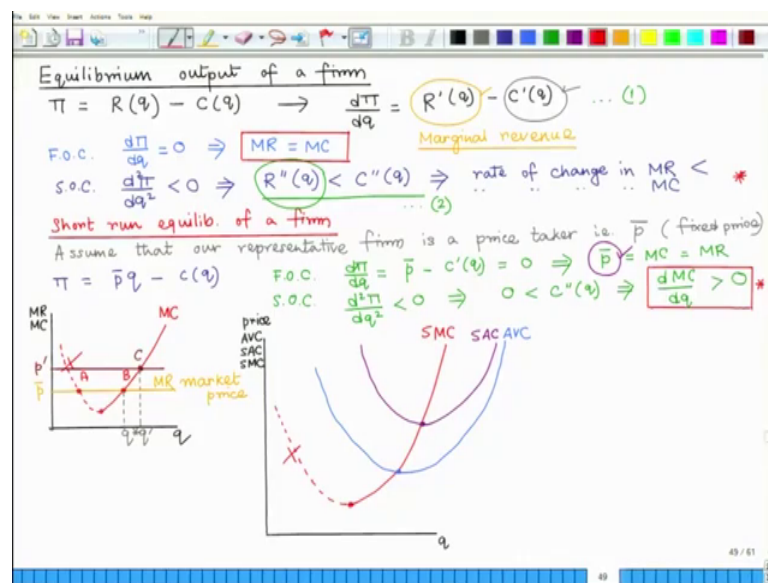


Microeconomics: Theory & Applications
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Lecture – 36
Short-run Equilibrium of Firm

Hi, welcome back to the lecture series on Microeconomics. After finishing production function and cost functions, now, we are in the last phase of theory of Firm, where, we are going to study how to find equilibrium output of a firm in short run and long run. So, before we study a firm's equilibrium in short run and in long run in the case of a competitive industry let us first write down a firm's profit maximization problem once again to derive important first order and second order conditions.

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So, we write profit as π and R is basically my revenue; revenue is a function of quantity produced by the firm of course, minus the cost which is also function of the output level q right ok. So, now, we know we need to maximize profit to maximize profit we need to take derivative with respect to output level and we get expressions like $R'(q) - C'(q)$. Now, we know this particular entity that is basically the marginal cost of production right. Now, there is a new entity that we have just introduced $R'(q)$. What is this? This is known as marginal revenue.

What is marginal revenue? By marginal revenue we mean that, if the firm produces one more unit of output how much extra it earns in terms of rupee or dollars for that additional unit of output. Now, we do not assume whether the firm is selling its product in a competitive market or in a non competitive market. So, we will discuss these complications later on let us have a very simple model as of now.

So, now let us look at the first order and second order conditions. So, the first order condition can be obtained after setting this $\frac{d\pi}{dq}$ equal to 0 and that leads to this condition $MR = MC$ right. So, this is a very important first order condition that we are going to utilize heavily in the theory of markets. Now, to find the second order condition we have to differentiate again and we have to find out $\frac{d^2\pi}{dq^2}$ right and we know that has to be less than 0 for the profit maximization problem. Now, that means, that $\frac{d^2MR}{dq^2}$ shall be less than $\frac{d^2MC}{dq^2}$ right.

So, in simple words that means, rate of change in marginal revenue shall be less than rate of change in marginal cost this has very important implication in theory of markets we will revisit this again. So, we have derived the firm's optimization conditions for profit maximization problem mathematically. But, what is the intuition? Let us look at that $MR = MC$ first order condition and the second order condition, but this time intuitively. So, what if we deviate from the $MR = MC$ point? So, let us try to understand the implication of the deviation first let us understand what is exactly happening at the firm's equilibrium where $MR = MC$.

So, at firm's equilibrium where the firm is producing its equilibrium output level for that particular output level the cost that the firm incurs is totally obtained by selling the product in the market. So, basically the extra dollars or extra rupee in that the firm earns in terms of revenue from selling this additional unit in the market is exactly equal to the cost of producing that very unit of the output. Now, let us see what if we deviate from that condition. Suppose, we take this case of $MR > MC$, what does that mean? That means, that if the firm is producing some output level for that particular output unit the firm is earning more by selling it in the market than the cost the firm incurs to produce that very unit.

So, now, let us go to the other side of the problem. So, if now the firm observes $MC > MR$ then what happens? So, in this case to produce that very unit of

output the firm spends more than actually it receives by selling that very unit in the market.

So, in that case the firm will not produce that unit of output because it is making loss. But, in the previous case which is basically MR greater than MC case they are the firm is in a winning situation because, by producing that extra unit of output the firm actually makes money. So, in both the cases firm will not be happy with its current output production level.

So, in the first case firm will increase the production of output and in the second case the firm will reduce its output production and eventually the firm will hit back the old equilibrium point which is basically denoted by or characterized by MR equal to MC the first order condition. Now, let us look at the implication of these first order and second order conditions when the firm is part of a competitive industry. What is a competitive industry?

So, first the we have to understand; what is an industry? So, an industry consists of many firms which produce the same good or service. So, a perfectly competitive industry is characterized by two features first the firm is a price taker and individual firms decision to produce 1 unit more or less of its output does not have any influence on the market price. And, the second feature is basically the feature of free entry and free exit; that means, that if the person waiting outside the market decides to enter the market opens up a new firm and start selling in the market nobody can stop him and if the firm, if the individual does not like the business he or she can always easily exit the market there is no restriction on either entry or exit.

So, if any firm satisfies these two characteristics or feature that firm is a competitive firm from a producers perspective. Now let us look how these first order conditions and second order conditions, that we have just derived has different interpretations for a competitive firm. So, here we are going to distinguish between short run and long run we are going to study the short run equilibrium of a firm into this lecture ok.

So, here, we assume that our firm is a price taker. Assume that our representative firm is a price taker it implies that if there is a market price P bar then the firm is selling its output at this particular P bar which is beyond its control. So, this is a fixed price ok. So, our profit maximization problem in that case, so, let me rewrite the profit expression

again. So, in that case it will be P bar the fixed price that the firm earns by selling one particular unit of output times the output being produced that is q minus the cost of producing output right. So, now, how my first order and second order conditions. So, let me write SOC here forgot that. So, now, let us look at the first order and second order conditions in this case. So, we will revisit what we have done earlier right.

So, in this case from equation number 1, we can see that we have P bar minus C' q right and we need to equate that equal to 0. So, finally, we get what we get P equal to marginal cost right, but note that this is also equal to marginal revenue because here the competitive firm is selling each and every unit of output it produces at a fixed price P bar. So, the additional revenue it earns by selling an additional unit of output is p bar. So, that is basically equal to marginal revenue right ok.

So, now, let us look at the second order condition. So, for second order condition we have to have $d^2\pi/dq^2$ negative right we have to have that condition what does that mean now note that here, please note this second order condition that we have derived let me call this 2 ok. So, from here, we can very well see that this R'' which is basically the rate of change in marginal revenue will be 0 in this case because here marginal revenue is constant that is basically the market price p bar right that should be less than equal to C'' q that indicates that my slope of marginal cost curve shall be positive right.

So, this is also a very important result from the perspective of theory of firm. So, that means; that the firm's profit maximization problem will reach a solution when the firm is operating on the upward sloping segment of the marginal cost curve. This is also very important, let us now look at a diagram to understand the first order and second order conditions of a short run equilibrium of a competitive firm ok. So, we measure output produced by the competitive firm along the horizontal axis and we measure marginal revenue and marginal cost along the vertical axis right ok.

So, drawing a marginal revenue curve in this case is very simple it is going to be line parallel to the q axis because marginal revenue in a competitive firm case is basically the market price right. So, let me denote this as my MR curve ok. So, now, the second order condition and the first order condition if I want to draw in this diagram I need to now

draw the upward sloping segment of a marginal cost curve. So, you would remember that marginal cost curve is basically an U shaped curve.

So, first it falls then it reaches an absolute bottom and then from minimum point you know there is an inflection point it starts to rise right. So, in this competitive industry case this part which I have drawn as the downward sloping segment of the marginal cost curve as a broken line does not exist and we get an upward sloping segment of the marginal cost curve right. So, if I assume an U shaped marginal cost curve then there will be two intersections right here one and then along the upward sloping segment.

So, these point say A and this point say B now I am saying that the A point is although meeting the first order condition, but it does not satisfy the second order condition. So, this is ruled out right whereas, the case of point B satisfies both the first order and second order condition and hence at this intersection point B the firm maximizes profit and it solves for the output level q^* at which this profit is maximized.

So, now we have seen how this firm actually maximizes and maximizes profit and finds the equilibrium output level given a market price. Now, note that these first order condition is the solution that we have just obtained is dependent on the parameter in the model which is basically market price. So, if now market price increases to say P^* then in that case there is a new equilibrium obtained right.

So, at point C first order and second order conditions both are satisfied and if we now draw a perpendicular from this equilibrium point to on the output axis we get another output level q^* which is profit maximizing at that particular price level.

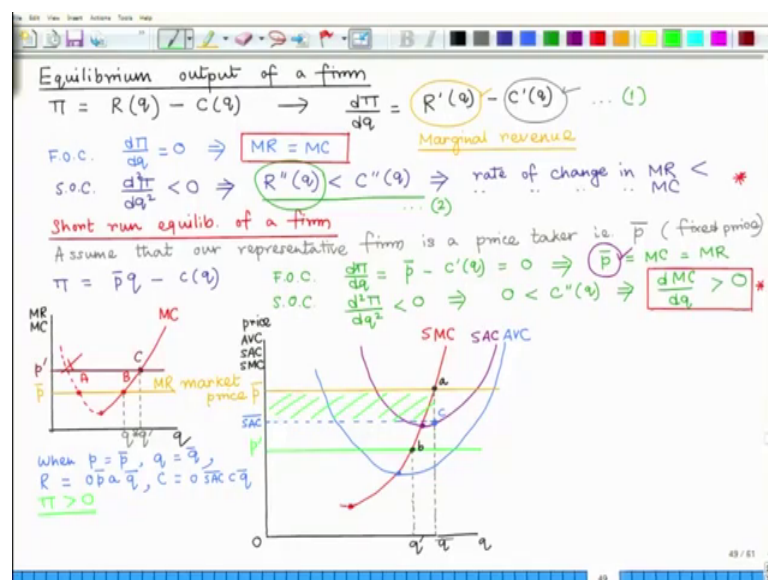
So, what we see? We see that there is a positive relationship between the market price and the firms supply in the market as market price rises firm tends to produce and supply more for a competitive industry, but does it mean that the firm supply curve actually is the upward sloping segment of the marginal cost curve? Wait we will find out the answer very soon.

So, let us now have a diagrammatic exercise to find out firms short run supply function. So, we are going to revisit the diagram that we have drawn while we analyze the short run cost curves. So, now, we are going to revisit the short run average cost average

variable cost and short run marginal cost curves and we will see the use of these curves in determining firms short run supply curve ok.

So, here is the diagram here I start by saying that although the complete diagram has an U shaped short run marginal cost curve, but as we have seen the in the perfectly competitive firms case the second order condition rules out this falling part of the short run marginal cost curve we can ignore that. So, I can erase this from the graph to make it clean. Now, let us start with some initial market price o. So, suppose there is origin here and I start with the market price which is pretty high to start with and say that market price is set at o p bar.

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So, if that is the case then let me draw a parallel line parallel to the quantity axis and you can see that at this particular intersection point firms equilibrium say this is point a ok. So, at this point a firms equilibrium is obtained and the firm basically produces firm produces output level q^* no let me call it q^* bar. So, firm produces q^* bar level of output as equilibrium output level given market price $\bar{p}$ bar.

Now, let us look at another price which is lower compared to the initial price $\bar{p}$ bar and let that price be here at $\bar{p}$ dash ok. And, to find the firms equilibrium again we have to draw a straight line parallel to the q axis. So, the firm cut. So, the firm needs its first order condition at this point b and firm solves for the equilibrium output level because at

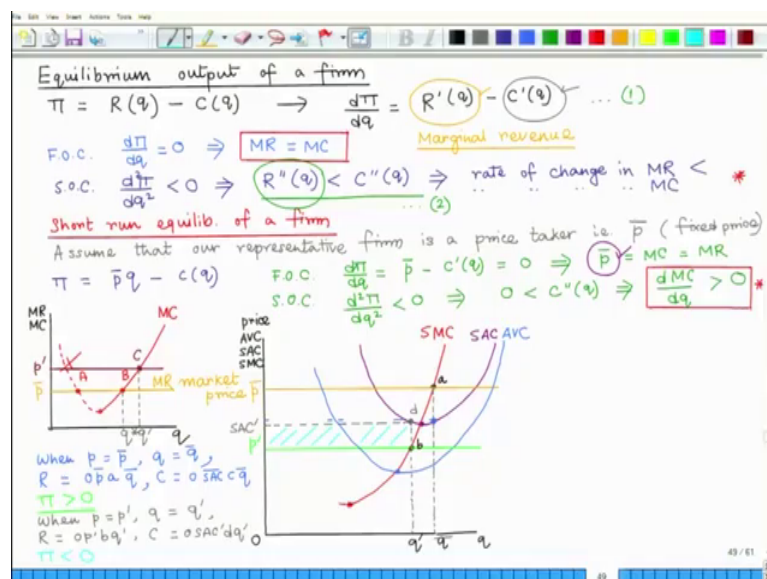
these point p MR equal to MC condition is met and firm solves for this output level q prime say ok.

Now, note the difference between the first case and the second case. So, let us find firms profit in the first case. So, when p equal to p bar and q equal to q bar then firms revenue R is basically the area $o p$ bar $a q$ bar right and what is the cost of production in that case the cost of production would be determined by the short run average cost curve. So, the unit cost right. So, basically to produce q bar level of output we have to see how much per unit cost of production firm incurs and that can be determined from the intersection of this vertical line $a q$ bar and the short run average cost curve.

So, basically I have to read the short run average cost value from the short run average cost curve for that particular output level and then let me say that this is point c and we are talking about some short run average cost curve some short run average cost level SAC bar right. So, basically here in this case we get this area $o SAC$ bar then this point c and then finally, q bar right. So, in this case you can see the firm is making a positive profit because the revenue is higher than the cost the firm incurs right ok.

So, here there is no problem firm will of course, produce and supply q bar units of output in the market. So, now, let us look at the case where the firm is experiencing a lower market price p dash what happens then. So, at this market price p bar the firm finds equilibrium at point b and firm decides to produce at q bar level q dash output level because you know at point b MR equal to MC and both the first order and second order conditions are made and mathematics tells the firm to produce at q dash level. Now, let us look at the economics of it and let's see whether the firm will be happy by producing here.

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So, now if I want to find out the profit, so, when p equals p dash then q is equal to q dash. As per my first order and second order conditions, but let us now look at the revenue. So, the revenue in this case will be $0p$ prime b and q prime now what about the cost. So, we will add up the same trick. So, we have to now go to my short run average cost curve and read the number from that curve which will give me the unit cost of production at that level of output.

So, basically I have to basically extend that perpendicular line till that perpendicular line at q prime level of output till that perpendicular line meets the short run average cost curve and then we see from the axis I can get the short run average cost of production at that output level let us denote that level of unit cost of production by SAC prime. So, in that case we know that this is the cost of production. So, let me denote this point as d .

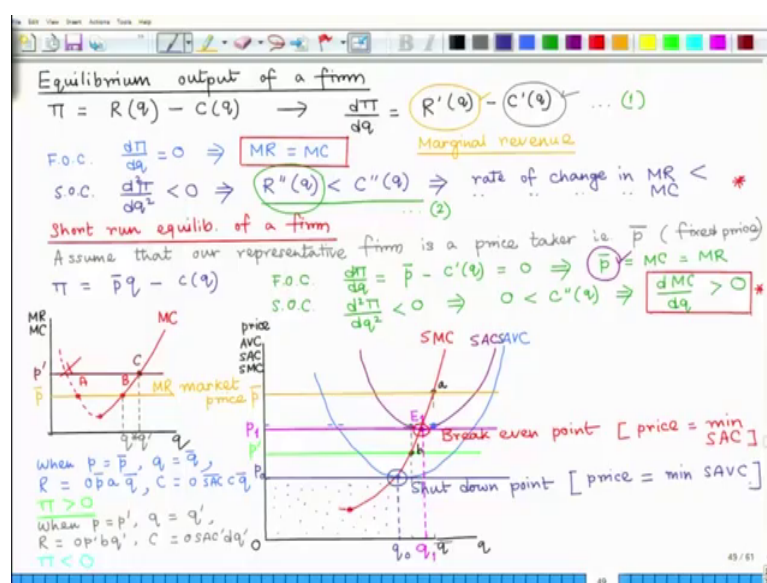
So, this is right ok. So, now, here we can see that the firm is making loss because the total cost of production is actually higher than the revenue that it earns. So, in this case of course, the firm earns a negative profit right. So, should the firm make any production if it suffers loss that is the next question that we would like to answer ok. So, now, let us study whether the firm will continue to produce if it experiences loss in short run.

So, now we are going to introduce two concepts which are very interesting the concepts of breakeven point and shutdown point. First we will start by looking at the concept breakeven point. So, note that on the short run average cost curve there is a point where the firm actually earns 0 profit and what that point would be. So, if a firm faces a market

price which is exactly equal to the minimum point of the short run average cost curve then basically the total cost of production would be exactly equal to the total revenue that the firm earns by selling its output in the market.

So, that point is known as the breakeven point. Let's locate that point in the graph. So, now, here you will see that I have cleaned up the graph quite a bit to make it look less clumsy.

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So, basically we are talking about a price level I need to erase this SAC. So, now, we talk about some market price say p one. And, let me denote this minimum point of the short run average cost curve as E_1 and note that here at this point E_1 my first order condition and second order condition are both paid because we know that the marginal cost curve passes through the short run average cost curve right.

So, here the firm will find its equilibrium and the firm will produce key one level of output right. So, this particular point which is the minimum point of the short run average cost curve is known as firm's breakeven point because, the firm makes 0 profit at this point. So, at breakeven point price is equal to minimum value of short run average cost curve right now we are going to study the case where firm is going to shut down its production.

So, already we have seen that if the market price is low. Like, you know we have seen in the case of market price p prime then the firm makes a loss now the question is that; how much loss the firm is willing to suffer to stay in the business in the short run? So, let us have a look at the diagram to answer the question. So, here we see that there is a market price at which firm will be exactly able to cover its variable cost of production because, fixed cost is independent of the output being produced by the firm right.

So, the fixed cost that the firm has made is already gone. So, now, the firm will try to cover at least the variable cost in the short run right. Let us say, that there is a market price p naught now the p naught is basically a market price such that if I plot it in the diagram the parallel market price line will pass through the minimum point of the short run average variable cost curve.

So, now please pay attention to this point. So, here basically the firm is meeting its first order conditions and the second order condition for short run profit maximization and that mathematics will dictate it to produce q naught level of output now note that if the firm decides to produce q naught level of output facing the market price p naught then the firm is at least earning that much of revenue from the market by selling output to cover up its variable cost of production.

So, what would be the variable cost of production in this case it will be this area which currently I am marking by dots right. So, this area is both the revenue that the firm earns by selling q naught output level at p naught price in the market and this is exactly the variable cost that it incurs to produce that level of output. So, fixed cost you know it will fit as foregone and it will stay in the business with the hope that in near future market price will improve and you know the firm will be able to gain some profit in the long run it will stay in the business because, at least it is covering the variable cost that is currently being incurred by the firm to produce the output.

So, now, this point is known as the shutdown point of the firm. So, the condition to obtain shutdown point of a firm is this price has to be equal to the minimum short run average variable cost right. So, we will continue with the discussion in the next lecture.