ECON 1101-58 Fall 2004
ADDITIONAL NOTES #3

FIRMS

I hope we all remember what is a firm: it is something that takes inputs and transforms them into the outputs according to some process, which is described by Production Possibility Frontier. Now we put the firm into the bigger model: remember our flow diagram. In whatever follows we suppose for simplicity that the firm is producing *one output*. This assumption does not really harm the generality of the model since the firm that produces several outputs can be viewed as bunch of one-output firms.

Consider the market for the good that is produced by the firm (firms). Consumers generate aggregate demand on this market, which is given by aggregate demand curve. We assume that the firms cannot influence aggregate demand in any way and have to take it as given. We also abstract from exact models of factor markets (or markets for inputs) and assume that they just give us fixed input prices, which the firms take as given. The firm buys inputs on the factor markets and pays these fixed prices per unit of each input. Then, the firm chooses the amount of output to produce. This amount should be feasible in the sense that it should be on the PPF, which corresponds to the input bundle the firm has chosen. Afterwards, the firm gets the revenue from selling output to the consumers.

So the firm gets

$$\textit{TOTAL PROFIT} = \textit{TOTAL REVENUE} - \textit{TOTAL COST}$$

We assume that the goal of the firm is to maximize Total Profit. This means that, given the information about all the factor markets, output market and its own PPFs, the firm tries to choose how much inputs to buy and how much output to produce in order to maximize Total Profit. However before we get to the question of how this maximization happens we should describe the components of Total Profit in more detail

TOTAL REVENUE

The firm sells the output it produces on the market. Therefore, we can write Total Revenue as

$$\mathrm{TR}(Q_{\text{out}}) = P_{\text{out}} \cdot Q_{\text{out}}$$

This looks easy, however there is a problem here: what is P_{out}? Indeed, as I said above the firm cannot influence the demand side of the market, which is aggregate demand curve formed by the consumers. Therefore, firm cannot just choose Q_{out} and P_{out} as it desires. If it chooses P_{out} then the market will decide what is firm's Q_{out} and vice versa. From now on assume that firm only chooses Q_{out} and P_{out} is determined by the market.

The value of P_{out} depends on demand and many other things among which are the following:

- Aggregate Demand
- Number of firms on the market:
  - One firm (monopoly)

    When there is only one firm on the market it has complete power in choosing among available combinations of Q_{out} and P_{out} determined by the Aggregate Demand. For each possible level of Q_{out} the firm (monopolist) knows exactly the price at which this amount of the good can be realized. This is given by the Aggregate Demand equation.
  - Several firms (oligopoly)

    With several firms on the markets (by several I mean 5, 6 something like that) the price of the good depends not only on the Q_{out} of the firm under consideration, but also on the Q_{out}'s of its rivals. This is so since the amount of the output on the market now is the sum of outputs of all firms producing. Therefore, the decisions of rival firms matter for the Total Revenue of the firm.
  - A lot of firms (perfect competition)

    In this case the number of the firms on the market is *very large*. For example, this happens on the markets for groceries, cigarettes, and any other stuff, which you can buy everywhere. The distinct feature of such markets is that each given firm is very small and cannot change the price P_{out}. If the firm decides to raise the price, all its customers will leave to the other producer "next door". Therefore, when choosing Q_{out} the firm just takes P_{out} as fixed.
- Type of good: existence of substitutes, compliments that can affect the demand

  If the good has a lot of substitutes (Coke, Pepsi, sodas) the producer has hard times controlling the market: the decisions of the producers of substitutes affect the demand for the good. The same with compliments: the decisions of the producers of compliments affects the demand for the good.
- Entry possibilities of others

  In some markets entry of other firms is hard or impossible (by this I mean that if some other firm decides to start producing the good, it cannot do it). This can happen because of natural, legislative or economical reasons. Examples: the firm is producing the output out of very rear inputs, which can be found only in one place on the planet, and the firm owns this land; the law forbids other firms to produce the good (because the firm has a patent); the fixed costs of production are super high (space travel).
- Other

For now we abstract from all these things, which we will discuss later in this course. It is enough for us for now to just assume that the firm simply *knows* Total Revenue for all levels of Q_{out}. This means that the firm understands the market it is operating in and can calculate TR taking into account all the stuff affecting TR.

TOTAL COST

As I noticed above, we assume that the firm takes the prices on factor markets as fixed. Therefore we can write total cost as

$$TC = P_{in1} \cdot Q_{in1} + P_{in2} \cdot Q_{in2} + \ldots + OPPORTUNITY\ COSTS$$

Opportunity Costs of the firm equal to the profit the firm forgoes by not pursuing the best possible economic activity. This is to say, the maximal profit the firm can get after selling all its property and investing all the money into some possible business.

As you can see TC depends on many things. We cannot draw it yet. However it becomes easier when we think about maximization of the total profit.

MAXIMIZATION OF THE TOTAL PROFIT

Suppose we are given the following information:

- The Total Revenue curve TR(Q_{out}) – so that we know Total Revenue for any Q_{out}
- Production process, namely PPFs for each possible input bundle
- Prices of all inputs (P_{in1}, P_{in2}, P_{in3}, etc.)

Suppose the firm tries to maximize TP by choosing: Q_{in}'s and feasible Q_{out}. How does it do it?

Let me illustrate the procedure with an example. Suppose

$$TR(Q_{out}) = 7Q$$

the prices of three inputs are

$$P_{in1} = 1;\ P_{in2} = 1;\ P_{in3} = 4$$

and all productions possibilities are given by the first four columns of the table:

line	Q_{out}	Q_{in1}	Q_{in2}	Q_{in3}	TC (ignoring OC, since same)	TP = TR - TC	MP
1	0	0	0	0	0	0	----
2	1	5	1	0	1*5 + 1*1 + 4*0 = 6	7*1 – 6 = 1	1-0=1
3	~~1~~	~~2~~	~~1~~	~~1~~	~~1*2+1*1+1*4 = 7~~	~~7*1 – 7 = 0~~	
~~4~~	~~1~~	~~1~~	~~2~~	~~1~~	~~1*1+1*2+4*1 = 7~~	~~7*1 – 7 = 0~~	
5	2	*1*	*2*	*1*	1*1+1*2+4*1 = 7	7*2 – 7 = 7	7-1 = 6
6	**3**	**2**	**2**	**1**	**1*2+1*2+4*1 = 8**	**7*3 – 8 = 13**	**13 – 7 = 6**
7	~~3~~	~~1~~	~~2~~	~~2~~	~~1*1+1*2+4*2 = 11~~	~~7*3 – 11 = 10~~	
8	4	3	3	3	1*3+1*3+4*3 = 18	7*4 – 18 = 10	10 – 13 = -3
9	5	3	4	5	1*3+1*4+4*5 = 27	7*5 – 27 = 8	8 – 10 = -2

The firm follows three steps to find optimal Total Profit:

1. *The firm should produce according to the Production Efficiency Principle.* Given Q_{in}'s the firm should produce the maximal possible amount of output, Q_{out}. Compare lines 4 and 5. Given the same levels of inputs the firm can produce 1 or 2 units of output, thus we throw away line 4 – it is inefficient.
2. *The firm shouldn't waste money on buying inputs.* After the firm threw away all lines in 1), it should think about how to spend money on different inputs given current input prices. Compare lines 6 and 7: in both cases the firm produces the same amount of output, however in line 7 the TC of production are bigger, therefore line 7 is not optimal. This happens because input 3 is expensive and the firm should try to use as little of it as possible. For the same reasons the firm throws away line 3.

These two steps ensure that the firm is not wasting money or resources in any way (either by not producing to full capacity or by not choosing input combinations smartly). Now after we did these stages we can finally draw our TC as a function of Q_{out} (so I denote it TC(Q_{out})). For each level of Q_{out}, TC(Q_{out}) represents the cheapest way to produce that much. Now that we have TC(Q_{out}) and TR(Q_{out}) we come to the final stage:

3. *The firm should find Q_{out}, which gives maximal Total Profit.*

This could be done in two ways. First way is to simply calculate Total Profit for all possible levels of Q_{out} using the formula

$$TP(Q_{out}) = TR(Q_{out}) - TC(Q_{out})$$

and then choose Q_{out} that gives biggest Total Profit. The second way is to use marginal analysis.

Both ways lead to the same answer, however the former is much more demanding. Indeed, it is not easy for the firm to calculate TP(Q_{out}) for *all possible* Q_{out}. This is just because the firm rarely has all the information needed for that or this information is hard to collect. Marginal analysis on the other hand does not demand all information and needs only some of it. This can be compared to two ways of locating the highest point of the mountain: you can either hire a helicopter and to see the mountain from the air so that it is clear straight away where is the peak or you can just approach the mountain by feet and at any point try to go up. The first way is expensive but easy. The second way is more complicated, but cheap.

In our example above we can calculate TP(Q_{out}) and MP(Q_{out}) (Total and Marginal Profit)

$$MP(Q_{out}) = TP(Q_{out}) - TP(Q_{out} - 1) = TR(Q_{out}) - TC(Q_{out}) - (TR(Q_{out} -1) - TC(Q_{out} -1)) = TR(Q_{out}) - TR(Q_{out} -1) - (TC(Q_{out}) - TC(Q_{out} -1)) = MR(Q_{out}) - MC(Q_{out})$$

Notice that if $MP(Q_{out}) > 0$ then adding one more unit increases TP. If $MP(Q_{out}) < 0$ then dropping one unit increases TP. Therefore maximal TP is reached at Q_{out} where $MP(Q_{out}) = 0$. You should be careful though, since in the examples we consider there might be no Q_{out} at which $MP(Q_{out}) = 0$. Then the optimal choice is *the biggest Q_{out} such that* $MP(Q_{out}) > 0$.

The optimal rule $MP(Q_{out}) = 0$ can be rewritten in the terms of Marginal Revenue and Marginal Cost (and this is actually the way this rule is usually put)

$$MP(Q_{out}) = MR(Q_{out}) - MC(Q_{out}) = 0$$

therefore

$$MR(Q_{out}) = MC(Q_{out})$$

Notice that this formula for finding optimal Q_{out} works for all firms, whatever they are. This is because nowhere we assumed any special shape of TR(Q_{out}).