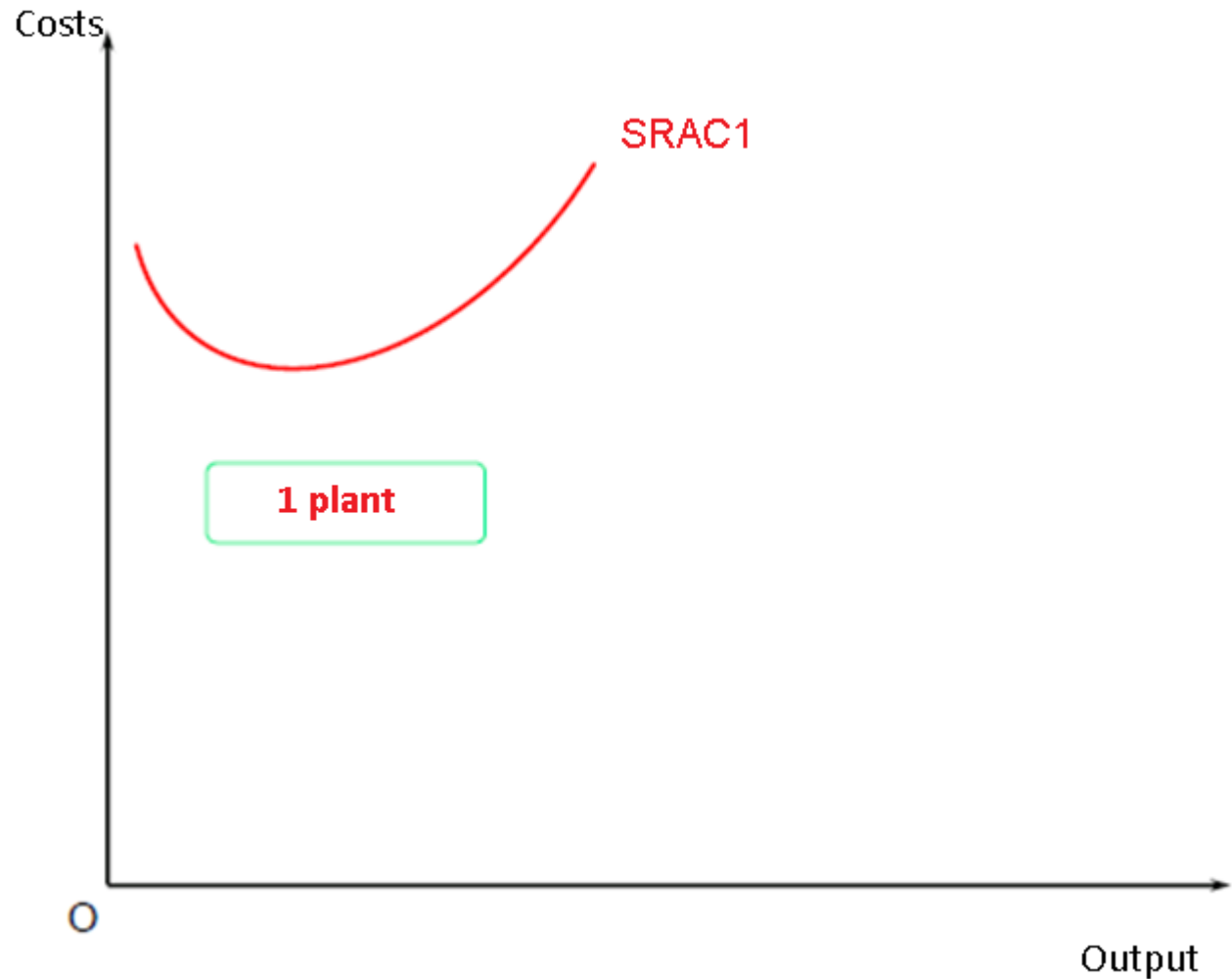
Large companies can be more difficult to manage than smaller ones (diseconomies of scale).

Diseconomies of scale

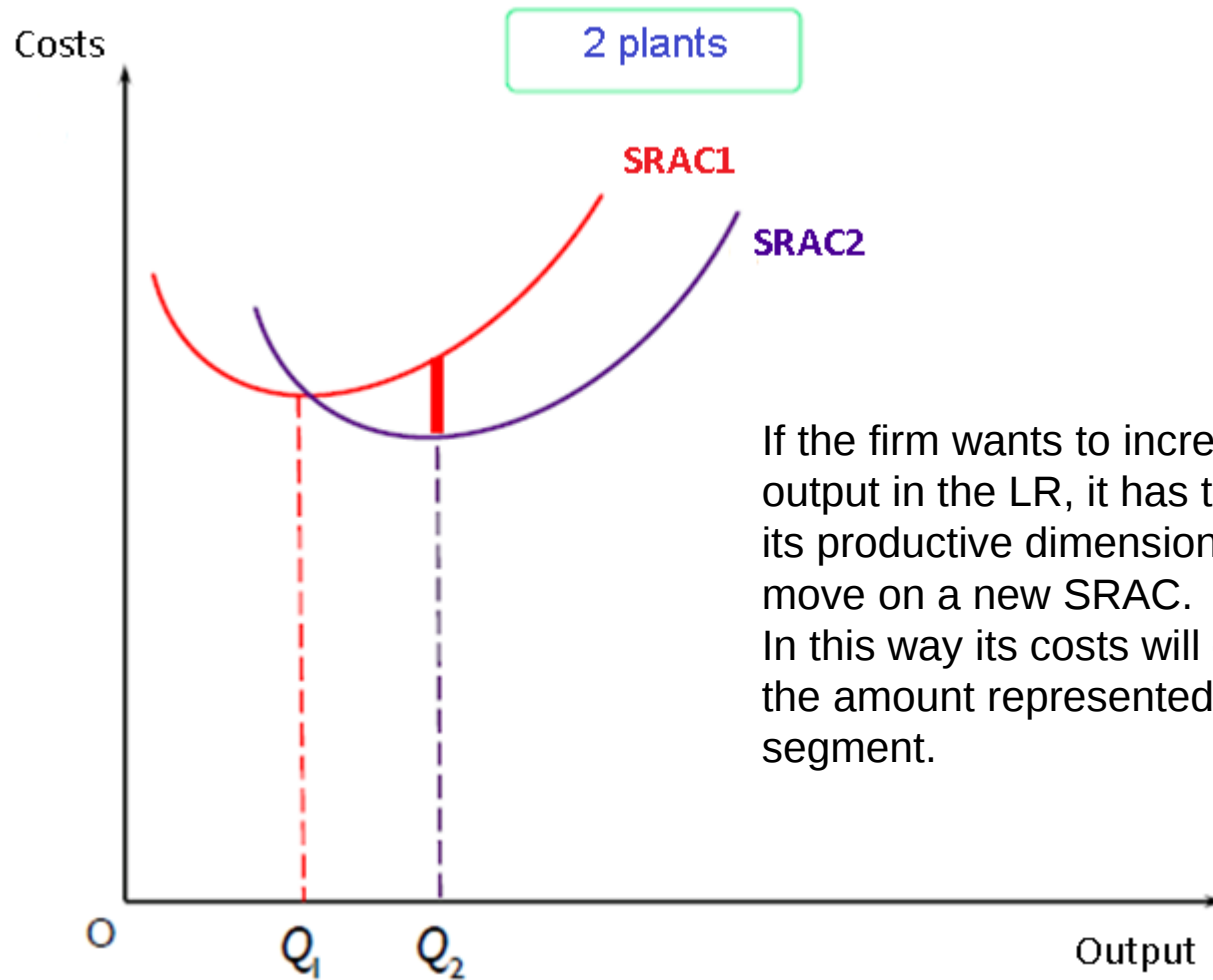
When the firm grows too much, diseconomies of scale arise. They are mainly **managerial diseconomies**:

- Difficult communication between different parts of the organisation;
- Complex organisational structures, with possibility to increase communication distortions;
- Un-personalisation of work;
- Complex relations between workforce and management

The relation between short run and long run average cost curves

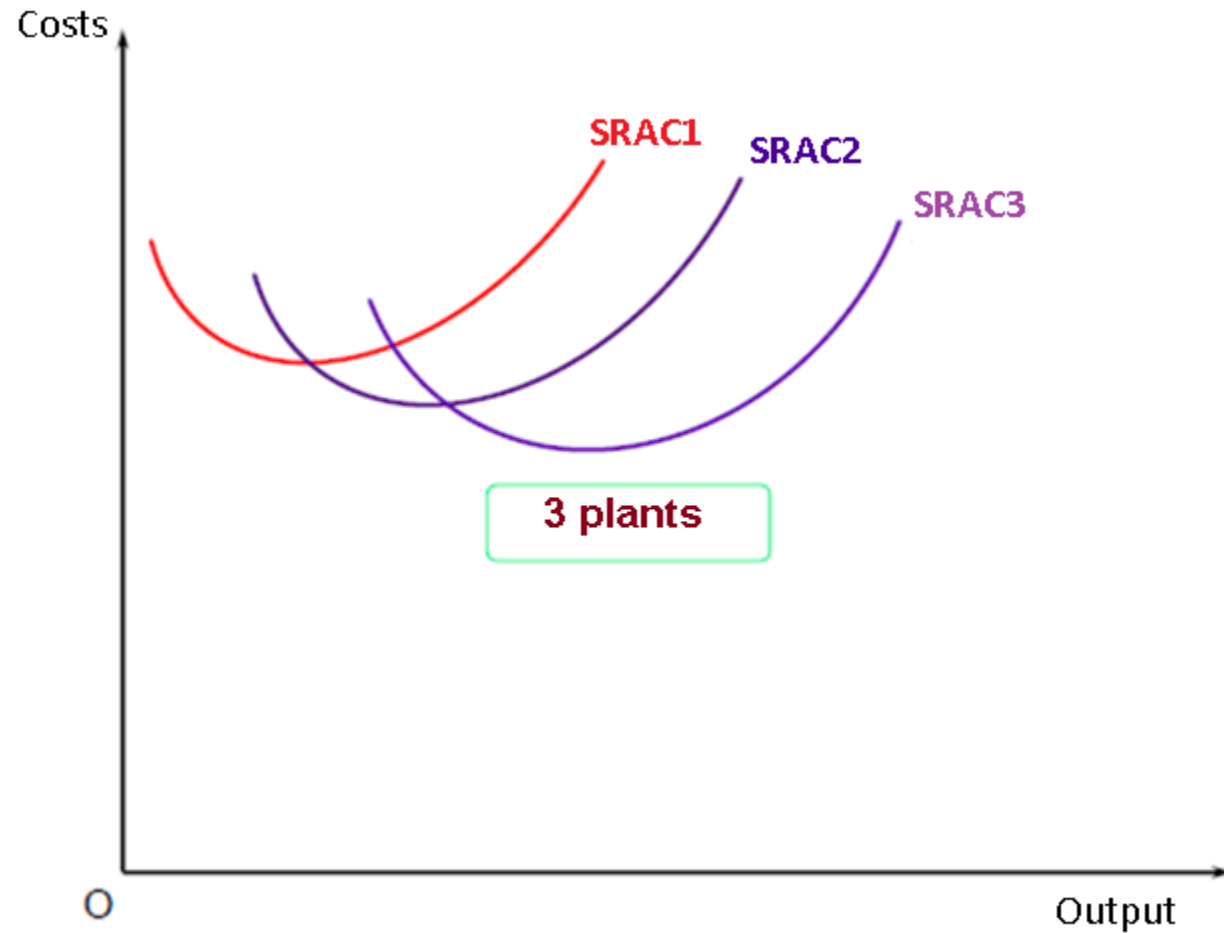


The relation between short run and long run average cost curves

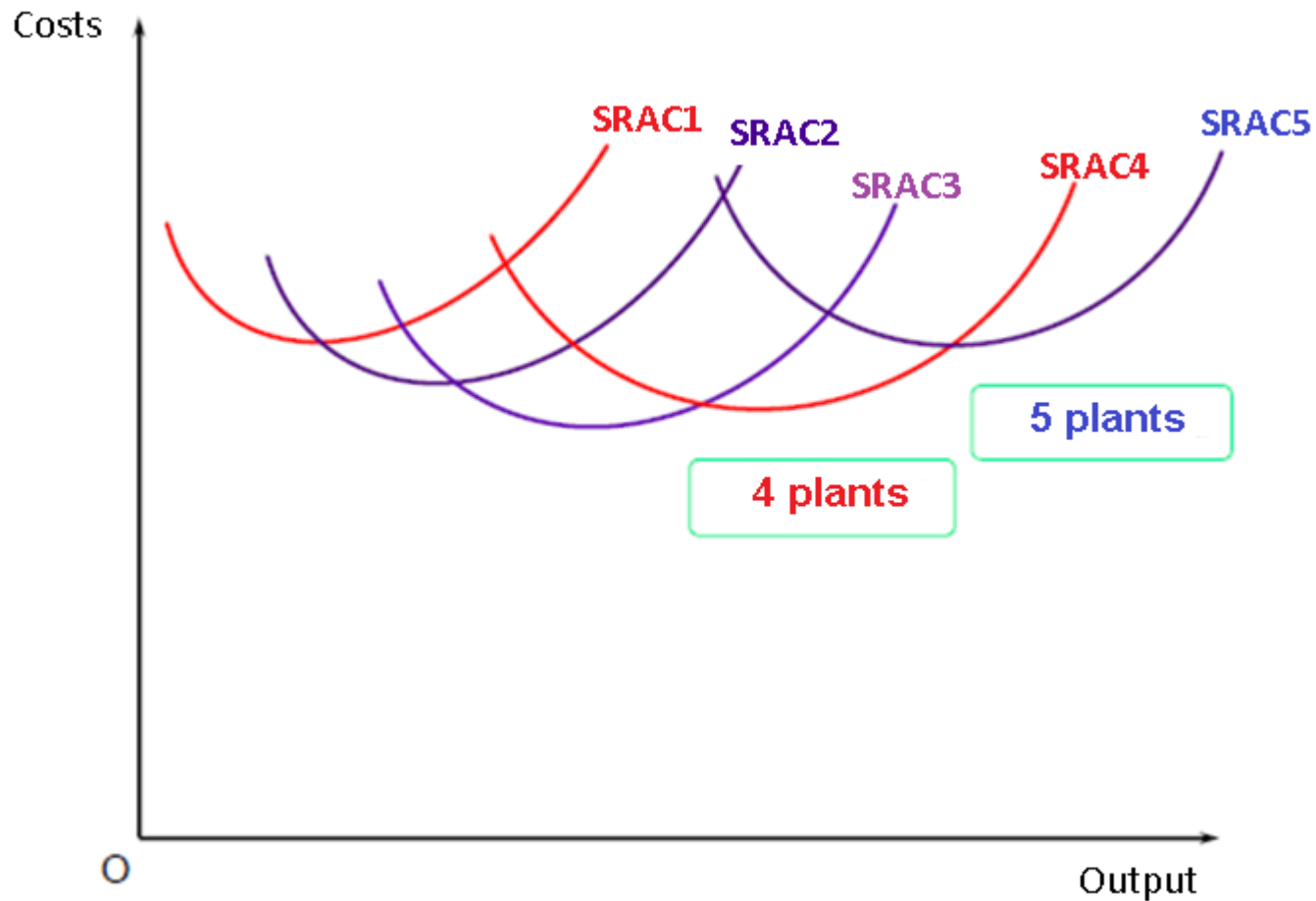


If the firm wants to increase its output in the LR, it has to increase its productive dimension and to move on a new SRAC. In this way its costs will decrease of the amount represented by the red segment.

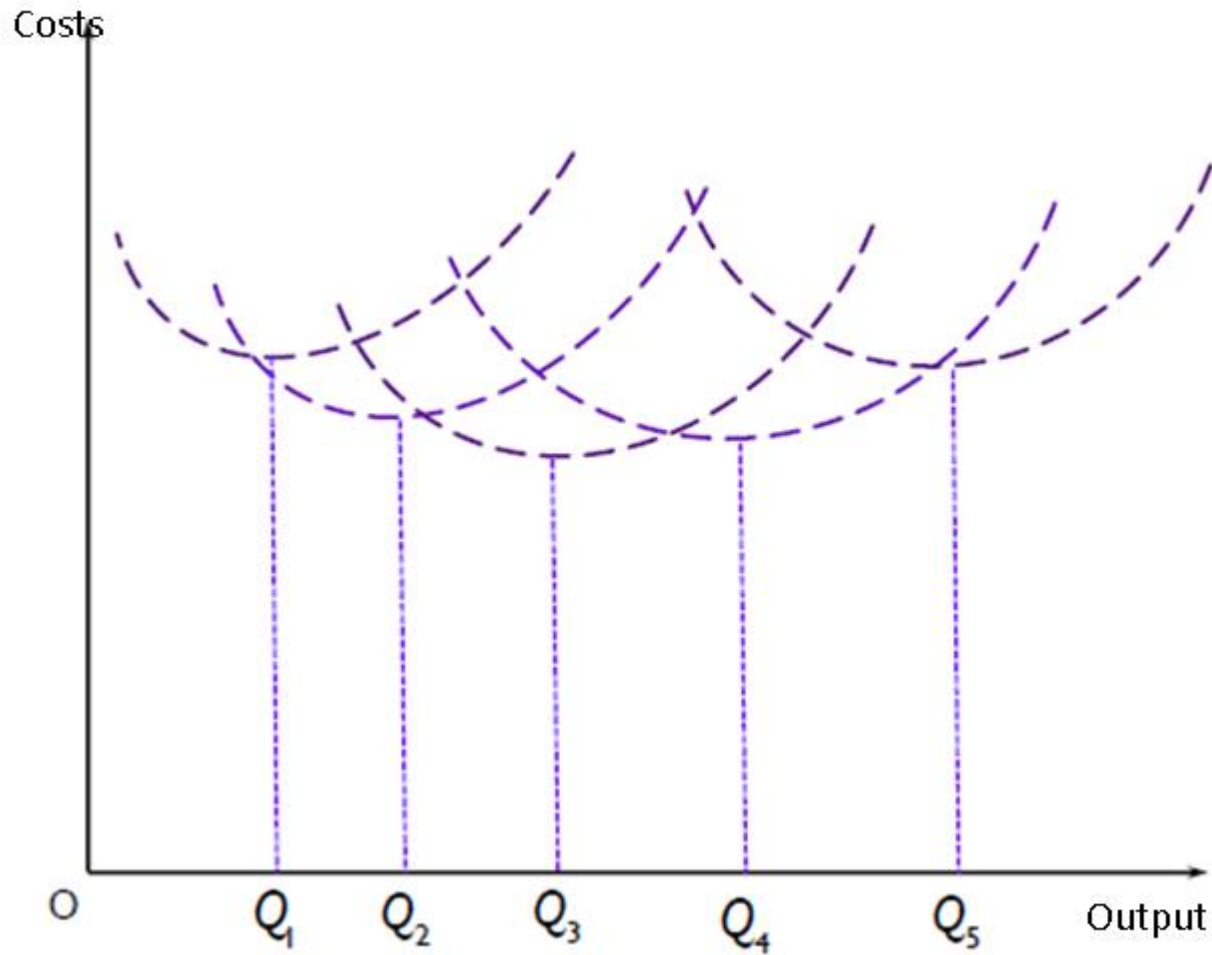
The relation between short run and long run average cost curves



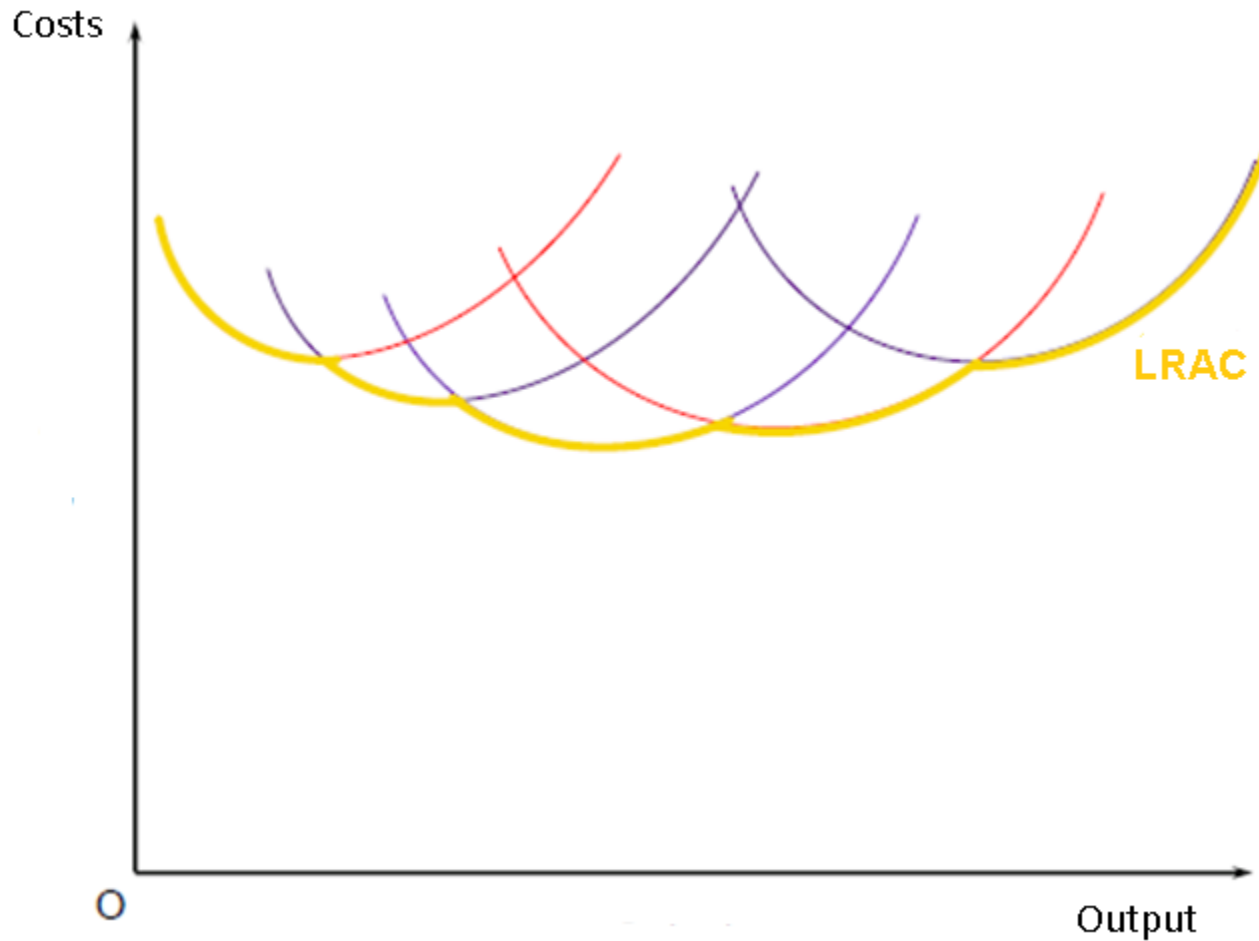
The relation between short run and long run average cost curves

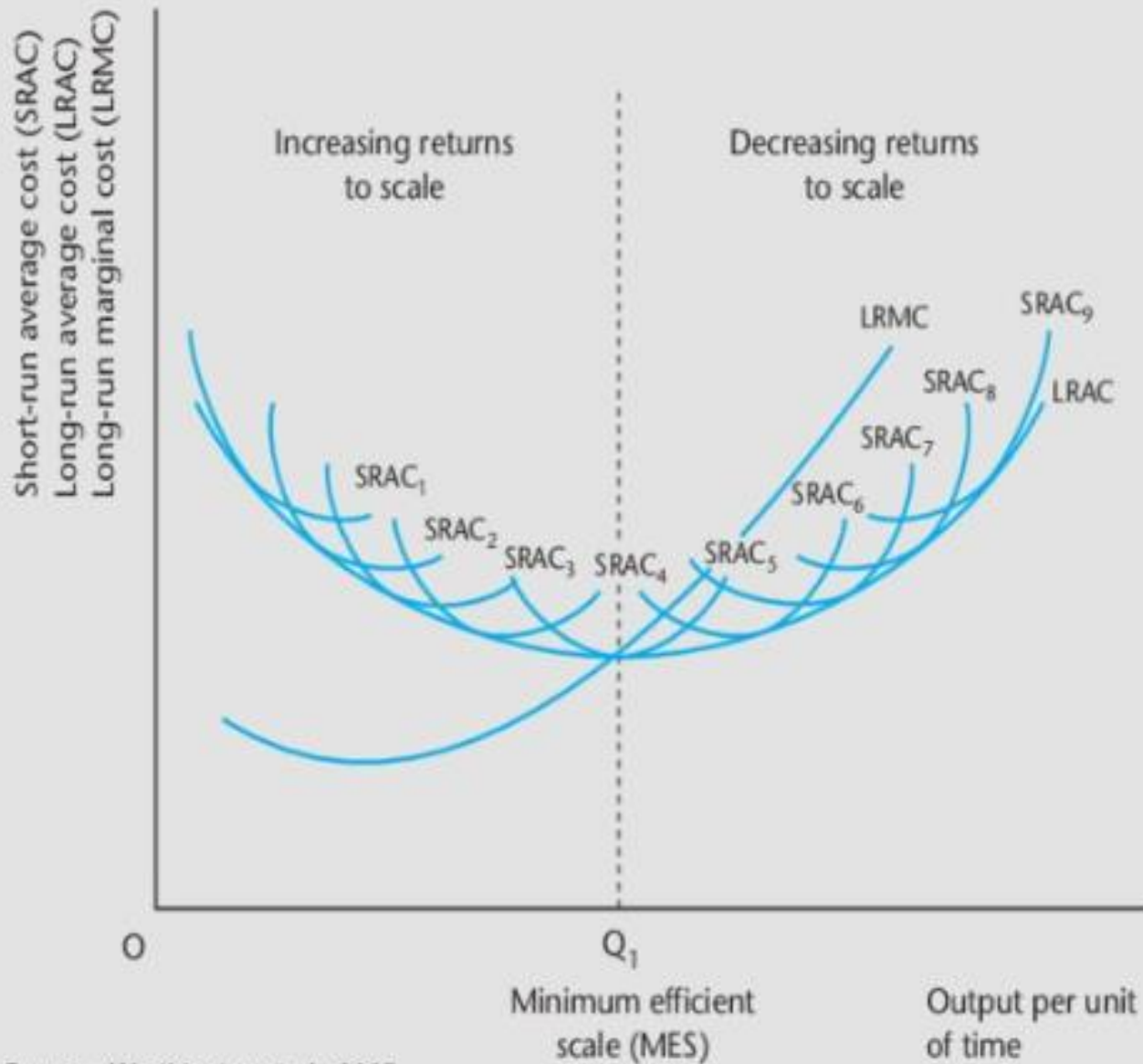


The relation between short run and long run average cost curves



The relation between short run and long run average cost curves





Source : Worthington et al., 2005

Profit maximisation: revenues

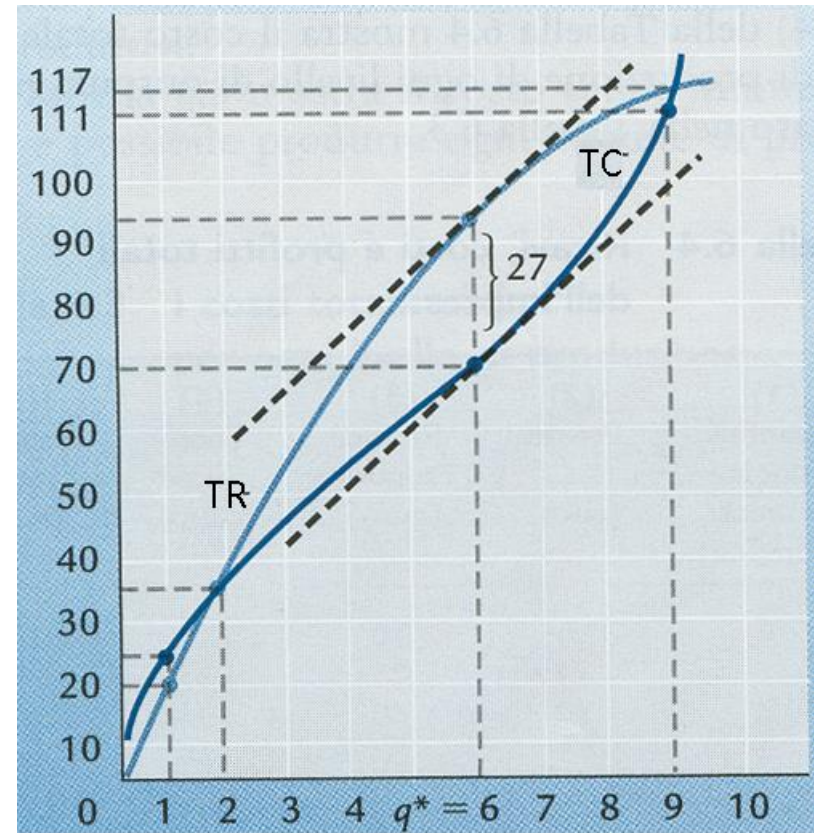
To identify the optimal quantity that should be produced in order to minimize costs is not enough, because we also need to take **demand** into consideration.

This means to introduce revenues:

$$\Pi = (p*q) - (c*q)$$

What quantity maximises profits? The total profit approach

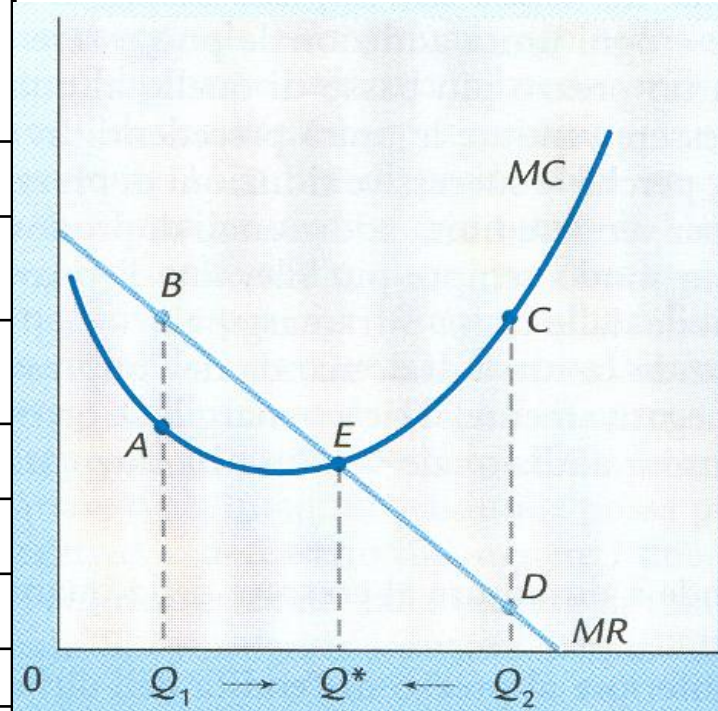
Out put	Total costs (TC)	Total revenues (TR)	Total profit (TR-TC)
0	10	0	-10
1	25	21	-4
2	36	40	4
3	44	57	13
4	51	72	21
5	59	85	26
6	69	96	27
7	81	105	24
8	95	112	17
9	111	117	6
10	129	120	-9



What quantity maximises profits?

The marginal cost/marginal revenue approach

Out put	Total costs (TC)	Total revenues (TR)	Marginal revenue (MR= Δ TR)	Marginal costs (MC= Δ TC)	Marg. Profit (MR-MC)	Firm's choice
0	10	0	0	0	0	↑
1	25	21	21 (21-0)	15 (25-10)	6 (21-15)	↑
2	36	40	19 (40-21)	11 (36-25)	8 (19-11)	↑
3	44	57	17	8	9	↑
4	51	72	15	7	8	↑
5	59	85	13	8	5	↑
6	69	96	11	10	1	
7	81	105	9	12	-3	↓
8	95	112	7	14	-7	↓
9	111	117	5	16	-11	↓
10	129	120	3	18	-15	↓



MAX PROFIT
CONDITION

$$MR=MC$$

N.B.

Summary

- ▶ The short run:
 - Production function
 - Law of diminishing returns
 - Average production and marginal product
 - Costs
- The long run
 - LRAC
 - Economies of scale (real and pecuniary, internal and external; measurement)
 - Diseconomies of scale
 - Relation between short and long run curves
 - Profit maximisation

Reading list

- Chapter 2 – Lipczynski et al., 2013