Marketing Analytics
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Lecture 18
Demand Forecasting and Pricing

Hello everybody. Welcome to Marketing Analytics course. This is week four, so module four as well, we will be talking about demand forecasting and pricing in this particular module. And this is Doctor Swagato Chatterjee from Vinod Gupta School of Management, IIT Kharagpur who will be taking this course. So, till now we have discussed about what consumers want and what kind of, how I can break them into multiple groups and etcetera.

In this particular course, we will try to focus, in this particular module we will try to focus on what are the, how I can know that okay, so if I know what customers want and I can have an offering for meeting that particular demand of the customer or need of the customer, how much demand we will be getting generated.

So demand forecasting or sales forecasting is something that is the purpose of this module and also another major predictor of sales is basically pricing. We will also focus on what kind of, how I can do pricing to actually play with demand. So, in the first session, we will try to just focus on, just assume that you know the demand function, you know how price impacts demand and we will see that what kind of, how I can optimal, I can find out the optimal pricing which can lead to the highest demand or if not the highest demand, the maximum profit.

So this is something that will be the major focus. So the first two, three slides will be more focused on pricing and then the next videos will be more focused on demand forecasting. And in the next module, we will do advanced pricing as well. So basics of pricing, basics of demand forecasting that will be in module four. And module five will be on advanced pricing, more detailed version of pricing.

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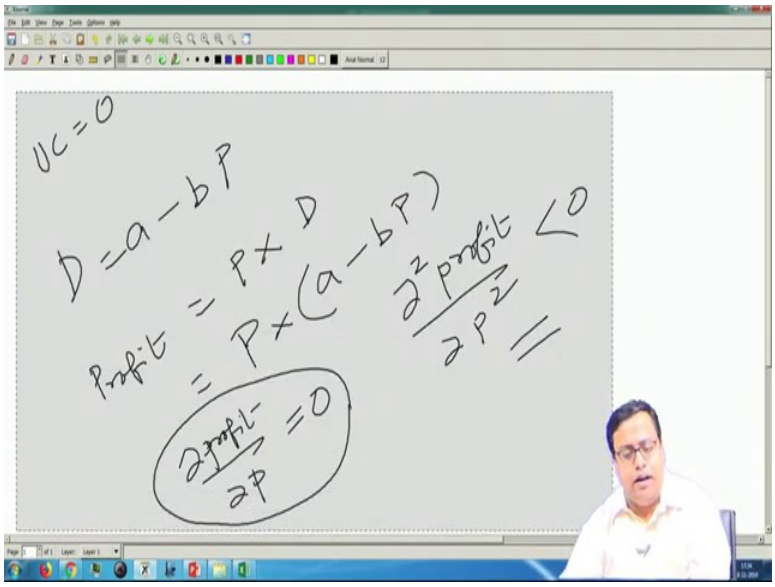

So, I will come directly to my job. So I have a blank Excel file and I will work on this one. So we all know from basic, basic economics that demand is a function of price. So we can say that okay, let us say demand (D) = a- bP where a and b are both positive let us say. That means price increases and demand drops. So if I have to find out what is the maximum and if I consider that my unit cost (UC) = 0, then what will I do to maximize my profit?

My profit is basically nothing but price(P)×demand(D) because unit cost is 0. So there is no cost involved. So that means price(P)×(a-bP), something like that. And what we do is we try to find out at what case the del profit, $(\delta Profit)/\delta P=0$ and also $\delta^2 Profit/\delta P^2<0$. That is where you find out the maxima. So this is from economics 101, basic economics we can know that.

So this is where profit maximizes. So to check that whether that point is a maxima or a minima, we have to do a double differentiation and that double differentiation has to be negative. Not always the profit function is so simply given, not always, it will be linear. When it is linear, it is easy to solve. I can find out a close form solution when it is not linear or when it is something, some other different I would say type it gets difficult to find out what is my optimal pricing. So we will use analytics to find out what is my optimal pricing.

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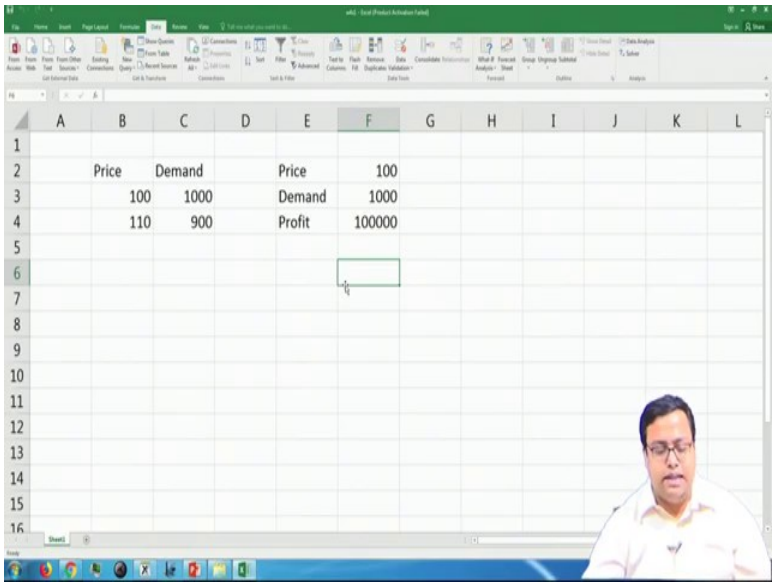
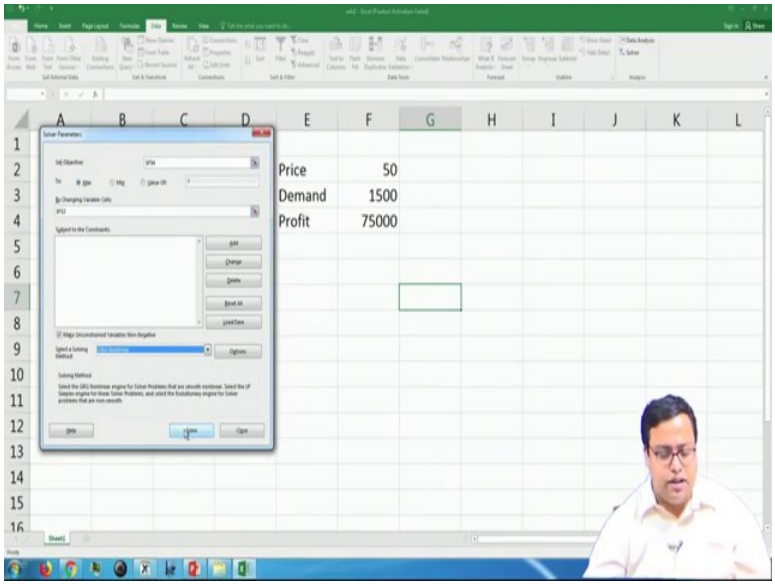
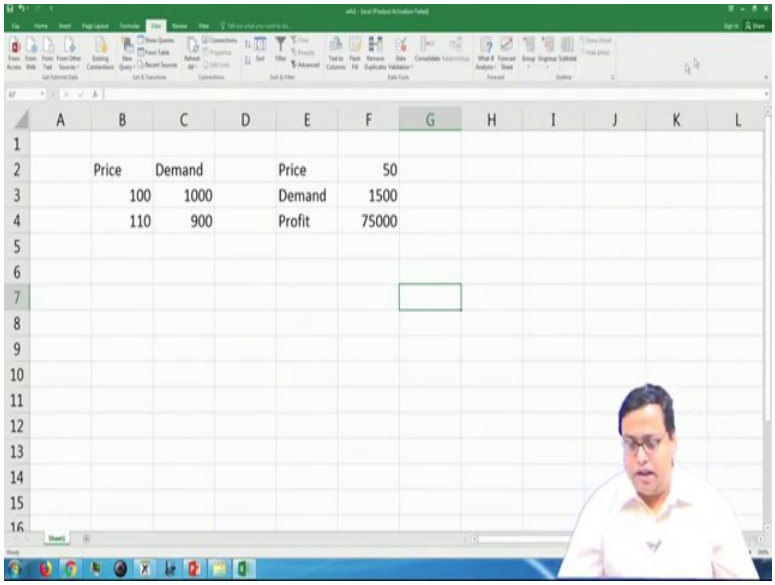
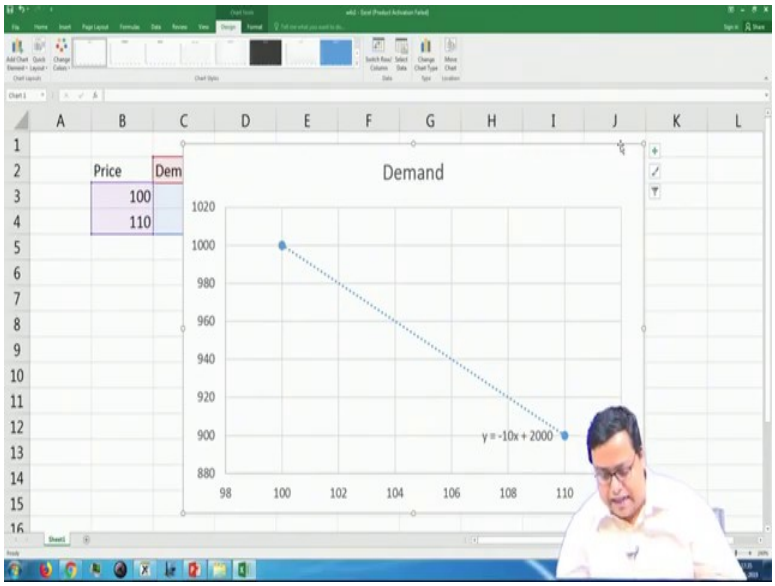
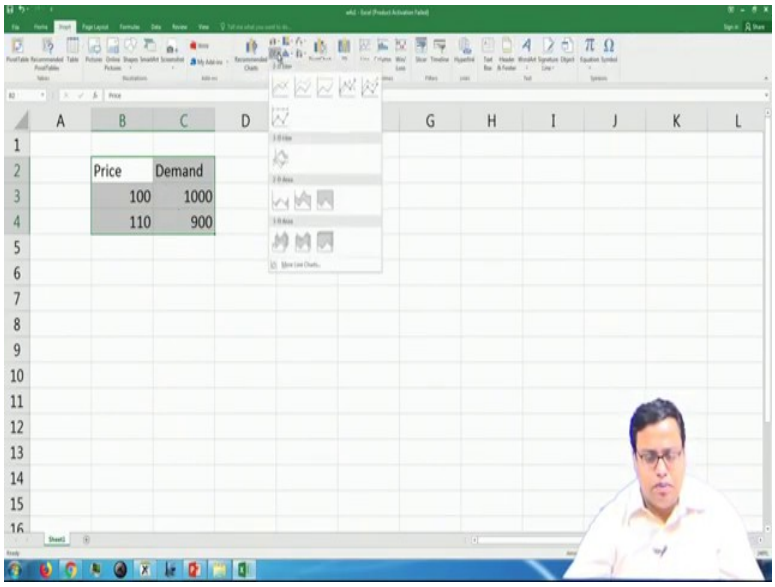





Price Demand
100 1000
110 900
Price 50
Demand 1500
Profit 75000


Price
100
110
Demand
y = -10x + 2000


Price Demand
100 1000
110 900

So let us say to start with, let us say I have a product which has, I have a product which has different kinds of demands for different kinds of prices. Let us say here the price is 1,000 and when the price is 100, the demand is 1,000. And when the price is 110, the demand is 900. So the first job is to find out that, so this kind of data will be there the price and the demand and first job is to find out what is the relationship between the two.

So I will quickly try to find out a linear plot between two because I have only two these things, so I will try to find out a, basically I will try to find out x, y scatter plot. Let me find out x, y scatter plot. So it looks like this. And if I just add a trend line, so I add a trend line and when I trend a line this is the equation on chart. If I do this, it is giving me the equation is actually -10X. You see it is written here, y=-10X+2000; so 2000-10X is the formula for this particular point.

So I can say that if the price is let us say 50, then the demand will be 2000-10×50=1500. And what will be my, if the unit cost is 0, what will be my overall revenue or profit in this case? If the unit cost is 0, remember the unit cost is 0, then it is nothing but demand × price. Fair enough. Now I have to all, what I have to do is I have to maximize my profit by changing my price. So what do I do?

I just see that whether there is a solver, so there is no solver here. If there is no solver here, you have to go to file options, add-ins, files option, add-ins and see at the bottom there is a Excel add-in kind of thing. So you have to press on go, check solver. We may also use analysis ToolPak at a later point of time, so check that also and press okay. And you will, if you just press okay, we will get the solver button here. So we are fine, solver button is here. So I will click on this solver button and what do I set?

My set objective function is this particular cell, F4. F4 is my objective function, objective cell which I am trying to maximize and I will actually by changing with cell, by changing the cell called price, I am changing the price cell. And price make unconstrained variables non-negative. Now price is my only unconstrained, independent variable which can change and again non-negative. That means the lowest possible value of price can be 0, it can be higher than that.

So if I now try to solve using GRG non-linear, that is why we will start and we will see that for other things if there are other options available, which one we can use. Right now GRG non-linear, solve and it is saying that okay, I found a solution, so okay keep that solution and

it is saying the optimal price should be 100, demand at that time will be 1,000. So this is my actual optimal solution.

So this is something that will get and I will just name that as let us say, linear feet, something like that. So that is something that is the first job. So if I have a linear function, this is how you have to solve.

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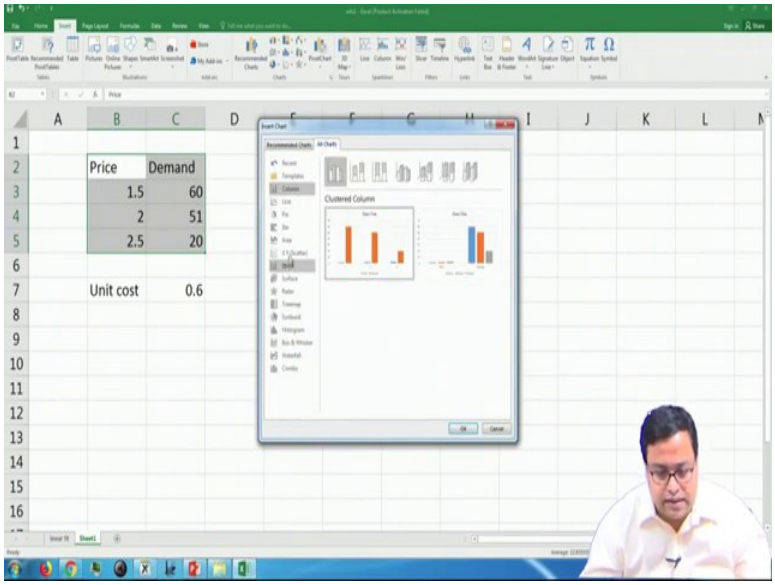

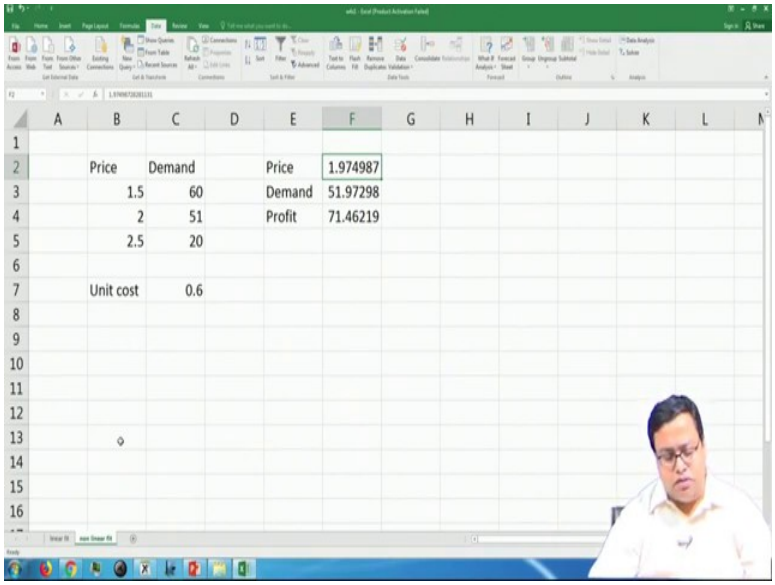

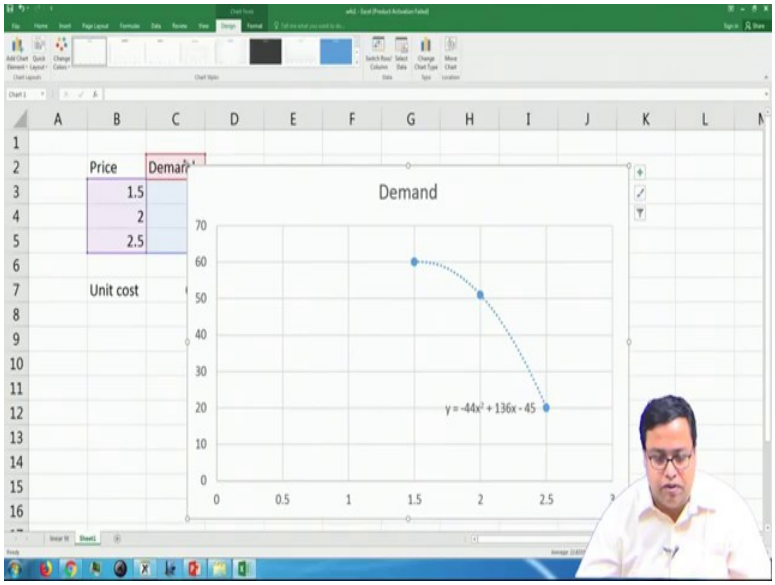

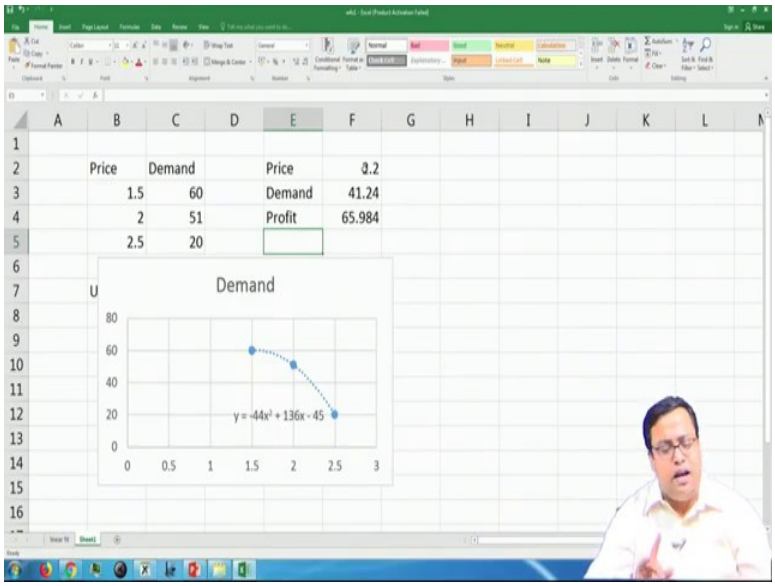

Not always you will have a linear function, not always all demand functions will be linear. There can be non-linear demand functions also. So what I write is price and demand and let us say I have certain non-linear, 1.5 and then 2 and 2.5 and correspondingly, I have let us say 60, 51 and 20 some demand.

And I know also that my unit cost is something let us say 0.6, I am not sure, 0.6 let us say. If this is something that has been given to me what will I do? Again, as usual I have to plot a non-linear, so this is not linear. You will see that this thing is not linear. So I will first plot a scatter plot. So insert x, y scatter plot and this curve. And you will see that it is exactly not linear. So if I just add a trend line, the linear trend line will look like this.

There is lots of options. Let us say I use logarithmic it does not look good, I might use power, it does not look good. Polynomial, okay polynomial looks good. And this is the equation on chart. So the equation is basically $y=-44x^2+136x-45$. So that is my equation. So I will remember this. Probably I will put it here. So now if my price was by chance let us say the price was by chance 2 rupees or let us say 2.2 rupees, then corresponding demand will be how much?

The corresponding demand will be (D)= $-44\times x^2+136\times F2-45$. That will be my demand. So this is my demand, the demand is coming to be 41.24. Fair enough. And my unit cost, if you remember the unit cost has been given as 0.6. Then my profit will be basically Profit= Demand×Price- Unit Cost. So this -0.6, let us say I make it hard coded, 0.6, so that is my profit.

So now what is my job? As simple to before, I have to maximize profit. So maximize f4 by changing what? Tell me by changing what. Changing F2, very good.So I will go to data as usual. So I can probably now delete this one. I will go to data, solver, okay, I want to set objective function here, f4. Maximize this by changing price and this will be unconstrained. Solve it and it give me solution. So very close to 1.9745 and etcetera. My solution and your solution might be little bit different depending on the software that you are using or the computer that we are using, the processor speed and etcetera.

There are various factors but probably it will be pretty close, the values will be pretty close. So here this is how I solve and if I, if we use some other, if we use R for algorithm purpose for solving this kind of optimization, this will become further closer. So this I am naming as non-linear feet, so that is also one way. So in all, all you have to do in that case that if you purchase a demand and make a price, you have to find out how this demand and price are related.

And if you are able to find out how these guys are related, you can actually find out the optimal price as well. At what you should sell this particular product. So I got linear feet, non-linear feet. Now there are other kind of pricing where we call it as a, so I forgot the name of the pricing but where we not always actually try to maximize the profit for one product but we try to maximize the profit for a combination of products.

For example, let us say my classic example is probably will be the Xerox machine where you know that okay, so that particular product is of high cost and probably the price in which it is

sold is much lower than the cost even if I do a profit maximization. But what they do actually charge you is on the usage and not on the capital items. So they charge you on the cartridges, on the paper, they make business on that. For a very long period of time that was the case and they did not actually charge much for the actual machine which is highly costly at that initial period of time when the productivity, the usage, the number of people who will use is low.

So similar thing is here, I will give an example. So in the next part, we will talk about another type of pricing which is called let us say, but it is a two-part kind of, so where you actually focus on, there is a capital item with which you actually capture the customer. Now for that capital item, when you try to use that capital item, only the company's products can be used. For example, let us say for a very long period of time you could only use some specific ink and let us say the pages in Xerox machine.

Now that is something was done to make sure that the price of the Xerox machine that they used to charge was not actually, probably sometimes it was lower than the cost. They are making loss there but they were making huge profit on the usage and how? When they were charging on the ink or charging on that particular papers.

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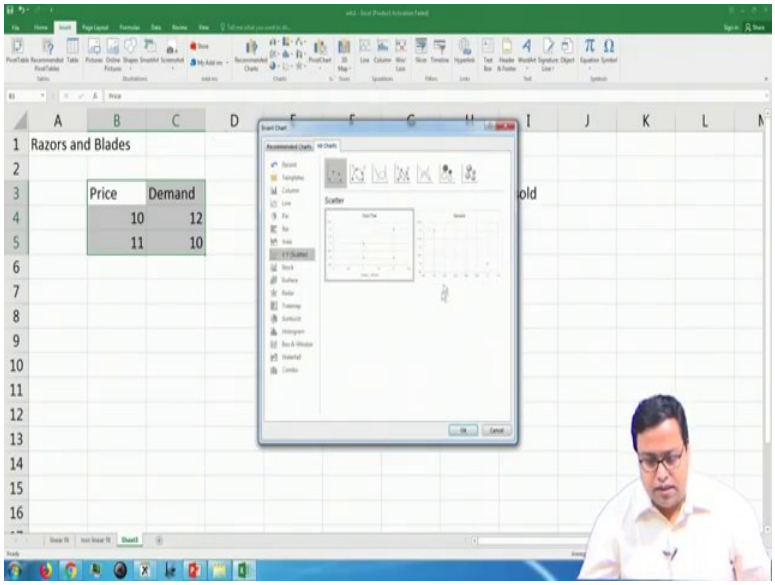

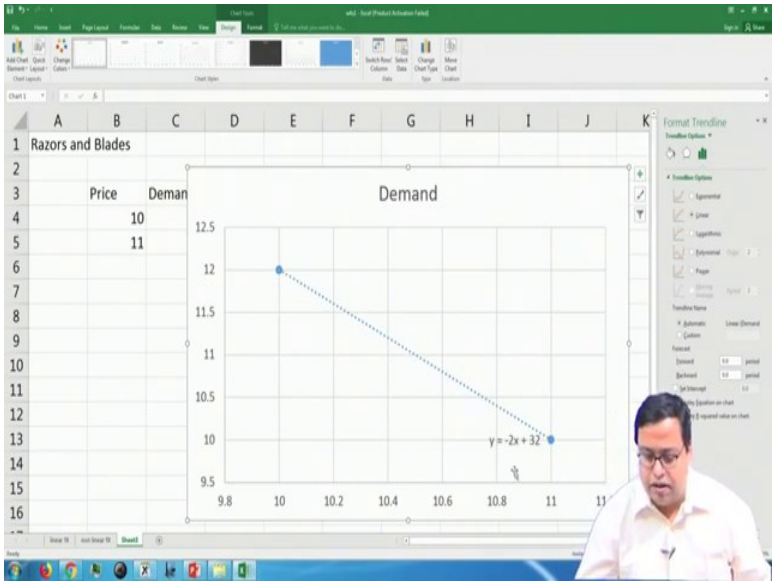

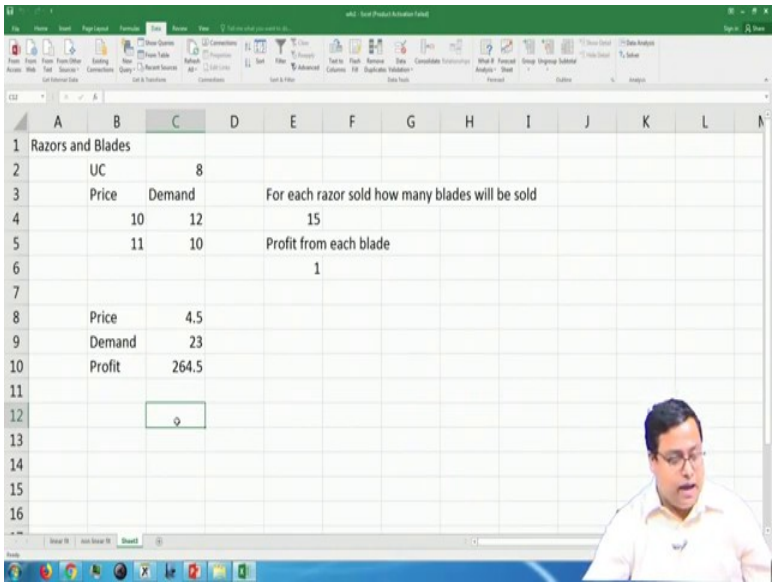

Similarly, a classic example is let us say, razors and blade. So often the blades are actually of the Razor Company, you cannot use somebody else's blade. So let us say the demand and price of this thing is let us say 10, 11, when it is like that it is 12 and 10. Something like this is the demand of the razors. And correspondingly, for each razor sold how many blades will be sold? So how many blades will be sold? For each razor sold the how many blades will be sold is let us say 15 and let us say profit from each of these thing, each blade is around 1 dollar.

Now this is the situation, this is the case that has been given to me. That, there is a demand function for the razor and for each razor sold I know there are 15 blades that will be sold and I can charge, I can get, I can earn 1 dollar per blade. Now how much should be the price? And this is a classic case and I will show you something here. So the first thing first, I will

create a plot here. x, y scatter plot, I will use this one and then okay, and then I will include a trend line and the trend line is linear.

This is the equation on the trend line, it is 32-2X, that is the trend line. So when the demand is let us say, when the price is around let us say 8 rupees, the demand is nothing but basically (32-2×8) rupees. And let us say this is also given that unit cost is also 8 rupees. Let us just assume. So then how much is the profit? The profit is nothing but basically profit=Demand×Price-UnitCost. So when I charge 8 rupees for something which has unit cost also as 8 rupees, I get profit as 0.

But this is not closed here. I also get some amount of money from the blades. For each of these 16 demand, I get 15 razor for each of them and how much money for them? 1 dollar. So this is my profit. Now easy thing, I have to maximize this by changing this. So I go to data, I will solver, maximize c 10 by changing c 8 and solve. The moment I solve it, I get 4.5 as my optimal price. So carefully see what this mean. 4.5 is the price that you are charging for each razor. The unit cost of razor is 8 rupees, 8 dollars.

So you are actually charging less than the unit cost. You are making a loss on every razors sold but you are making money, how? Because every razor sold will also be 15 blades. And each of those 15 blades give me 1 dollar. So that is where you are making profit. So you are making sure that I will charge in such a way such that I have enough razors sold so that I can make a quite a bit of money from the blades also.

So this is another type of pricing which is let us say, which is different from the previous one, we call it two-part actually. And then comes let us say, but till now we have considered that our unit cost will be fixed. So I have, so what if the unit cost is also variable? Why the unit cost will be variable? Sometimes the it is the make to order. That means you get the order fast and then you produce.

So, if you get the order fast, based on your marketing initiatives you got the order and then you produce, that means that if the marketing initiative is such that the order volume is high, your unit cost will come down due to economies of scale. So the marketing expenditure, this price whatever you are doing if this price impacts demand, and you are saying that this demand will impact unit cost, then the profit function will be different and you have to think about that.

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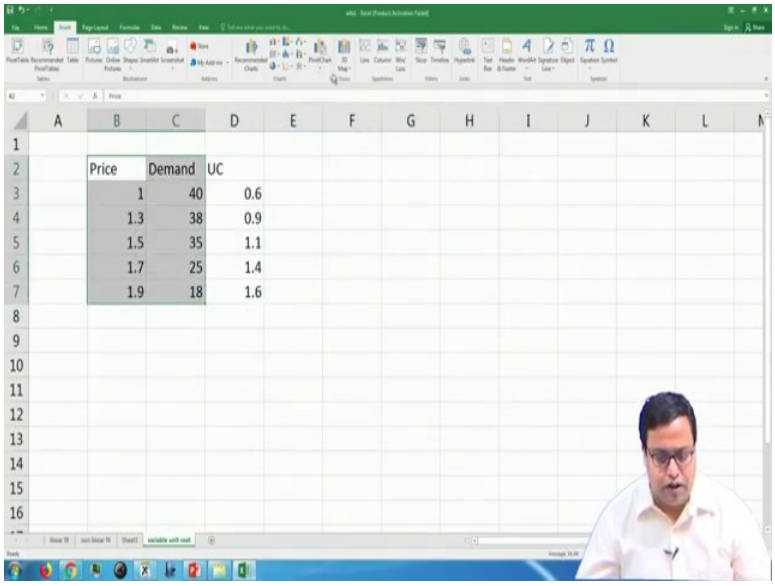

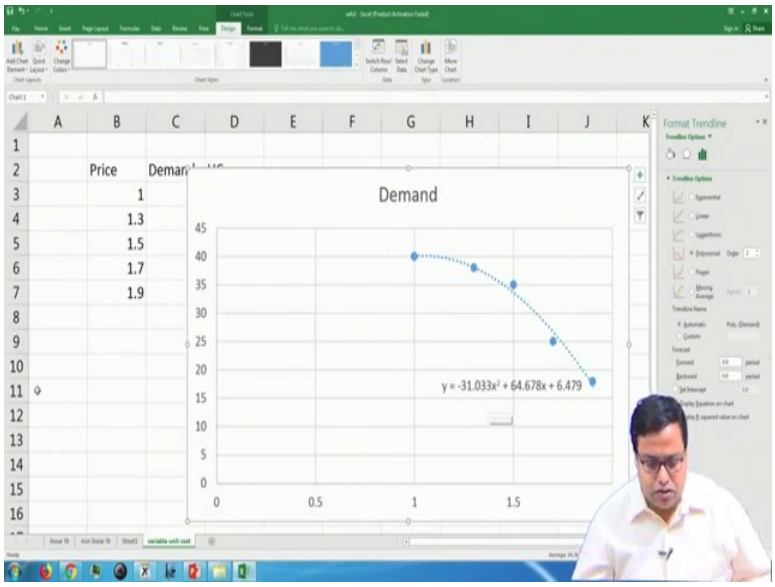

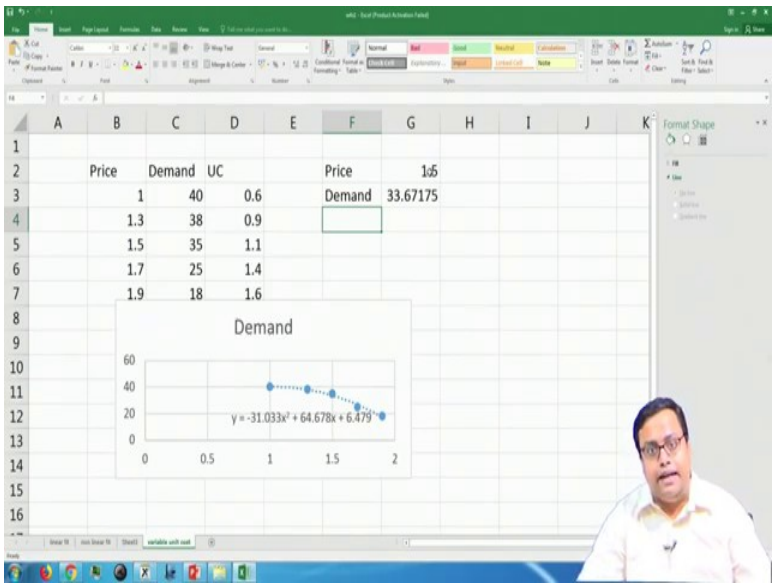

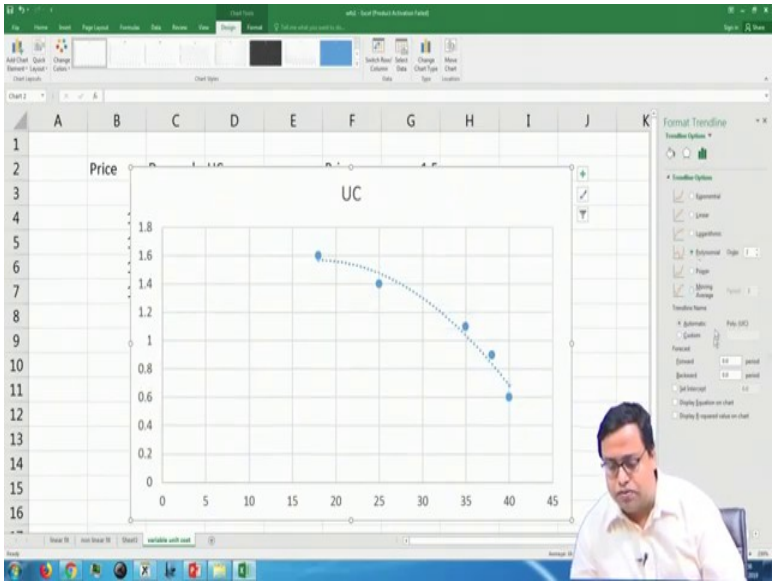

So I am writing something where price, historically price, demand and unit cost has been listed. So what is the price? The prices are actually let us say, 1, 1.3, 1.5, 1.7 and 1.9. These are the prices that has been given to me. And what is the demand? The demand is let us say 40, 38, and then 35 and let us say 25 and 18, something like that. That demand is given and what is the unit cost?

The unit cost is 0.6 and then 0.9. As the demand goes down, the unit cost goes up. So 1.1, 1.4 and 1.6. So this is my, this is the data that has been given. That is all. Now what? Simple whatever we have done before, I am inserting a x, y scatter plot. First, here my, x, y sorry, I will insert x, y scatter plot for these two first. So x, y scatter plot and this is how it looks like. x, y scatter plot, I will include a trend line and the trend line should be, it should, it is going down.

So polynomial, fair enough, polynomial looks good actually, should I increase the power? No. I am okay with this. And display equation is what is important. So the equation for demand is basically like this. So if the price is by change if I price it as let us say 1.5 rupees, corresponding demand will be basically Demand=$-31.033\times G2^2+64.678\times G2+6.479$.

So this is my demand that I will get. And what is the price? What is the unit cost? The unit cost is this thing. So I will insert another x, y, now unit cost will depend on the demand because the more you make the less is the unit cost. So as production increases, your unit cost goes down. And if I add a trend line and again I use a polynomial, let us say I am not sure, a polynomial works well. This is the equation chart, this is the equation that I get.

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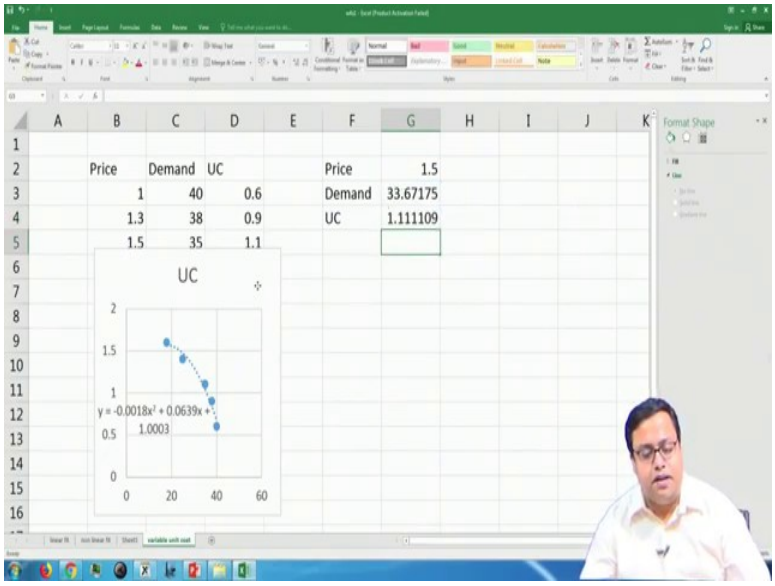

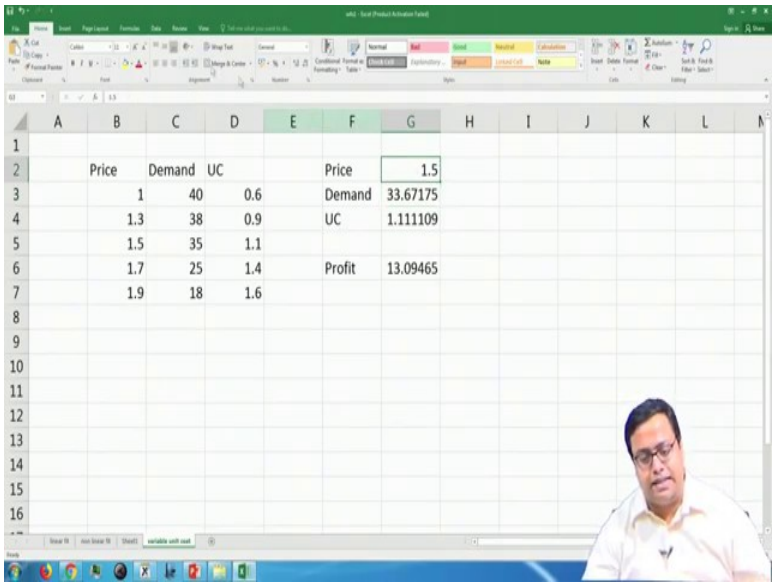

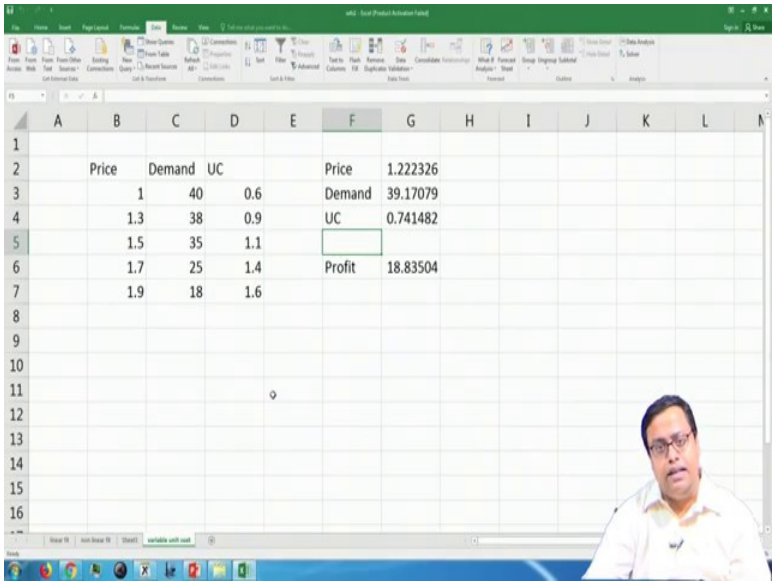

What is the unit cost? Unit cost will be a function of demand. So unit cost will be basically UnitCost=-0.0018×$G3^2$+0.0639×G3+1.0003. Fair enough. That is my unit cost. So now what will be my profit then? My profit is nothing but Profit=Demand×Price-UnitCost. So that is my profit. So this is my profit. Now see demand is dependent on price and unit cost is dependent on demand.

That means the only guy who is actually floating around is the price. So I have to optimize, maximize my profit by changing price and price has to be non-negative. Solve, got a solution. And it is saying the price should be 1.22. So here it is a little bit more mixture where the unit cost is also dependent on your price through demand, so that is something that is interesting. Now the last thing that I will talk about is the basics of bundling. So actually we will discuss on this thing in the next slide. The basics of bundling probably we will take a small video on basics of bundling and then we will go ahead with demand forecasting.

If here we are all doing it through Excel, the demand curves and etcetera but how to actually forecast if you do not have an Excel and if you have a huge data, how to find out the demand curve? Is something that is important. So in the next videos, we will actually discuss about that in this module. So thank you very much for being with me in this particular module and I will see you in the next video. Thank you.