Managerial Economics
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Lecture - 41
Theory of Cost (Contd...)

We will continue our discussion on theory of production cost. So if you remember in the last class, we were discussing about the short-run and long-run cost analysis. We just introduced the short-run cost analysis. In today's class we will talk about the long-run cost analysis, how long-run cost curves are derived from the short-run cost curve. Then we will talk about the break even analysis and learning curve.

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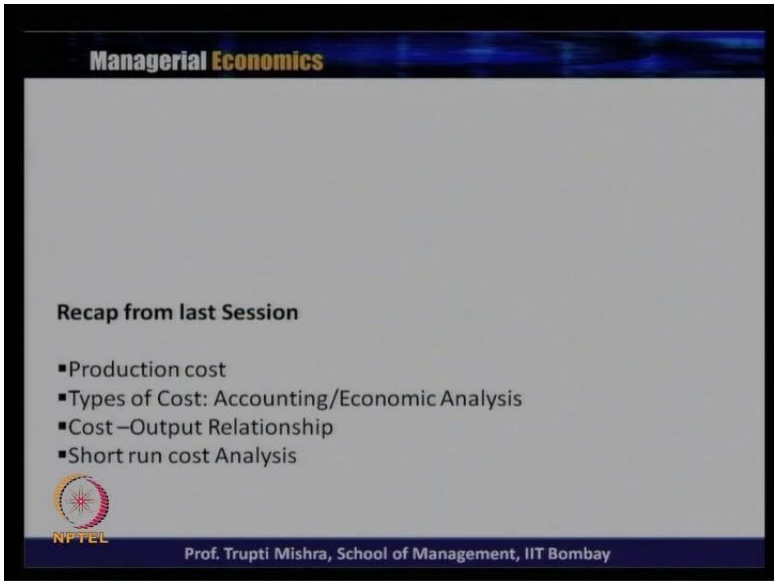

So, if you remember this is the topic what we discussed in the last class; like we introduce the production cost, different type of cost in both accounting sense and economic analysis sense. Then we discussed about the cost and output relationship, specifically in the context of short-run cost analysis.

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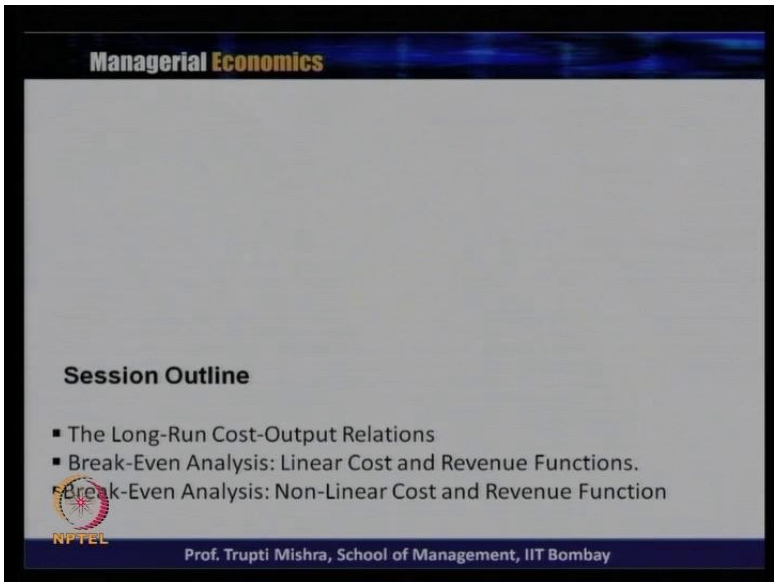

In today's class we will talk about the long-run cost-output relationship, breakeven analysis in case of linear cost and revenue function, and breakeven analysis in case of non-linear cost and revenue function.

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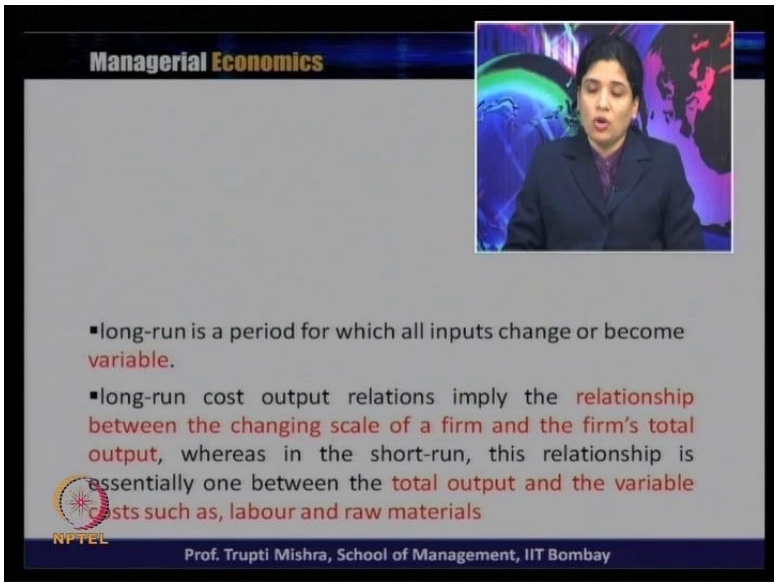

So as you know, I think we have already differentiated the difference between the short-run and long-run; one is the time specific and second, in case of typically in case of production analysis; short-run, long-run is on the basis of classification of the how the inputs behave, whether the inputs they are fix or whether they are the variable input. In case of short-run, at

least there is one input has to be fixed; but in case of long-run, all input has to be variable which implies that when the output increases it, and there is a requirement to change all the inputs or may be in the other, to put it in the other way, when all inputs changes then only the output changes or maybe we can take another implication of this that the change in the output is large. So, it cannot be change; only by changing few inputs all input has to be change.

So, long-run is a period for which all inputs change or become variable, and long-run cost-output relation implies the relationship between the changing scale of firm's and firm's total output. So if it is comes to a cost-output relationship in case of long-run, it is basically a relationship between the changing scale of firm and the firm's total output.

Whereas if you look at in case of short-run generally the relationship is not the scale relationship, rather it is the change in the output or change in the input with respect to change in the output. So, it is one between the total output and in the specifically the variable cost. So in case of long-run it is a scale relationship and in case of short-run this is a one-to-one relationship between the total output and the variable constant. The variable constant includes the raw material and the labor.

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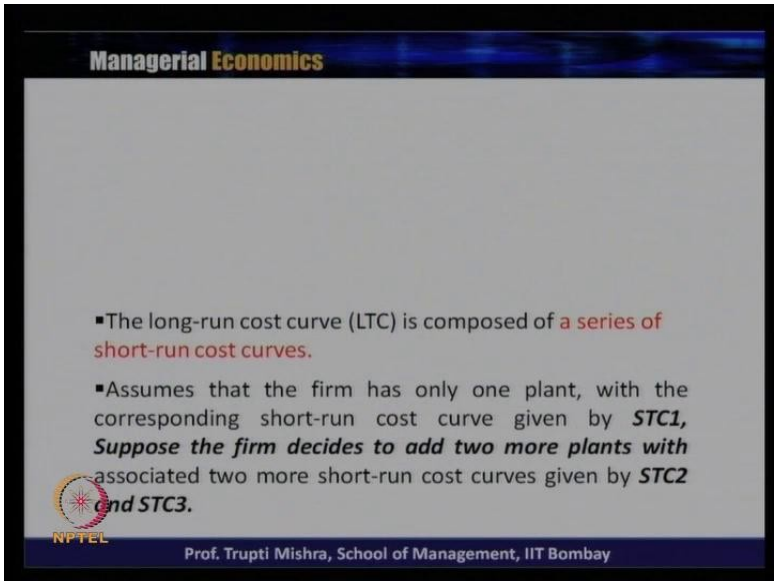

Then when it is coming to the cost curve of the long-run total cost or may be the long-run cost and altogether, this is composed of a series of short-run cost curve. So, when you take a series or when you take a more than may be two, three, short-run cost curve that gives us the long-run cost curve. Assume that firm has only one plant with a corresponding short-run cost

curve given by suppose STC1 that is short-run cost curve in one period, and suppose the firm decides to add two more plants with associated two more short-run cost curve given by STC2 and STC3.

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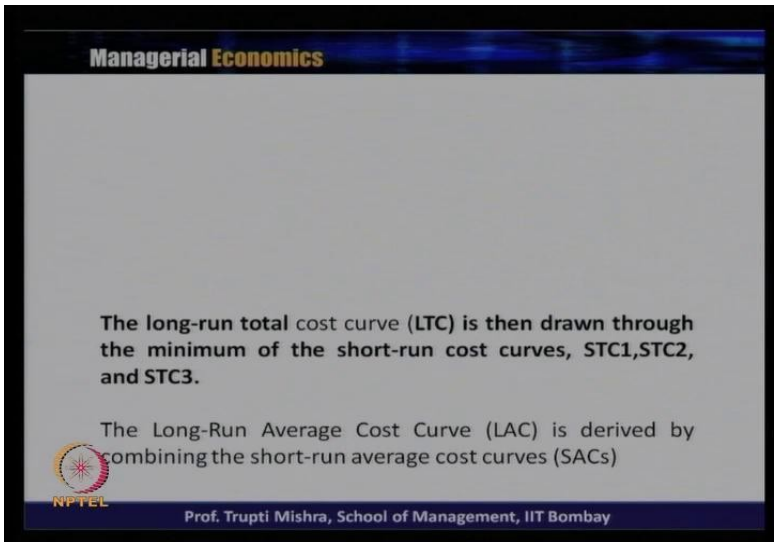

If you now take all these STC1 that is cost curve in one short-run, STC2 that is cost curve in the second short-run, and STC3 that is cost curve in the third short-run. And altogether STC1, STC2, and STC3, they will come they will then leads to the long-run total cost curve and similarly, the long-run average cost curve is also derived from the combining the short-run average cost curve. So, this is the long-run total cost and if you look at how this has been derived this long-run total cost curve.

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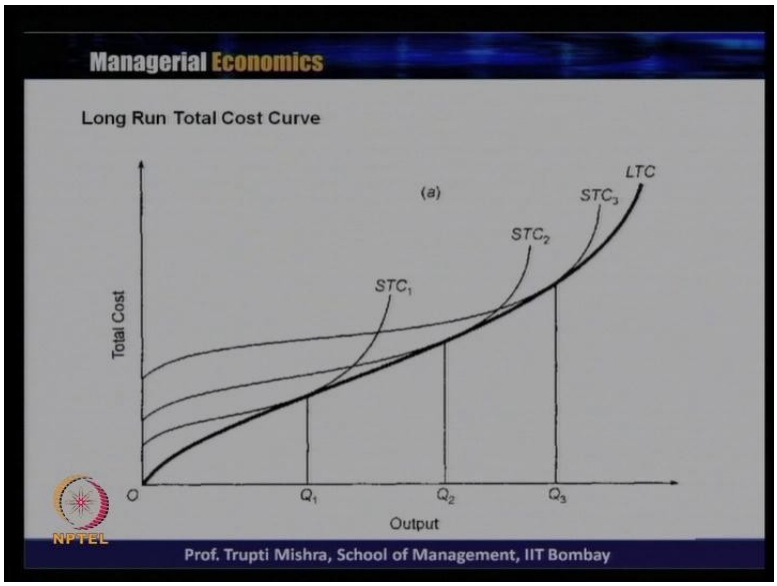

This is as we say that this is the combination of or may be this is the combination of a series of short-run cost curve and how this short-run cost curve is derived. Suppose the output is 100 units. So by changing variable unit, only the output can achieve up to 100 units. So, this is one short-run cost curve. When the output which can be maximum changed by 200 unit by changing the variable, that is another short-run cost curve or may be when the output can be changed by 500 unit of output.

By changing only the variable unit that is another short-run cost curve. So for a specific output level, keeping the fixed input only the changing variable input, how much a maximum output can be increased that consist of one short-run cost curve. So, taking a series of short-run cost curve at different level of output that gives us the long-run total cost curve.

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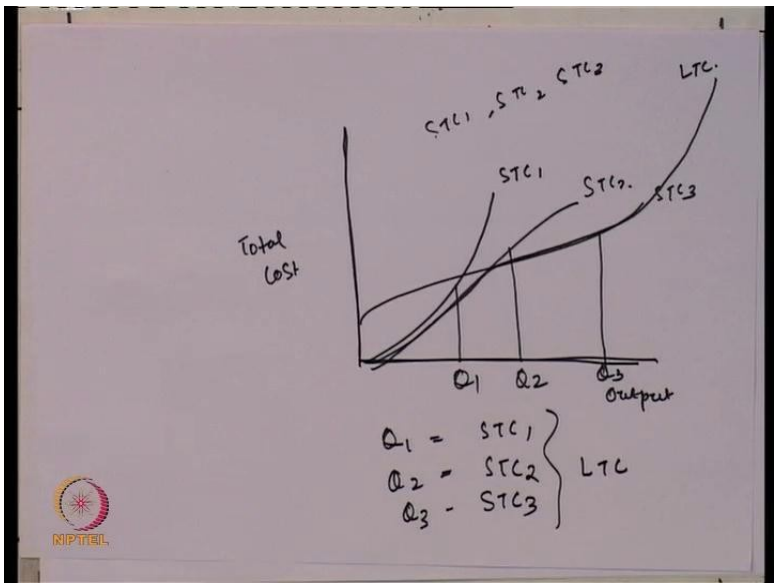

Now, we will see how the long-run total cost can be derived from the short-run cost curve at the different level of output. So, here we can say the output. Here we can say the total cost. So, maybe we have one short-run cost curve that is STC1. May be we have another short-run cost curve that is STC2 or maybe we have one more short-run cost curve that is STC3. So when you join or sum together of all, this short-run cost curve that gives us the long-run total cost curve; so STC1, STC2, and STC3.

So, if you look at this is corresponding to maybe this is Q_1 level of output; this is Q_2 level of output, and this is Q_3 level of output. So, corresponding to Q_1 level of output, the cost curve is STC1. Corresponding to Q_2 level of output, the short-run cost curve is STC2, and

corresponding to Q_3 level of output, the short-run cost curve is STC3. Taking altogether all these three, we get the long-run total cost curve.

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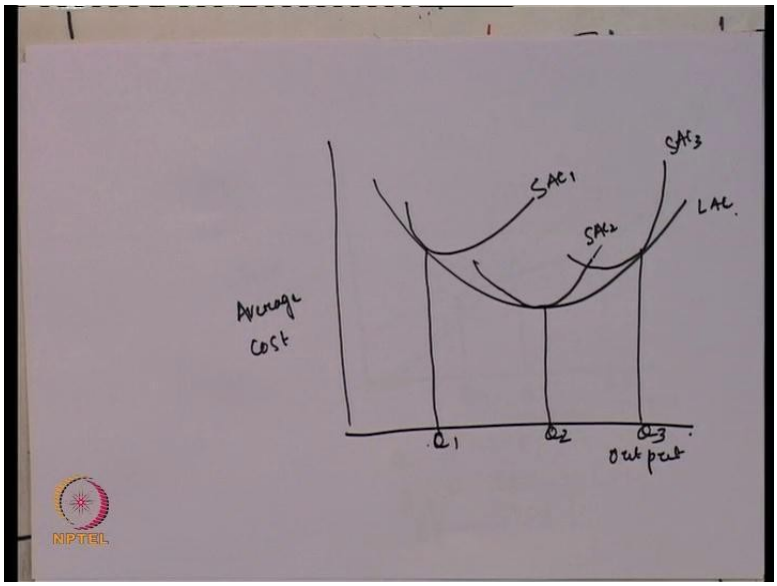

So, long-run total cost curve is the series of short-run cost curve at the different level of output. Similarly if you look at we can also derive the long-run average cost curve taking the series of the short-run average cost curve. This is x-axis will take the output; y-axis we will take the average cost since we are drawing the long-run average cost curve. So, similarly we get a short-run average cost curve here.

Then short-run average cost curve 2, and similarly the short-run average cost curve 3; so corresponding to that we get three level of output because that leads to three level of cost curve. So, this is SAC1, SAC2, SAC3 and this is long-run average cost curve. So, hence we can derive the long-run total cost curve from the series of total short-run total cost curve.

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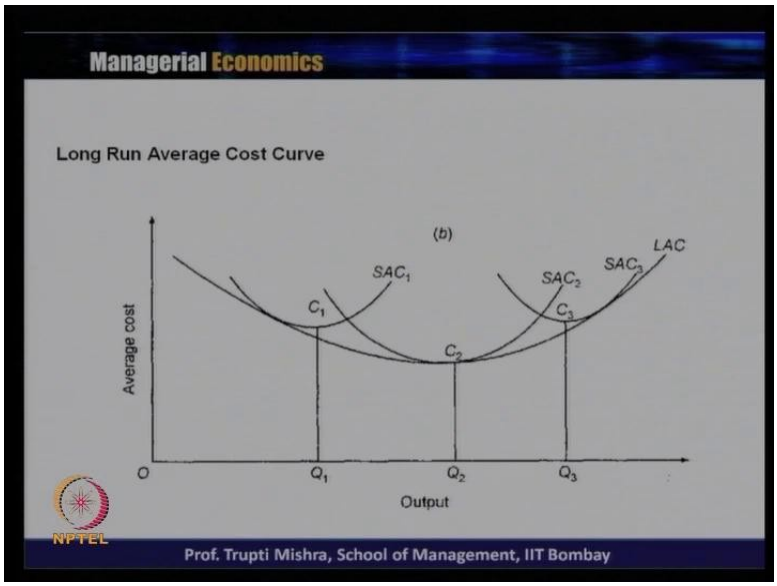

Similarly, we can also derive the short-run average cost curve. From the series of short-run average cost curve, we can try the long-run average cost curve; and long-run cost curve is nothing but the series of the short-run average cost curve at different level of output. Specifically in this case, if you look at its Q_1, Q_2, Q_3 which keeps three different level of output.

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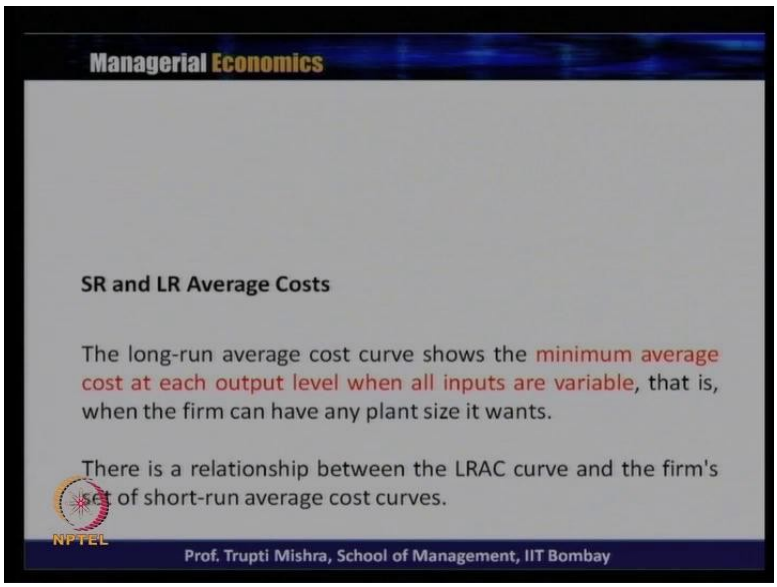

So now we will see, what is the relationship between the short-run and long-run average cost curve. So, long-run average cost curve shows the minimum average cost at each level of

outputs when inputs are variable, that is, when a firm can have any plant size it wants. So, there is a relationship between the long-run average cost curve and the firm state of short-run average cost curve. So, as we say that the long-run average cost curve is the minimum average cost at each output level when inputs are variable.

So whether if you look at the SAC1, SAC2, and SAC3, it gives three different level of variable cost and that is why this long-run average cost curve takes out the minimum of average cost at each short-run level of output, and it gives the minimum average cost curve of each output level when the variable in it is or some inputs are at least variable.

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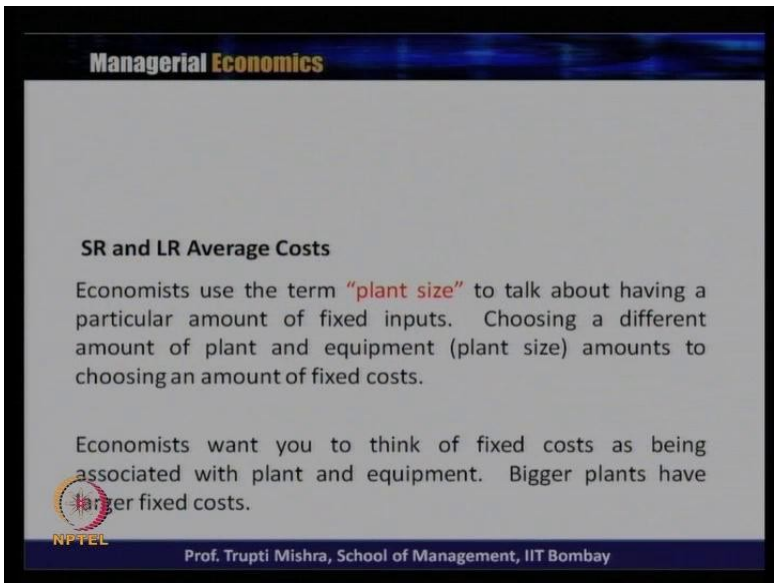

When it comes to the economies analysis of the short-run and long-run how they are related to each other. Economists specifically use the term "plant size" to talk about having a particular amount of fixed input. So, choosing a different amount of plant, equipment; that is plant size amount to choosing an amount of fixed cost. So, if the amount if you look at choosing a different amount of plant and equipment if it is a large plant, obviously large amount of fixed input is required.

If it is a small plant, then it is a small may be the less amounts of inputs is required and that correspondingly has some amount; in fact that correspondingly lead to the amount of the fixed cost. So if it is a large plant, there is large fixed cost. If it is a small plant, that is a small fixed cost and since they use the term plant size; so if the plant size is large, fixed cost is

more and it is in a different short-run cost curve. If the plant size is less, then it is a less fixed cost and the plant size is again different.

So, generally that is the reason the plant size has a reference point for the short-run average cost curve with regards to the fixed input and with regards to the fixed cost. So, economists want you to think of fixed cost as being associated with the plant and equipment. Bigger plant has large fixed cost and vice versa, smaller plant has the less fixed cost. So it always the, may be when you are in thinking about the cost of production; the fixed cost and the variable cost of production, always the plant size is in the back of the mind that, what is the plant size because that is the direct impact on the fixed cost of the production at least the initial stages of production.

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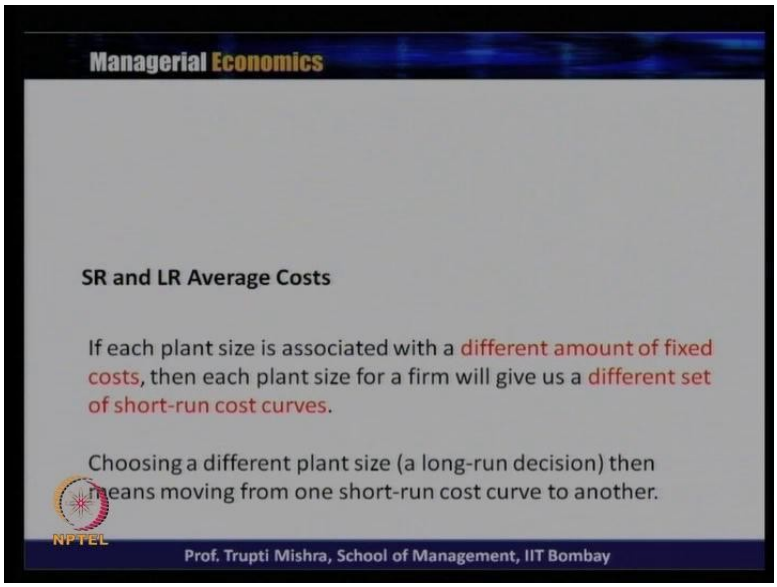

So, each plant is associated with a different amount of fixed cost. If it is a large plant, large fixed cost. If it is a small plant, they say there is less fixed cost. So each plant size is associated with a different amount of fixed cost, then each plant size for a firm will give a different short-run cost curve.

So, if you look at in the previous graph also we are explaining the short-run total cost curve one, two, three, how they differ from each other. They differ from one; they differ from each other on the basis of output. And second, they differ from each other on the basis of the cost. So obviously if the output level is higher, then the fixed unit is higher and also the variable input is higher; and if it is a small then the fixed and variable cost will also differ. So, in this

case STC1, STC2, STC3, they show three different level of output and also different level of cost.

So, each plant size is associated with a different amount of fixed cost and each plant size of a firm will give us a different state of short-run cost curve. Choosing a different plant size that is a long-run decision then means moving from one short-run cost curve to another or to simplify this, when you are moving the output level or when you are trying to increase the output level from one level to another level. Basically it is a transition from one short-run cost curve which is at the lower level of output to another short-run cost curve which is a higher level of output.

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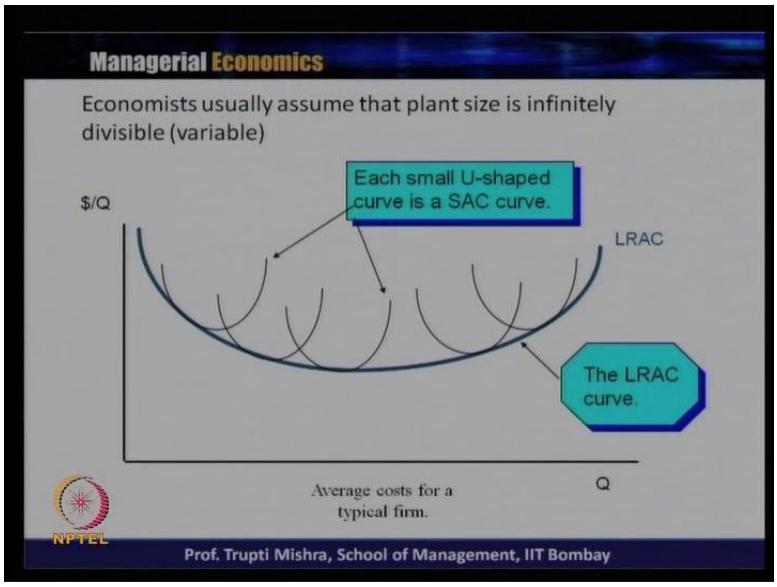

So, this is the typical example of the long-run average cost curve and economist usually assume that the plants are size is infinitely divisible, that is variable and each small U-shaped curve is the short-run average cost curve and this is the long-run average cost curve. In the x-axis we are taking the average cost for a firm; where x-axis we are taking the average cost of the firm and the y axis we are taking the level of output.

So, long-run average cost curve is the summation of each small U-shaped short-run average cost curve which is different from each other in two aspect; in term of variable and in term of the different output and in term of the cost associated with that level of output.

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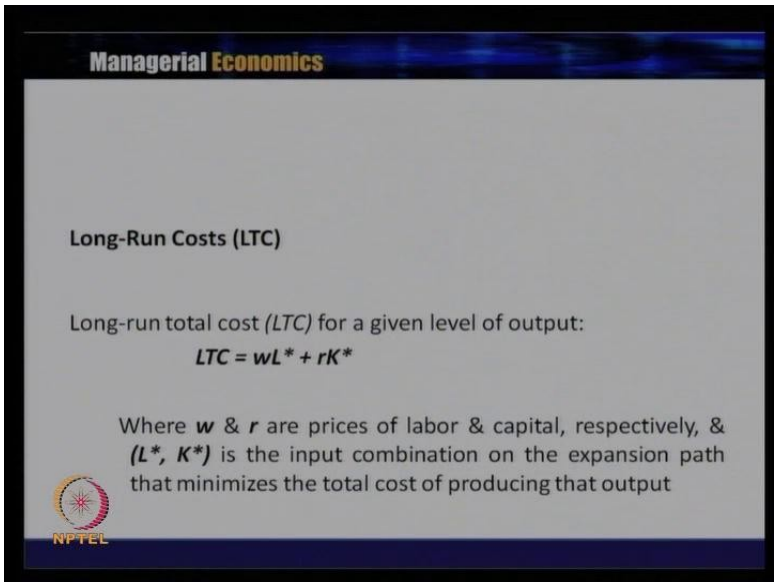

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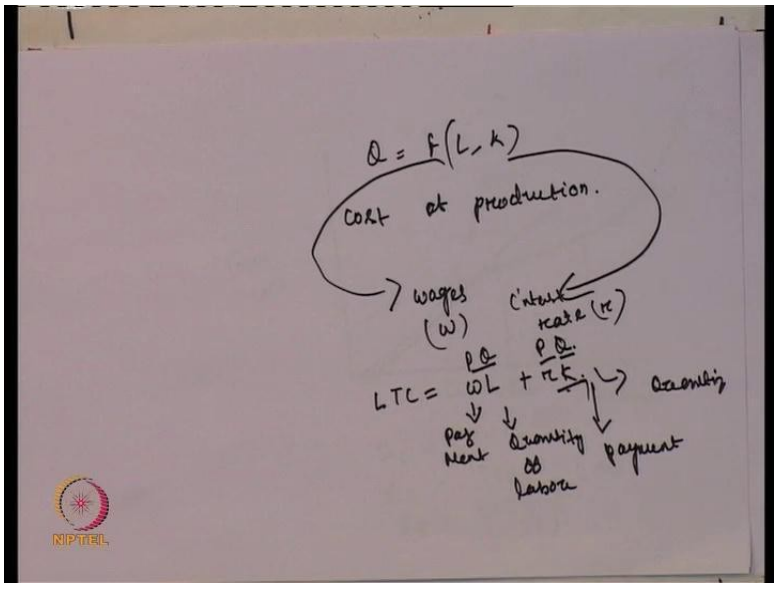

Then when it comes to formulizing the long-runs total cost curve(LTC), till the time we are assuming that the long-run total cost curve or the cost curve altogether is Q is a function of labor and capital. When it comes to cost of production, what is the expense the firm they are incurring when they are producing a product. So, the major expenses come from the input to produce the product that is labor and capital. So, labor is the payment whatever we make to

use labor as the input of production that is wages and k whatever the payment we are spending on k that is comes as the interest rate.

So, if you take w as the wages, r is the interest rate, then long-run total cost $LTC = wL + rk$, w is the payment for using labor, L is the quantity of labor input, r is the payment for using capital, k is the quantity of capital input. So, w is the payment for labor, L is the quantity of labor. So this is price, this is quantity. Again this is price, this is quantity. So, this is the quantity of labor input, this is price of labor input and long-run total cost is equal to whatever the payment or whatever the cost of expenses what the firm is incurring on the two different level of output.

So, long-run total cost curve is $wL + rk$, where w and r are as the price of labor and capital respectively, and L and k is the input combination the expansion path that minimize the total cost of producing output. Why we take the input combination on expansion path. Because that give us the optimal production with a minimum cost of production and that is the reason we take the input combination the expansion path because that gives us the optimal output keeping the cost constant in the background.

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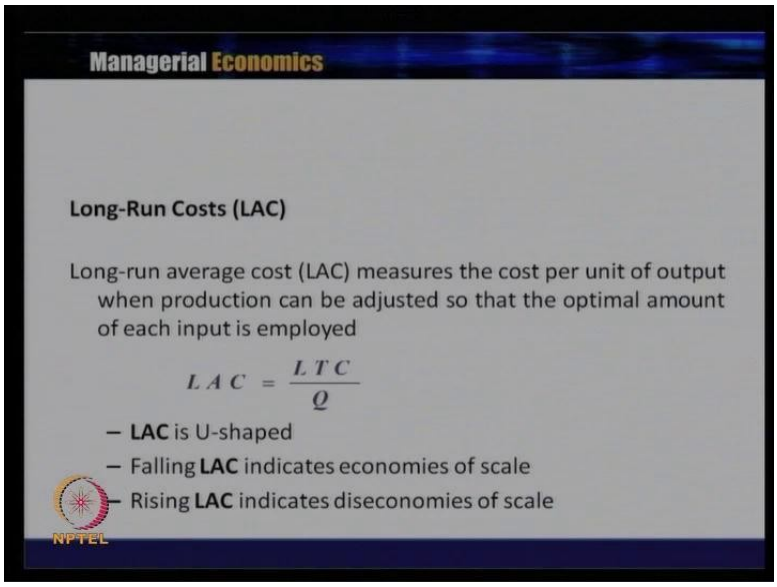

Then how to measure the long-run average cost curve or algebraically how we can find out the long-run average cost(LAC) curve. It measures the cost per unit of output when production can be adjusted so that optimal output of each input is employed. So, long-run

average cost curve measure the cost per unit of output when production can be adjusted so that optimal amount of each input is employed. So, $LAC = \frac{LTC}{Q}$. So, Q is the unit of output. Long-run average cost curve is U-shaped. Decrease in long-run average cost curve indicates economies of scale and increasing long-run average cost curve indicates the diseconomies of scale. We will discuss more on the economies of scale and diseconomies of scale at a later point of time specifically what are the economies of scale, different type of economies of scale, and what are the different type of diseconomies of scale, how economies of scale leads to decrease in the cost of production, and how diseconomies of scale leads to increase in the cost of production.

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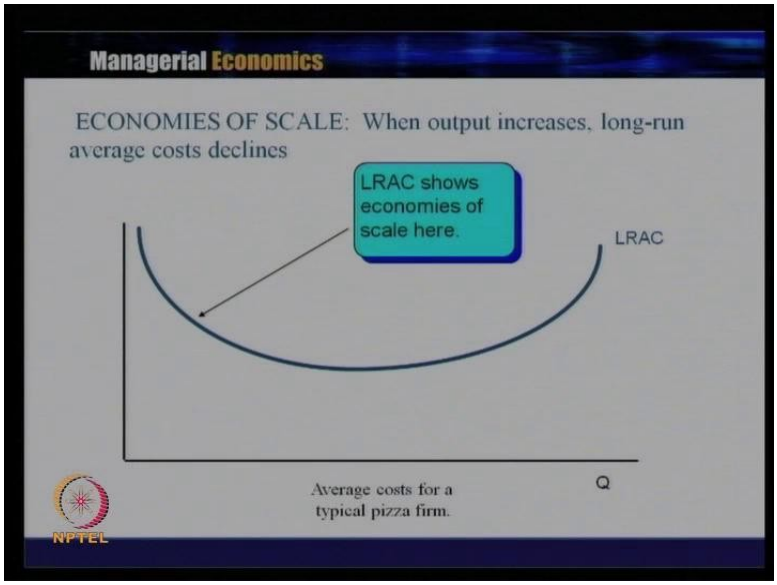

So, economies of scale basically what is the meaning of economies of scale. When output increases, long-run average cost curve decreases and that is the reason the long-run average cost curve is decreasing at the initial stage and that is because of economies of scale.

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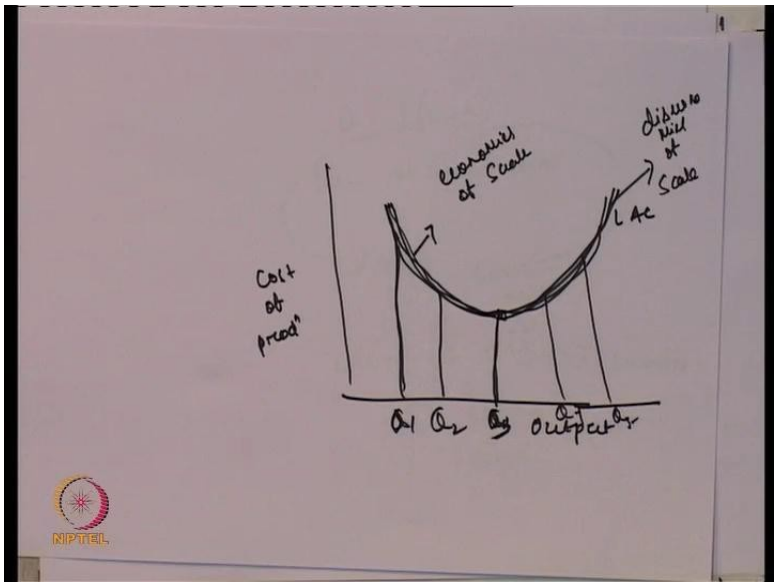

So, if it is a case of U-shaped long-run average cost curve, then at the initial stages when it is decreasing; if you take output here, cost of production here, then generally the long-run average cost curve is follow a U-shaped, where this because of economies of scale the decreasing part is economies of scale and the increasing part is diseconomies of scale. So, what are economies of scale? As you mention that when the output increases, so output is suppose Q_1, output is Q_2, output is Q_3

So Q_1, Q_2, Q_3 at the different level of output, the cost of production decreases and when it is the minimum point; this is the minimum point. This can be called as the optimal output because this is the level of output. Beyond which if you are increasing the level of output, the cost of production increases; so up to this. This is the evidence of economies of scale and beyond this if still the output is increasing, the average cost per unit is increasing and that is the reason this is the evidence of the diseconomies of scale.

So, the decreasing part of long-run average cost curve is because of economies of scale; that is reduced cost of production, reduce average cost of production or may the per unit cost of production and when it is increasing, that is in term of increase in the cost of production or per unit cost of production beyond a certain level of output. The minimum point at the long-run average cost curve is generally known as the point of optimal output; that is the minimum cost that can be by incurring that, that is the maximum level of output what the firm can produce.

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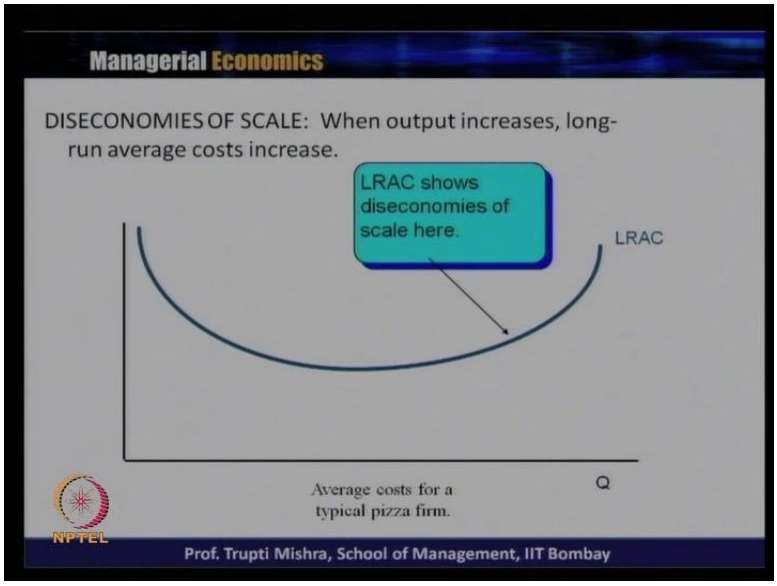

So, again this is the graphical example of diseconomies of scale and the meaning of diseconomies of scale is when output increases, long-run average cost increases and that is in the increasing phase of the long-run average cost curve.

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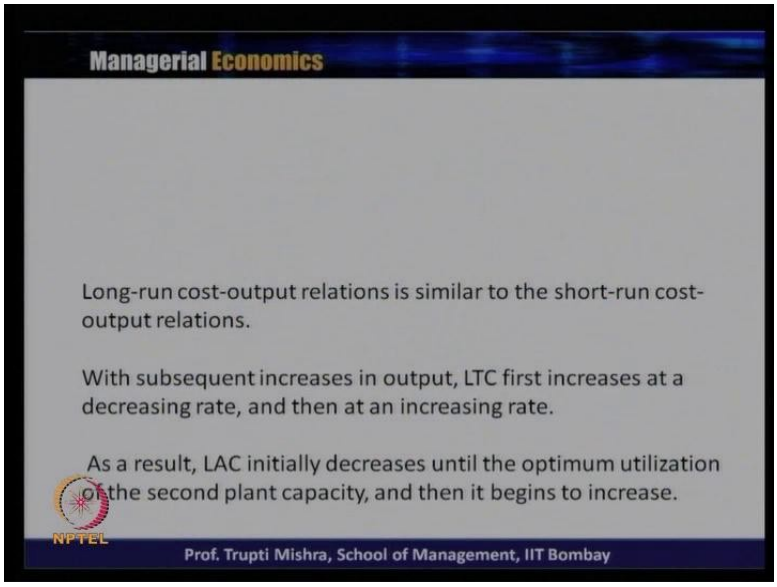

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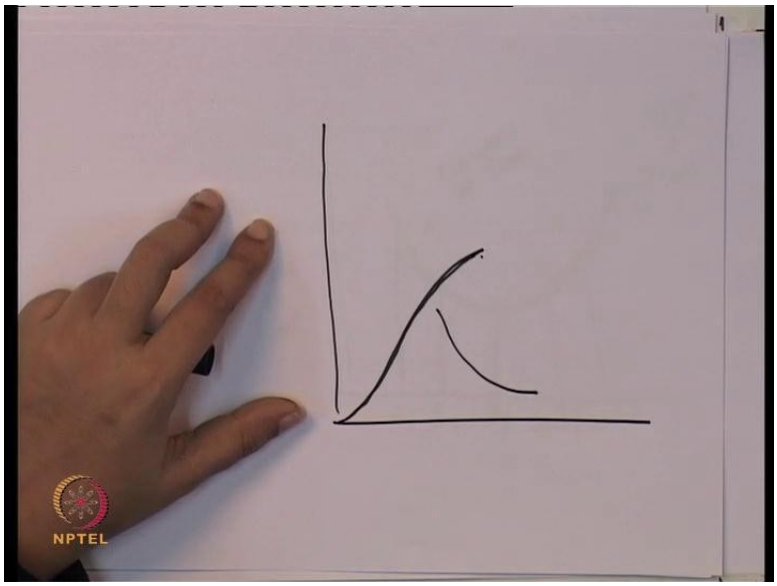

So, if you look at whether it is a short-run cost-output relation or in the long-run cost-output relation, the long-run cost-output is similar to the short-run cost-output relation. With subsequent increase in output, the long-run average total cost curve initially first increases if you look at it first increases and then it decreasing rate, and then at the increasing rate and as a result if you look at if it is the long-run average cost takes this shape that is the reason initially the average total cost or as long-run average cost curve is decreasing. So, with the subsequent increase in the output, long-runs total cost curve is first increases at the decreasing rate.

Then at increasing at the increasing rate and since long-run total cost curve is increasing at the decreasing rate initially, the long-run average cost curve also initially decreases and when long-run total cost curve is increasing at the increasing rate, then generally the long-run average cost curve also increases. Because average cost is nothing but derived directly from the total cost dividing by the number of unit of output. So, as a result when long-runs total cost curve is increasing at a decreasing rate, long-run average cost curve initially decreases until the optimum utilization of the second plant capacity and then it begins to decrease.

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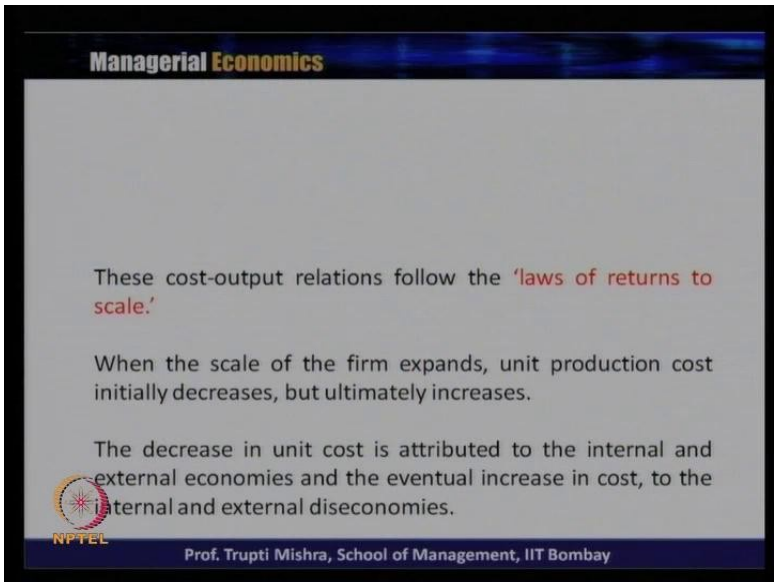

So, this cost-output relationship whether it is a specifically in case of a long-run, it follows a law of return to scale. So, you remember your return to scale that when input increases in a fixed proportion; if the output increases more than that, this is the case of increasing return to scale. If the output increases less than that this is the case of a decreasing return to scale. And if the output is increasing in the same proportion as the input increases, then this is the case of a constant return to scale. So, the cost-output relation in case of long-run it follows the „law of return to scale". When the scale of firm expands, the unit production cost initially decreases, but ultimately it increases.

So initially when the scale of output increases when the level of output increases, then the unit production cost is initially decreases but ultimately beyond a level beyond the minimum cost of production after that generally, the unit production cost is increasing. So, the decrease in the unit cost that is the average cost is attributed to the internal and external economies of scale. As we discussed just before couple of minutes, because economies of scale is the reduced the cost of production and so the decrease in the unit cost is attributed due to the economies of scale which is of two types; one is internal economies and another is the external economies and eventually when there is a increase in the cost that is because of the diseconomies; and diseconomies is again two types. That is internal and external diseconomies.