Selling Under Uncertainty: The Newsvendor Model

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Learning Modules

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2. Inventory Decisions
3. Assortment Planning
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5. The omnichannel customer
6. Fulfilling omnichannel demand
7. Omnichannel journeys
8. Supporting an omnichannel strategy
• One of the main reasons retailers have to carry inventory is that demand is uncertain. Retailers often need to have inventory “just in case”.
• In this video, we are going to study the trade-off between ordering too much and ordering too little when demand is uncertain.
• We are going to present a model called the newsvendor model that allows to choose the optimal inventory when there is a short selling season.
We are going to discuss this using an example. Mary is the manager of a Starbucks store that among other things offers pre-made sandwiches with fresh ingredients. Mary has to give her staff instructions of how many sandwiches to prepare for the day.

The economics of the sandwiches is the following:

- Sandwiches sell for 10 USD
- Cost 4 USD to make
- Sandwiches that are not sold in the end of the day are given to charity.
- The demand is uncertain.
- Mary has a forecast that indicates that demand follows a normal distribution with mean demand is 24, and standard deviation 8
- If customer wants to buy but there are no sandwiches left, customers leaves without purchasing.
- Newsvendor
M2.4 Order Quantity

• The question that Mary wants to answer is: how many sandwiched she should prepare if her goal is to maximize profits.

• What information Mary needs to answer this question?
  • Demand distribution: Normal distribution with Mean 24; SD 8
  • The profit made for every sandwich sold: 10-4=6
    • We will call this the cost of underage since this is how much it will cast Mary when she cannot sell a sandwich because she doesn’t have one
  • The cost incur when there are sandwiches left at the end of the day: 4
    • We will call this the cost of overage since this is the loss Mary incurs when she has leftovers.
M2.4 Order Quantity

• Now Mary can calculate the critical ratio that is defined as:

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CR = \frac{C_u}{C_o + C_u} = \frac{6}{4 + 6} = 0.6
\]

• With the CR she can find the optimal order quantity that in this case is 26
• In the exercises for this module we walk you through how to obtain this order quantity from the CR.
M2.4 Performance Measures

• Once Mary knows what is the Optimal Quantity she might want to know a few Measures related to that quantity:
• For example, if she might want to know what are the expected lost sales when she ordered the optimal quantity of 26 sandwiches.
  • The Expected Lost Sales are 2.3
• Expected Sales = Mean – Expected Lost sales = 21.7
• Expected Left Over Inventory = Q – Expected Sales = 4.3
• Expected Profit = \((Price – Cost) \cdot Expected Sales\) – \((Cost –
M2.2 Service Level

• Profit is not the only consideration
• If the service level is inadequate profit might get hurt in the long run
• What is the service level. It measure how many times we where able to cover all the demand. For example if out of 100 days Mary covered all her demand 80 days then the service level is 80%.
• Let’s see what is the service level for the order quantity that maximizes profits for her:
  • With the demand parameter we know, when she orders 26 sandwiches, this corresponds to a service level of 60%.
M2.2 Service Level

• What if this service level is unacceptable?
• I can define a service level and see how much I need to order to achieve that and then look at my profits in that scenario and evaluate the trade-off
• If Mary wants a service level of 90% she needs to order 34 sandwiches and her profits are going to be 99 dollars instead of 113.
• She also needs to be ready to see on average approximately 10 sandwiches left for charity...
M2.2 Closing

• Optimal order 26. This is higher than the mean. Losing a sale is more costly than producing a sandwich that will not sell.
• You can now play with the tools to gain some insight about what would happen as you make changes in the parameters of the problem.
• For example, what do you think will happen to the optimal order size if instead of donating unsold sandwiches to charity you sell them at a discounted salvage rate in the end of the day?
• That reduces the cost of overstock and so it will push Mary to order more sandwiches. This would increase the service level.
• Similarly, you can use the tool to evaluate what would happen if your product sold at a higher retail price, or if the cost was higher.
M2.2 Closing

- In this video, we have explored the trade-off between ordering too much and ordering too little when demand is uncertain.
- We have presented a model called the newsvendor model that allows to choose the optimal inventory when there is a short selling season.