Forecasting

Revenue maximization

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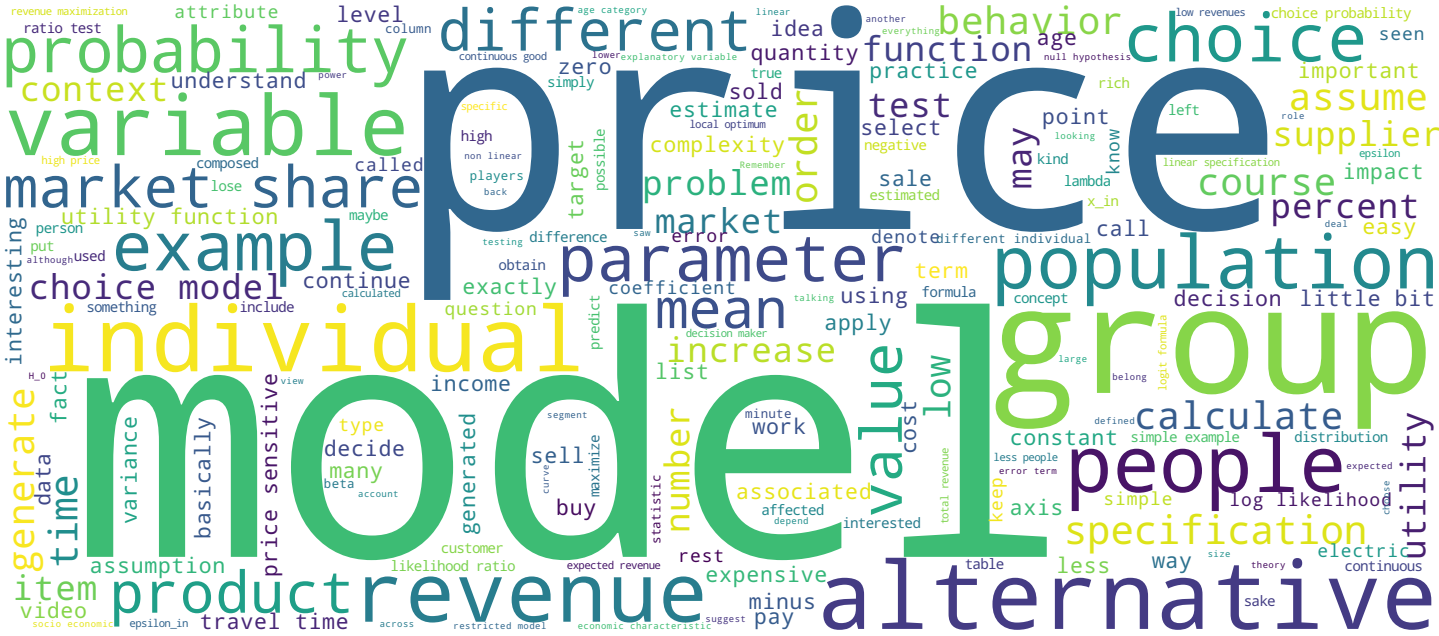
Introduction to choice models

ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE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Revenue maximization

Hello, in this video, we will look into another application of choice models. We will look at the problem of maximizing revenues taking into account the decision of your customers.

Notes

Summary

0m 04s

Revenue

Supplier i

- Consider the supplier of alternative i in the market.
- The price offered to individual n is p_{in}.
- The expected revenue generated by individual n is

$$p_{in} P(i|x_n, p_{in}; \theta)$$

- The total expected revenue is therefore

$$\sum_{n=1}^{N} p_{in} P(i|x_n, p_{in}; \theta)$$

So when we do that we look at the problem from the point of view of the supplier. So the supplier is the person who is providing alternative i on the market. And this alternative is provided at a given price. So let's denote by p_in the price that individual n will pay for alternative i. This price is decided by the supplier of alternative i. Of course in most markets, the price is the same for all individuals. But let's keep the formulation general. And let's give the possibility to the supplier to provide different prices to different individuals, or to different groups of individuals. Now, if individual i pays the price p_in, the expected revenue, which is generated by this individual, is simply the product of the price and the probability that he selects and, therefore, he buys this alternative. Its p_in times the choice probability. And here when I write the model, I explicitly mention x_n which is the list of all explanatory variables which are in the model, but I've written explicitly on the side p_in, which is one of these variables, but I wanted to appear explicitly in the model. So now it's easy to calculate the total expected revenue in the population. Because we just have to sum this quantity over all people in the population. Of course, like before, if the population is too large, we can use sample enumeration.

Notes

Summary

0m 17s

Revenue maximization

Solve the problem

$$\max_{p_{i1},\ldots,p_{i_N}} \sum_{n=1}^{N} p_{in} P(i|x_n, p_{in}; \theta)$$

Notes

- In practice, prices are often the same for the population, of for large groups.
- It assumes that the rest of the market is not affected.
- In practice, it is likely that the competition will also adjust the prices

But the concept is exactly the same. Now the supplier wants to maximize his or her revenues. So he has to select the list of prices that has to be proposed to each individual in the population, such that the total revenue, which is given by the formula that we have just calculated, is maximized. So this is interesting because here the behavior of the customer is really in the core of the calculation of the revenues. Now we can make some comments about this. So first, as I said in practice the prices are often the same for the population or for large groups. But this can be easily adjusted. But the most important assumption that we make when we look at this problem is that we assume that the rest of the market is not affected. And this is not true in practice. Usually,especially in competitive market, if one of the players is changing the prices, the other players will react. In order to model this, you need a theory called "game theory". And this is out of the scope of this course. So here we will assume that the rest of the market is not affected. So what is interesting is that the role of the supplier is not easy.

Notes

Summary

1m 56s

Revenue maximization

Solve the problem

$$\max_{p_{i1},\ldots,p_{i_N}} \sum_{n=1}^{N} p_{in} P(i|x_n, p_{in}; \theta)$$

Notes

- In practice, prices are often the same for the population, of for large groups.
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- In practice, it is likely that the competition will also adjust the prices

If the price is too low, the probability that the item i will be sold to individual n will be high, but the quantity of revenue that will be generated will be low as well, because the price is low. On the other hand, if the price is too high, selling the item will generate a high revenue, but the probability that this item will be sold will be low. So, the whole point here is really to find a good trade-off between a low price so high market shares but low revenues. Or high price, low market shares and low revenues as well.

Notes

Summary

3m 04s

Illustrative example

Binary logit model

$$V_{in} = \beta_{pn} p_{in} - 0.5$$
$$V_{jn} = \beta_{pn} p_{jn}$$

so that

$$P_n(i|p_{in}, p_{jn}) = \frac{e^{\beta_{pn} p_{in} - 0.5}}{e^{\beta_{pn} p_{in} - 0.5} + e^{\beta_p p_{jn}}}$$

Two groups in the population

- Group 1: $\beta_{pn} = -2$, $N_1 = 600$
- Group 2: $\beta_{pn} = -0.1$, $N_2 = 400$

Assume that $p_{jn} = 2$, $\forall n$.

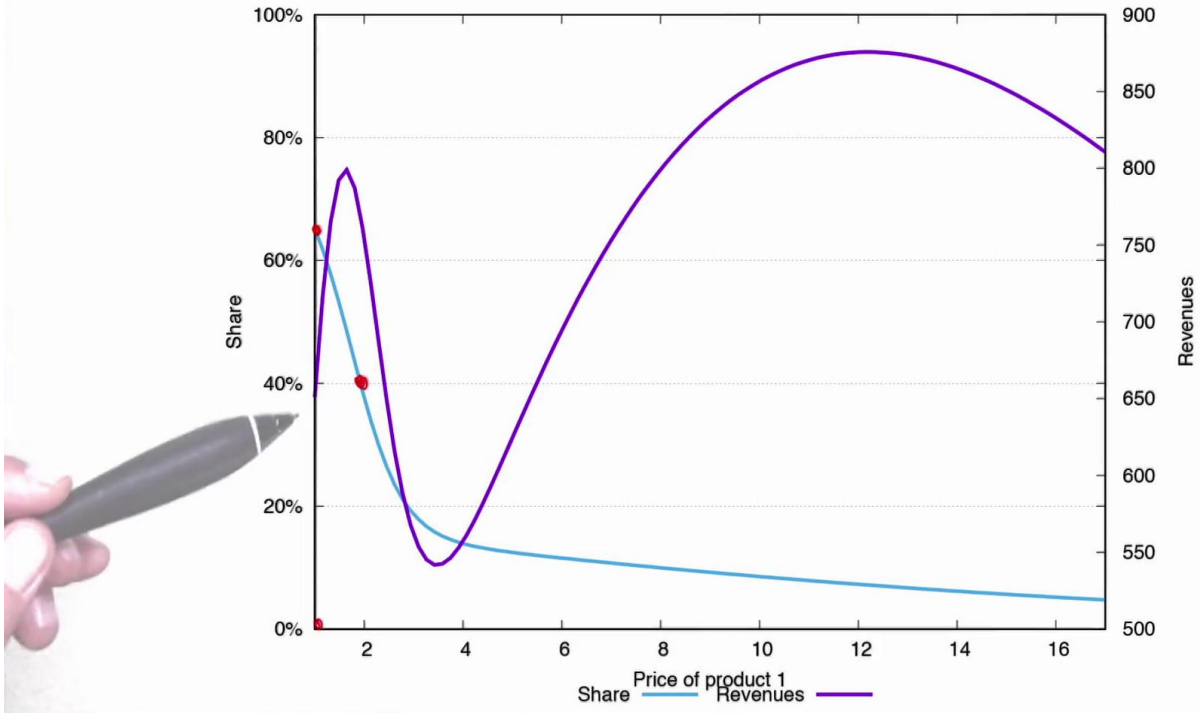
And actually, this problem is quite complex. And in order to analyze the complexity, we will take a very simple example. So consider that there are only two products on the market. I am the supplier of alternative i. And there is a competitor who is selling alternative j. And to make our model simple, we will assume that only the price matters. But then there is a constant. So, in average, people tend to prefer product j to product i. So the constant associated with product i is negative. So it's a binary model. We can use the logit formula to calculate the choice probability, which is given by the well-known logit formula, here, which depends on the price and the parameters. Now, we will make the following assumptions in terms of behavior: we assume that there are two groups in the population. Group 1 is highly price sensitive. So the beta parameter for this group is minus 2. It means that increasing the price a little bit will decrease significantly the utility. The second group has a lower price sensitivity: -0.1. And, for the sake of the example, we will assume that group 1 is composed of 600 people, and group 2 is composed of 400 people. And to complete our example, we will assume that the competitive item, j, is sold at a price of two. So now the question is, at what price should I sell my product, i, so that I will maximize my revenue?

Notes

Summary

3m 38s

Illustrative example



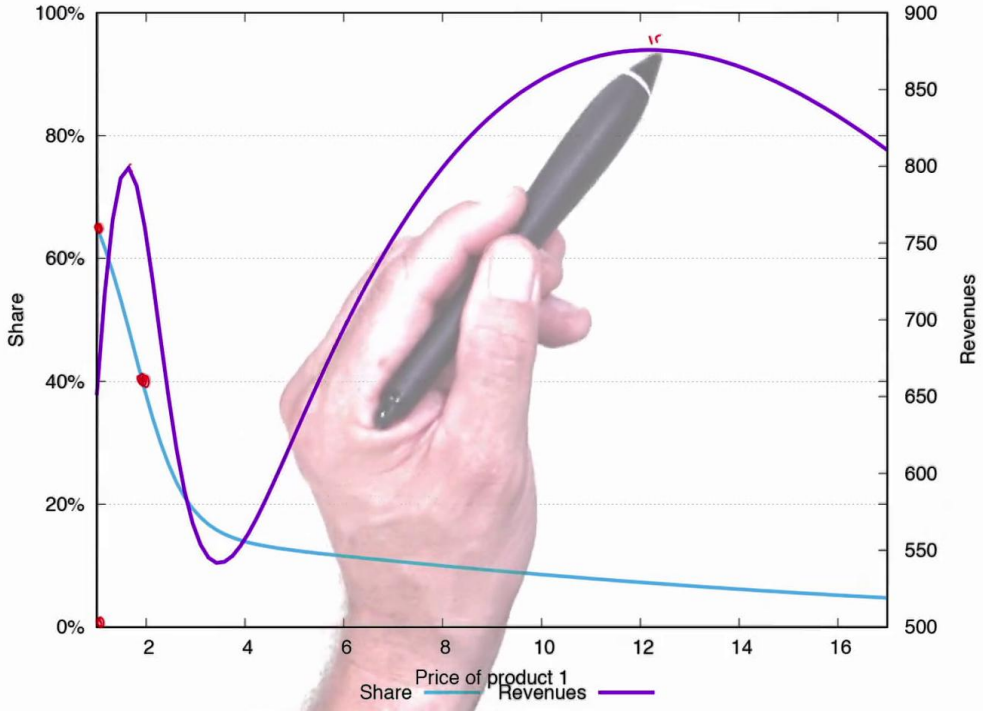
So, in order to understand the complexity of this revenue maximization problem, let's look at the following chart. So here, we have the x-axis the price of product one, which is ranging from 1 to 17. Then we have 2 y-axes: the left y-axis represents the market shares, from 0 to 100 percent. So for example if I sell my product i at a price of one, I will get a little bit more than 60 percent market shares. Remember, the constant was negative so, everything else being equal, the people prefer the competition. And actually, if I put the same price as the competition, price two, I get something like 40 percent of the market share. So this is consistent with my model. And as expected, when the price increases, the market share decreases monotonically. That's expected. The more expensive my item is, the less attractive it is on the market and, therefore, the lower the market shares. Now let's look at the revenues. The y-axis on the right represents the total revenues generated by each price reported on the x-axis. And you see an interesting phenomenon. So if you sell your product at the price of one, the revenue is about 650 francs, let's say. OK? And then, if you increase the price, you will increase your revenue.

Notes

Summary

5m 25s

Illustrative example



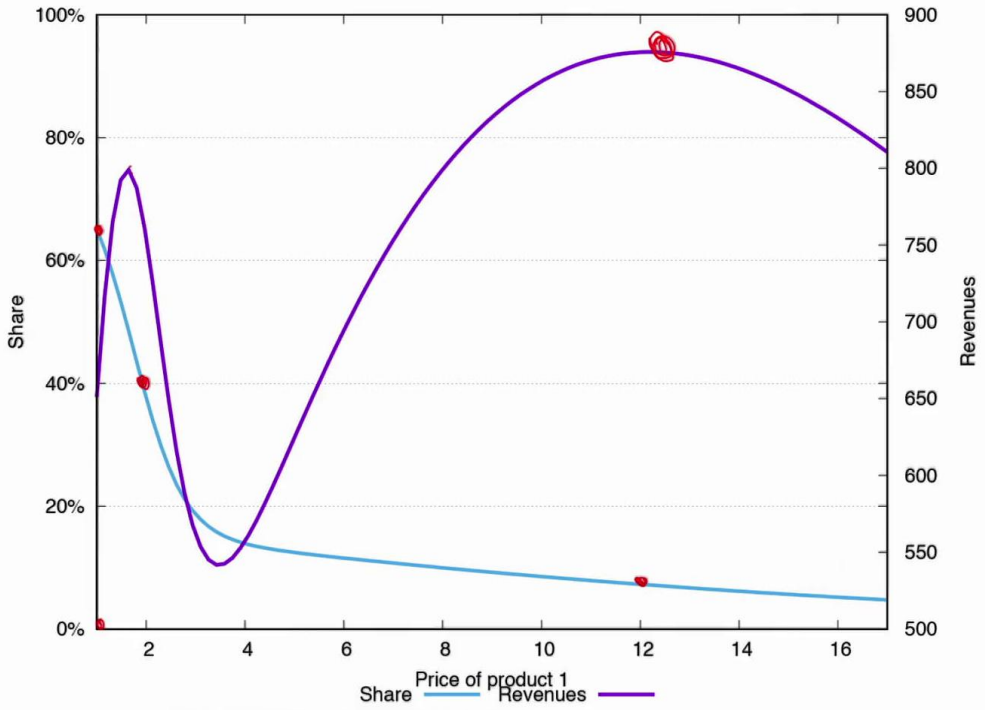
Indeed, each sale will generate more revenue and therefore you will reach this local optimum here. Which is about 2 maybe a little bit before 2. Then if you continue to increase the price, well then people will believe it's too expensive. And less and less people will buy it. And this curve will decrease. So although each sale is generating higher revenue (because the price is higher), less and less people are buying it, and therefore it decreases. And actually, these people who are leaving the market, I mean your market, for alternative i, are people who are very price sensitive. The group one. Group two, they care less, so they are ready to pay this kind of price. So at some point you lose all these people from group one, and your revenues are going down. And at some point, you continue to increase your prices, and then, the revenues start increasing again because the people from group two, continue to buy it (they don't care if it is more expensive), and will generate more revenues because each sale is generating more revenues. And then you get this second increase, which takes a lot of time, up to this local optimum, which is somewhere here. So this is at the price of twelve.

Notes

Summary

7m 09s

Illustrative example



So basically you generate more revenue with very little market shares (right? You are about 10 percent of the market share) but you generate a lot of revenues because each sale generates a lot of money. And therefore, it's really a market decision that you have to make. Which group should I target? Well, if I target the people who are very price sensitive, not only I will make less revenue, but I will lose them very quickly if I make some adjustment to the price. While if I target the second group, which is less price sensitive, who are willing to pay more for my product, not only I will generate more revenue (we are talking about almost 900 here) but also it will be less sensitive to modifications of the prices. So in this example it may be wise for the sake of revenue maximization to decide to put a high price to target the second group of the population, and to generate more revenues.

Notes

Summary

8m 32s

So this shows you the power of these choice models. Indeed, it's only if you are able to model the behavior of each group of the population that you will be able to plot this kind of chart, and to understand how the revenues will be generated. And of course as you have seen when we have developed the models, because the models are heterogeneous, we can deal with more than two groups of the population. We can really make a different model for each different individual. The complexity of the revenue curve is more important. But its richer as well. And because its rich it can make you rich as well. In order to understand better how it works, I suggest that you work on another example where you have three groups in the population instead of two. To understand how this complexity can be handled and how the model becomes rich in terms of representation of the behavior and its impact on the revenues that they generate.

Notes

Summary

9m 33s