

Theory of Firms

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- 1 Firm behavior
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- 3 Costs
- 4 Revenues and demand
- 5 Profit maximization problem

The principal interests of this lecture

- What is the goal of the firm?
- How do firms make decisions?
- What is a production function, marginal product, fixed and variable costs, marginal costs and marginal revenue?
- What is a perfectly competitive market and what is imperfect competition?
- What is the link to the demand function?
- How the firm determines its supply function?

The goal of the firm

- The producers of the goods and services are called firms (to distinguish the specific production units and their behavior)
- The business operation of the firm is the transformation of (typically multiple) *inputs* into (one or more) *outputs*.
 - The formal description of this transformation is called *the production function*
 - This transformation faces economic constraints - there are *costs* of production
 - The firm sells its production - it has to be aware of the demand in order to calculate its *revenues*
- The goal of the firm is to *maximize profits* (profit = total revenues - total costs, $\Pi = TR - TC$)
 - Can you provide the reason why?

Firm's profit maximization problem

- In general, the firm aims to maximize profits $\Pi = TR - TC$
 - the solution to the problem is found by setting the optimal Q (since $\Pi(Q) = TR(Q) - TC(Q)$)
 - the optimal Q can be produced using various combinations of inputs (typically, K and L) (i.e. $Q(K, L)$), hence the firm can find the solution by setting optimal K and L (i.e. $\Pi(Q(K, L)) = TR(Q(K, L)) - TC(Q(K, L))$)
 - alternative method is to formulate *the cost minimization problem* to produce a given quantity \bar{Q}

The production function

- The production function ($Q = f(F_1, F_2, \dots, F_N)$) describes the technological process of the transformation of inputs to outputs.
- The typical production factors (F) considered in the production of the firm are: capital (K) and labor (L).
 - $Q = f(K, L)$

Short run and long run

- Due to the technological limitations, it is usually time consuming to change the amount of capital used in production.
- This assumption is reflected in the distinction between the short run and the long run
 - in the short run, we consider some of the production factors (typically capital (K)) as fixed and only some as variable (typically labor (L))
 - i.e. $Q = f(\bar{K}, L)$, or for the sake of simple notation $Q = f(L)$
 - in the long run, we consider *all* the production factors as *variable*

Marginal product

- The marginal product of factor F_i ($MP_{F_i} = \frac{\partial Q}{\partial F_i}$; note it also shows the slope of the production function!) is the increase in output caused by the additional unit of the input (while other inputs remain constant)
- The marginal product is not constant, but is (typically) *diminishing*
 - In contrast, if you hire additional worker, or buy additional machine, the costs of the additional unit are often the same as with the previous unit
 - You can compare the marginal benefit (the increase in production) with the marginal costs (the increase in costs) to determine whether or not you want to add the additional unit of the input.
- Try to provide an example.

Figure : Production function in the long run

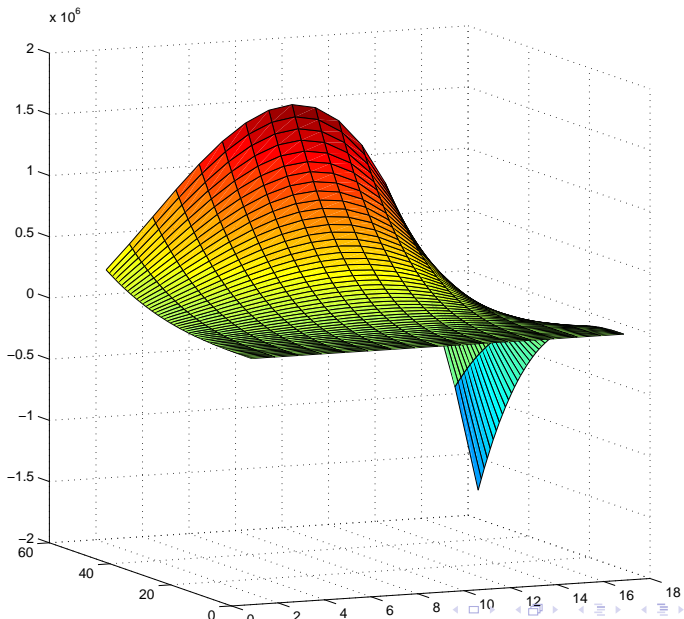


Figure : Production function in the short run

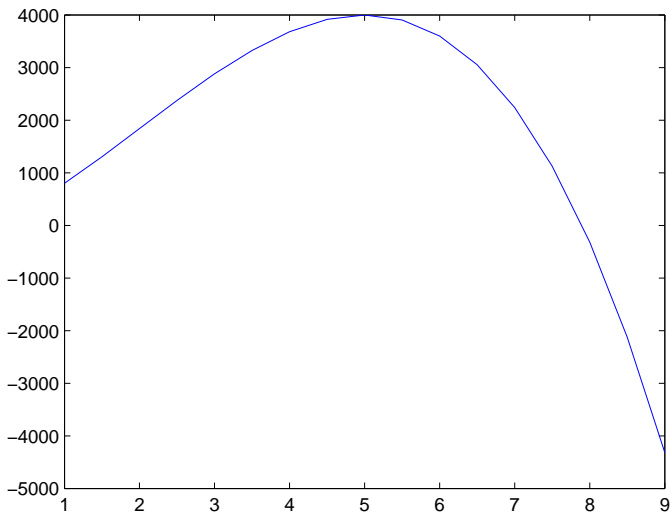
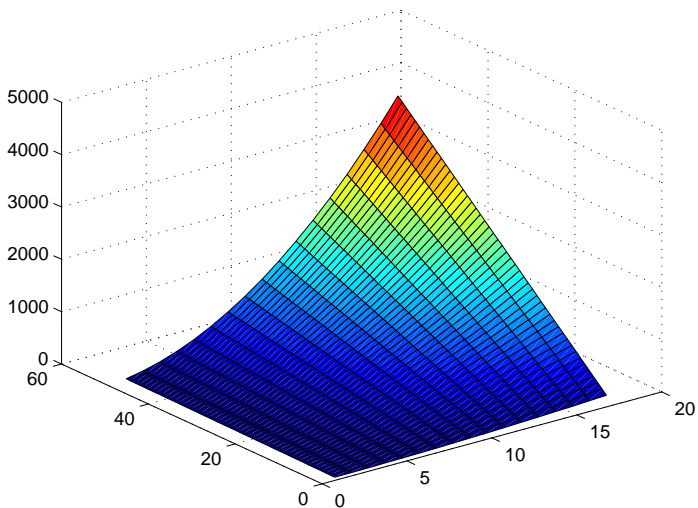


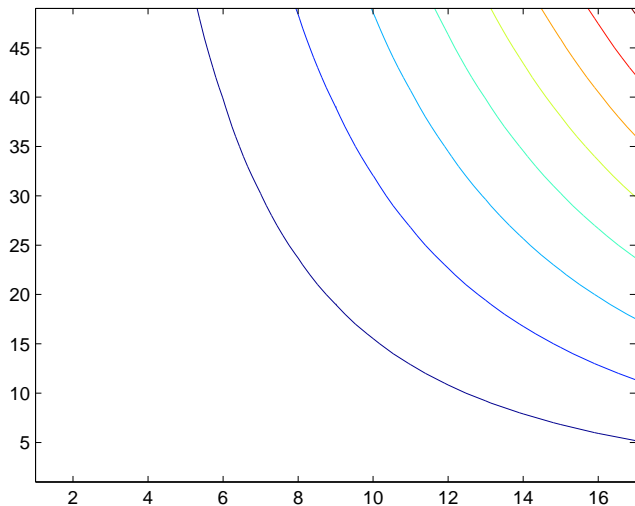
Figure : Production function in the long run, no diminishing returns
(non-decreasing function)



Isoquants

- *Isoquants* are the contour lines of the production function.
- Isoquants represent all points, where the various combinations of amounts of inputs (K and L) lead to the same values of the production function.
 - they show the one given level of output that can be produced using various combinations of inputs
 - In a similar fashion as *the indifference curves*, the *isoquants* are the 2-D representation of the 3-D figure
 - the slope of an isoquant is called *the marginal rate of technical substitution* - it shows the ratio in which we can substitute the production factors while keeping the output constant

Figure : Isoquants of the production function in the long run, no diminishing returns (non-decreasing function)



Costs

- In order to produce something, the firm has to pay for the inputs.
- We need to consider both *implicit* and *explicit* costs
- Explicit costs: everything that will show up in the accounting (e.g. the electricity bill, the wages of hired workers)
- Implicit costs: the opportunity costs (the value of foregone alternative use of resources)

Illustration:

you want to buy a machine, the price of the machine is \$10,000, you can both lend or borrow money, with the fixed interest rate 3%.

- you can take a loan for \$10,000 and pay 3% interest to the bank → explicit cost = \$300
- you can take your own \$10,000 and pay 0% interest to the bank → explicit cost = \$0
 - But you could have lent the \$10,000 to someone else and collect the 3% interest!
 - By using your own money your foregone interest is \$300 = implicit costs

Accounting profit vs. economic profit

- Accounting can only record actual events, not the alternate foregone opportunities.
- BUT economic costs are not meaningless → they influence the decisions! (it would not be rational / economical to pursue a certain activity, if there exists a more profitable alternative)
- Accounting profit = total revenue minus total *explicit* costs
- Economic profit = total revenue minus (total *explicit and total implicit* costs)

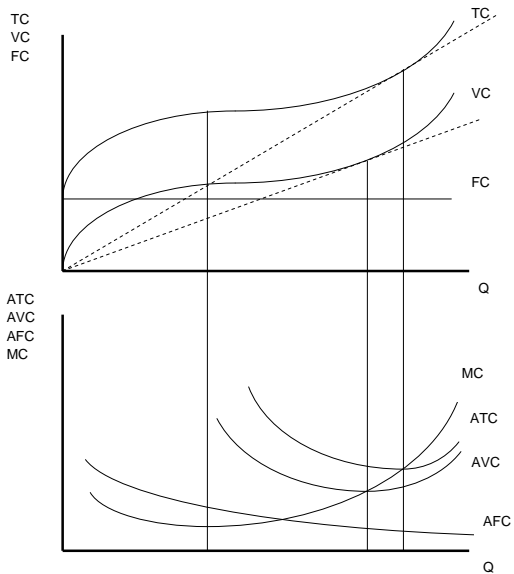
Fixed costs vs. variable costs

- We have already differentiated between the short run and the long run.
- This distinction implies that in the short run, we can not change the quantity of some production factors
 - BUT we still have to pay for them
 - these costs are *fixed* by the inability to change the amount of certain production factors in the short run
- If we can change the quantity of the inputs we include into the production, we are dealing with the *variable* costs
- In the short run, there are fixed costs (typically the cost of capital) and variable costs (cost of labor)
- In the long run, all inputs and hence all costs are *variable*

Marginal costs

- The marginal costs ($MC = \frac{\partial TC}{\partial Q}$; note it also shows the slope of the function of total costs!): the change in total costs caused by producing the additional unit of the output
- The marginal costs are not constant, but are (typically) *increasing* (due to the diminishing returns of the production function!).

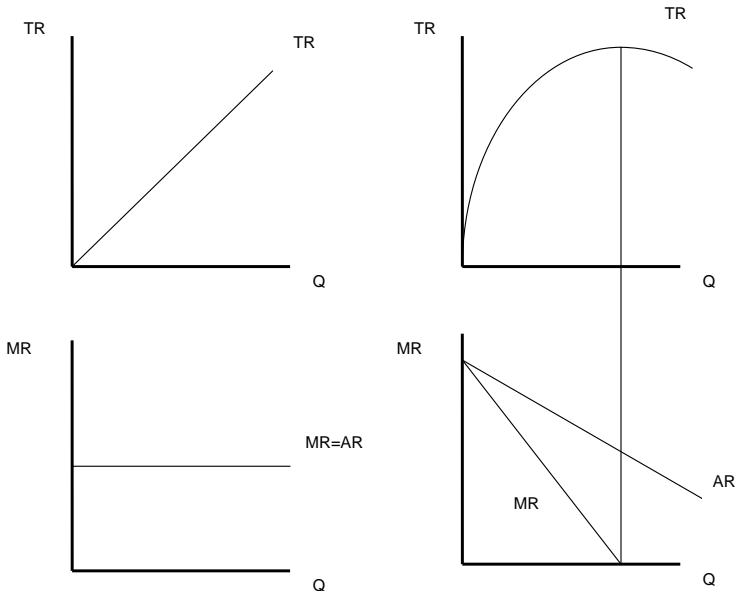
Figure : Total and marginal costs



Revenues

- Firms generate revenues by selling their output, i.e. $TR = p \cdot Q(K, L)$
 - we have seen the firm is able to influence the quantity of the product it produces by using various amounts of inputs
- Depending on the market structure (influencing the demand for their products), they either take the price from the market (p is constant), or they are able to influence the market price by changing the quantity produced (p is a function of Q)
 - perfect competition: $TR = p \cdot Q(K, L)$
 - imperfect competition: $TR = p(Q(K, L)) \cdot Q(K, L)$

Figure : Total, marginal and average revenue



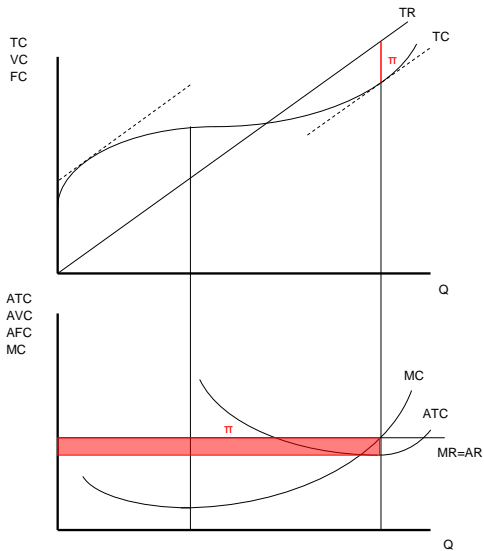
Marginal revenue

- The marginal revenue ($MR = \frac{\partial TR}{\partial Q}$; note it also shows the slope of the function of total revenues) is the change in the total revenue caused by producing the additional unit of the output.
- The demand function is different in perfect competition and in imperfect competition: the demand function shows the quantity demanded for the given price
- The perfectly competitive firm can sell as many units as it can produce for the market price
 - The demand function is a horizontal line, $AR=MR$
- The imperfect competitive firm: in order to sell more units of Q , it has to lower the price on *all* units \rightarrow it faces downward sloping demand
 - It has downward sloping marginal revenues

Profit maximization problem

- To maximize the profits $\Pi = TR - TC$, the firm will set the quantity produced so that
$$\frac{\partial \Pi}{\partial Q} = \frac{\partial TR}{\partial Q} - \frac{\partial TC}{\partial Q} = 0 \rightarrow MR - MC = 0 \rightarrow MR = MC$$
- In other words, the firm will produce additional unit of production, as long as the marginal revenue of this additional unit is larger or equal to what this additional unit costs.
 - Holds true for both perfectly and imperfectly competitive firms.

Figure : Total and marginal revenues



Supply function

- The supply function of the firm is the upward sloping part of the MC curve above the AVC (or ATC in the long run)
 - The profit maximization problem explains the supply of the firm - a firm will supply as long as the last unit of the product that is still profitable
 - In the short run (with existence of fixed costs), a firm might choose to produce, even if the production ends in red numbers (in loss)
 - The alternative option is to produce nothing, yet still pay fixed costs
 - If a firm covers at least variable costs for producing given amount of product, it will engage in production