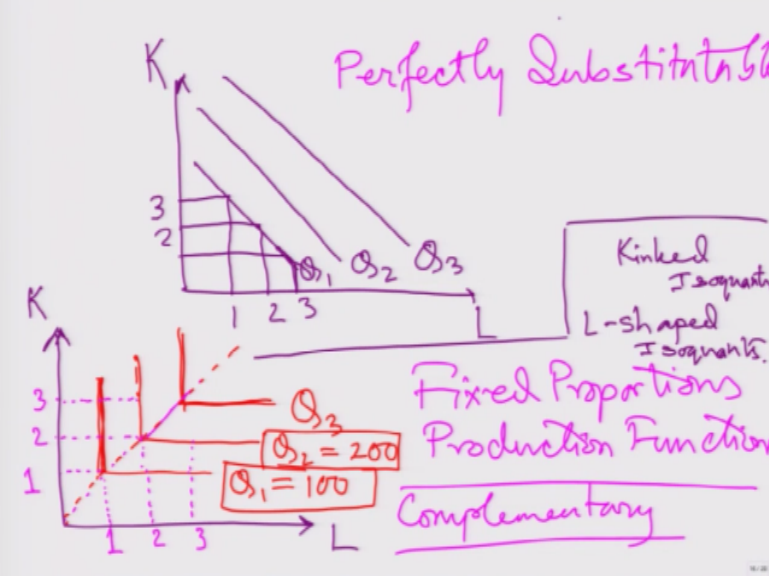
Economics of Health and HealthCare
Prof. Deep Mukherjee
Department of Economic Sciences
Indian Institute of Technology- Kanpur
Prof. Angan Sengupta
Department of Management, Amirtha Vishwa Vidyapeetham, Bangalore

Lecture - 13
Returns to Scale

After discussing about these isoquants now we will try to give you the 2 different types of isoquants and it is shapes, you know, generally we have seen that isoquant is downward sloping convex curve, but what happens when the 2 commodities or the 2 inputs not the commodities, 2 inputs are basically you know perfectly substitutable between each other. In that case when we have 2 inputs which is perfectly substitutable that I can substitute by 1 labour with exactly 1 capital or something like that.

(Refer Slide Time: 00:54)



Then my isoquants will be kind of straight-line, my isoquants will be kind of straight lines and parallel to each other, yes and each of these isoquants will give you a particular level of output. Now what does it say, again I can keep labour and capital over here, now what does it say, this you know these straight isoquants that the diminishing marginal rate of substitution technical substitution what we are saying or diminishing marginal return then when we are increasing 1 unit of capital or labour we are sacrificing less and less of the other unit is not it.

So that is the diminishing marginal rate of technical substitution, but what happens if over here I have 1 unit of labour and 3 units of capital and over here I have 2 units of labour and 2

units of capital and over here I have 1 unit of labour and probably 3 units of capital that means they are technically perfectly substitutable. I am substituting 1 labour when I am increasing 1 labour, I am sacrificing 1 capital.

When I am increasing another labour I am sacrificing one more capital, so they are perfectly substitutable right and hence you get your isoquants which is straight lines, which are straight lines and when the output increases with those perfectly substitutable products I mean factors of production we see output increases with more of a particular factors of production or both of the particular factors of production if more of a one then the other remaining same more is better we see the quantity of production is increasing parallel.

I mean the isoquants are moving parallely outwards. What happens when we have a fixed proportion production function, you know, they are kinked, kinked isoquants, fixed proportion. So here the factors of productions are substitutable or I will say perfectly substitutable, perfectly substitutable and here in these fixed proportions production functions they are kinked isoquants.

So what we find in fixed proportions production function that if we have the labour and capital, if we have labour and capital and I can draw my isoquants like this L-shaped. These isoquants will shape L and then this is my isoquant 1, isoquant 2, isoquant 3. Something like this, isoquant 3, which shows 3 different level of production. Now why do they look like this? This can eventually be you know when our goods are also complementary to each other.

My, I mean the factors of production are complementary to each other. What does this mean? This means let us take my labour is an exclamation operator and my capital is an exclamation. Now 1 x-ray machine can be operated by 1 operator. What happens if I have say 1 x-ray machine, but 3 x-ray machine operator and in a day with 1 x-ray machine I can manufacture maybe or I can produce maybe 100 x-ray sheets, x-ray copies.

Now when I have 1 labour with 1 machine with 1 x-ray machine I can manufacture 100 when I have 2 labours with 1 x-ray machine, I can manufacture 100 when I have 3 labours with 1 x-ray machine I can manufacture 100 right. Similarly, because even if I have 1000 operators but one x-ray machine I can maximum manufacture 100. Similarly, if I have 1 manufacturer, but I have 2 x-ray machines I have 3 x-ray machines does not matter.

Because 1 manufacturer can operate only 1 x-ray machine, or even if he is shifting, you know it does not really matter because the total output will remain same 100. So on this particular isoquant all this combination 3 capital 1 labour, 2 capital 1 labour, 1 capital 1 labour, 1 labour 1 capital, 2 labour 1 capital, 3 labour 1 capital will all give me 100 x-ray sheets. Similarly, if I take this example for Q2 = say 200.

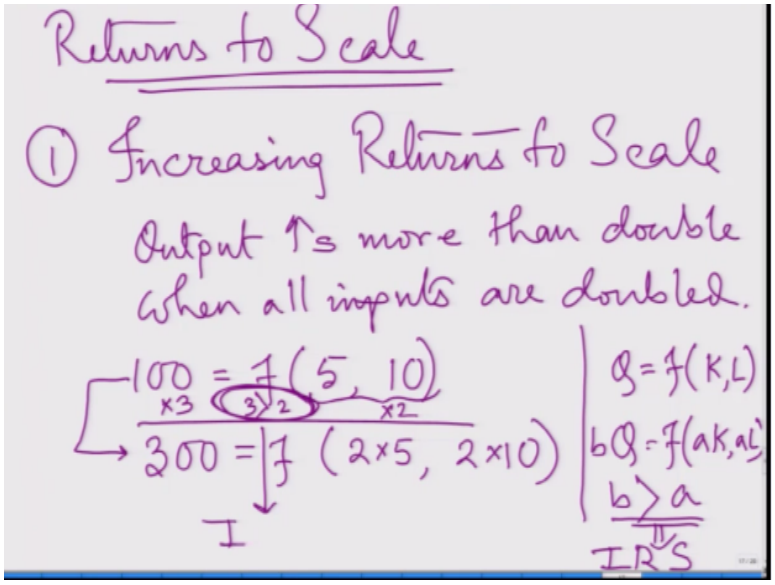
Here I observe that with 2 labours and 2 x-ray machines because with 1 labour I cannot manufacture more than 100. Similarly, with 1 capital with 1 x-ray machine I cannot manufacture more than 100. So I must require you know 2 labour and at least 2 labour and 2 capitals for this 200 x-ray sheets or x-ray charts. For this I have 2 labour and 2 capital. Similarly, if I have 3 labours but 2 machine only 200 or 3 labours 2 machines only 2 machines can be operated because I have 2 labours here I can manufacture 200.

So this is a fixed proportion, so the proposition remains fixed which is this proportion is generally the optimal proportion is generally given by this straight line. You know, 1 labour 1 x-ray machine, 2 labour 2 x-ray machine, 3 labour 3 x-ray machines, and all this kink you know the corner points of this L-shaped isoquants or kinked isoquants that is how they are known. Kinked isoquants or L-shaped isoquants, shows this fixed proportion production functions or complementary factors of production.

Now going to the returns to scale slowly we are moving towards the, towards demurrage between production and cost and how effective that mirage will be and how efficient will be the choice you know keeping the you know, looking at the total output given the budget and then based on that budget I will decide how many labours or capital I will recruit.

Having said that we have to think, now we have understood that we have idea about or we can get idea about combinations of capital and labour with a given production function or with an objective or particular level of production. So for that I need to understand that whether my capital and labour are working efficiently or not, you know even if cost does not come to the picture yet.

(Refer Slide Time: 10:00)



So that idea can be generated by the concept of returns to scale, returns to scale. So it shows it measures the relationship between the scale of production of the firm and output that how many production, how many output or what is the amount of production is possible given the output, the scale of output, scale of the firm or the size of the firm given the output, objective output.

Now one is increasing return to scale, now increasing returns again returns is my output when my output is increasing to scale. Scale is here, what is the scale of your production that how many labours, how many capital you have, in a hospital setup or something like that, how many doctors, how many consultants, how many surgeons, how many beds you have in your hospital that is the production right, that is the scale of, that is a potential input that particular hospital has.

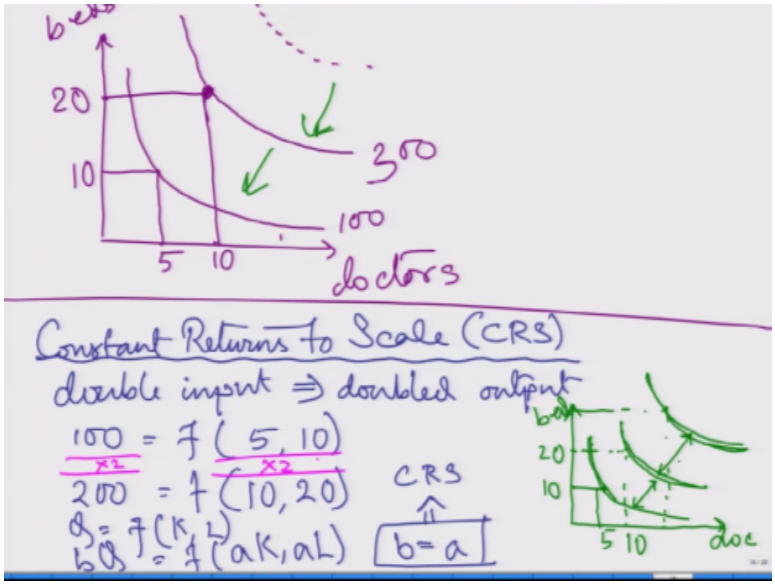
So increasing return to scale means just taking an example when my output, when output increases by more than double, more than double, output increases more than double when all inputs are increased by double or all the increased are doubled, you know, increased by twice or doubled, all inputs are doubled. Yes, that means I increase my capital.

If there were 5 capitals I take it to 10, if there are 5 labours, I take it to 10, 5 capital and 5 labour if I will write my production function as say 100 of patients being served with 5 doctors and say 10 beds. Now what I do I multiply these number of doctors and number of beds by 2 and I will try to see what is the patient turnover or the treatment. Now with this 10 doctors and 20 beds my number of patients being treated increases by 3 times right.

So if I can write it like this if Q = function of capital and labour and when I increase my capital and labour by a units and I observe my output total product is increasing by b times then if my capital and labour increases by a times, my output increases by b times and if b is greater than a that is the rate at which output increased if that rate is more than the increment of the capital and labour that rate of increase of capital and labour.

If b is greater than a then there is an IRS which is increasing returns to scale. Over here this is multiplied by 3 and this is multiplied by 2 and then 3 being greater than 2, I have an increasing return to scale.

(Refer Slide Time: 14:25)



If I plot them I will observe that these in isoquants make a larger curve and then with 5 doctors and 10 beds I was treating 100 patients and then with 10 doctors and 20 patients with 20 patients and 10 doctors, if I am on this isoquant and I have 300 patients being served then I have achieved an increasing return to scale, yeah and if in increasing return to scale actually the curves are you know the isoquant curves should move closer to each other.

Otherwise this 300 should have been further away because if this is being 5 to 10, 10 to 20 it essentially should be 200 and this 300 should be somewhere here with 30, 30 and 15, but it has moved closer, this 300 has moved closer to the place of 200 which shows that during increasing return to scale the isoquant curves will move closer to each other and similarly when I move from you know 1.5 times.

Say 10 to 15 and 20 to 30 capital with number of doctors and number of beds then what I find instead of, now this is 300, instead of increasing from 300 to 450 probably I will observe that it is giving 600 that means my capital and labour increases by 1.5 units but my increasing you know the output increases by 2 times so that is an increasing return to scale. So whenever you have an increasing return to scale you must invest in that because you are getting more output than your investment yes.

And you have to understand in which that means if you are you know if you can increase your scale of production and your returns are increasing more than the increment in the scale of the production then there is a profitable input and you know you are making an effective implementation, yeah. So at the same time when we have the constant return to scale it is not very hard to understand that the output when we have constant returns to scale it is CRS.

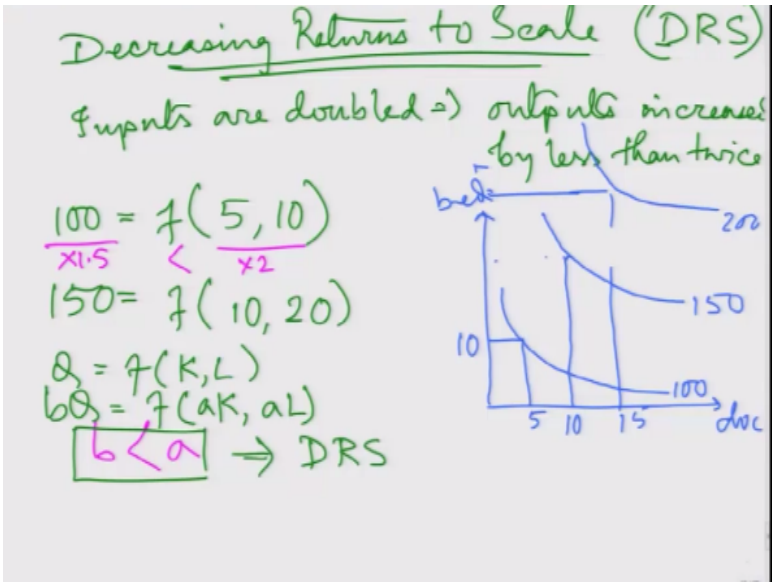
It is not very difficult to understand that when I double my input, will lead to exactly doubled output. Doubled input will lead to exactly doubled output that means if 100 was my production given 5 doctors and 10 beds, now when I increase my doctors and beds by 2 times when I increase my doctors and bed by 2 times and I get this 10 and 20 we can observe my output is also increasing by 2 times and we get 200.

Therefore, if I write it like this Q = f KL as a function of capital and labour and b * Q is a function of aK and aL and if my rate of increase of output = to the rate of increase in capital and labour then there is a constant return to scale, this shows that there is a constant return to scale that means how much I am increasing my scale, there is a same level of increase in the output and if I try to draw them then we see that the isoquants are in the equal direction.

So if this is 10 and this is 5, this is my doctor and this is my hospital beds, if this is 5 and 10 and I increase if this is 5 and this is 10 and if I increase my scale by 2 units where I have my 10 doctors and 20 beds and I can observe that my isoquant exactly doubles similarly if it increases to 15 and 30. So these 3 isoquants if they are equidistance then we have achieved our constant return to scale, yeah.

What happened in IRS, what happened? They came closer over here they are equidistant. So we are on a constant return to scale and decreasing return to scale is when.

(Refer Slide Time: 20:36)



Decreasing return to scale, DRS is when our input increases by twice, but output increases less than doubled, right. So inputs are doubled, but outputs increased by less than twice, yes, that means if I had 100s of units being produced with 5 doctors and 10 beds and if I multiply by them increase my scale by 2 units and we find that our with this 10 doctors and 20 beds my production is only 150 patients.

You know which is multiplied by 1.5 and this 1.5 being lesser than 2 or if we take the previous examples a < b, I am sorry, b < a when Q = function of capital and labour and the new production function says when I increase my capital and labour by a units I get bQ as my output and where my b < a it shows that I am on a decreasing returns to scale that means my output is not actually increasing at that level how much they were you know were supposed to increase or at the same rate.

So in the decreasing return to scale we see that the isoquants move further away from each other. So if we have this isoquant and this with 10 and 5, this is my doctor and this is my beds and if I am here then with 10 and 20 if this is 100 and then with 150 I should have 7.5 doctors and 15 beds right. I should have 7.5 doctors and 15 beds, but I see that I am actually getting with 10 doctors and 20 beds this amount of 150 right.

With for more, you know with maybe 15 doctors and 30 beds I am at around say 200, but this 200 should be somewhere here. So they are the isoquants are moving away from each other, yes, so now from 5 to 10, 10 to 15 you have again multiplied here by 1.5 over here you can see that it has increased by even less than 1 time. So or just 50 units out of 150. So here it

shows that the isoquants are moving far away from each other that means the production process is inefficient. Thank you.