OM 380.17 Bagchi & Gutierrez
Group Homework – 3 (worth 2.5% of your course grade)

Names of Group Members and Index Numbers

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***** By signing my name, I am affirming that:**

- **I have read the course syllabus.**
- **I have contributed as expected toward the fulfillment of this assignment.**
- **The work our group is turning in is the work product of our group.**
- **Our group did not get outside help in fulfilling this assignment.**

This homework consists of two exercises in newsvendor model analysis. You may want to consult the discrete demand newsvendor example on Canvas (Modules\Misc.). **Your submission must have this page as the cover page. Please submit on Canvas by the beginning of class on the day the assignment is due.**

Question 1. Please place each of your answers inside the rectangular box that follows each question.

Every year in preparation for Christmas sales, Organic Tea – a retailer – buys gift baskets from Bessmer, Inc. – a wholesaler. Organic Tea sells each gift basket for $50. The cost of a gift basket to Bessmer is $20. Bessmer charges Organic Tea $30 for a gift basket. Unsold gift baskets at the end of the season are donated by Organic Tea to charities. Organic Tea wants to maximize its expected profit. Estimated retail demand for gift baskets is as follows:

Demand	Probability
0	20%
20	20%
40	15%
60	15%
80	15%
100	15%

(a) Suppose Organic Tea orders 60 gift baskets.

(i) What is the expected demand?

46

(ii) What will be the expected quantity of sales?

37

(iii) What will be the expected quantity of leftovers?

23

(iv) What will be the expected quantity of unmet demand?

9

You will want to set up a table to: (1) help you answer the questions above and (2) show your work.

Demand	Probability	Sales	Leftover	Unmet Demand
0	20%	0	60	0
20	20%	20	40	0
40	15%	40	20	0
60	15%	60	0	0
80	15%	60	0	20
100	15%	60	0	40

Work for question 1's part (a):

i) In this case, the expected demand is calculated as the weighted average of all the demand scenarios base on their probabilities. Basically, it is the sum of the product of each demand quantity and the probability of having that demand.
Thus, 0*0.2 + 20*0.2 + 40*0.15 + 60*0.15 + 80*0.15 + 100 * 0.15 = 0+4+6+9+12+15 = 46

ii) Since Organic tea has 60 gift baskets, it will be able to send as many as the demand quantity as long as demand <=60. Otherwise, the sales will be capped to 60 since they have only 60 gift baskets. So as per the table able the expected sales value (similar to how we calculated expected demand in the above step) will be 0*0.2+ 20*0.2+ 40*0.15 + 60*0.15 + 60*0.15 + 60*0.15 = 0+4+6+9+9+9 = 37

iii) The leftovers will be the baskets that Organic tea was not able to sell due to low demand. So, if the demand <=60 then the leftover will be 60-Demand and if the demand exceeds that then there will be no leftovers (as shown in the table above). The expected value of leftover comes out as
60*0.2 + 40*0.2 + 20*0.15 + 0*0.15 + 0*0.15+ 0*0.15 = 12+8+3 = 23

iv) The unmet demand is the demand that organic tea couldn't fulfil. This if the demand <= 60 then there will be 0 unmet demand. Beyond 60, the unmet demand will be demand – 60 (as shown in the table). So, the expected value of unmet demand is calculated as:
0*0.2 + 0*0.2 + 0*0.15 + 0*0.15 + 20*0.15 + 40*0.15 = 3+6 = 9

Newsvendor Model: The optimal order quantity is the smallest Q such that P(Demand ≤ Q) ≥ MP/(MP + ML), where MP = marginal profit and ML = marginal loss.

(b) (i) What is Organic Tea's marginal profit?

$20

(ii) What is Organic Tea's marginal loss?

$30

(iii) How many gift baskets should Organic Tea order from Bessmer?

20

(iv) What is Organic Tea's optimal expected profit?

$200

Work for question 1's part (b):

i) Marginal Profit (MP) is the profit that Organic Tea makes from selling one more gift basket.
MP = Selling Price of Organic Tea – Cost price from Bessmer = \$50-\$30 = \$20

ii) Marginal Loss (ML) is the loss that Organic Tea incurs from not selling a gift basket they have in stock. So, unsold baskets are donated, the loss is simply the cost of the basket from Bessmer = \$30

iii) To determine how many gift baskets Organic Tea should order from Bessmer we can use the NewsVendor method $P(\text{Demand} \leq Q) \geq MP/(MP + ML)$. Here the critical ratio $MP/(MP + ML) = 20/(20+30) = 0.4$. Now we can determine the smallest order quantity Q such that the cumulative probability P is at least 0.4 (40%). From the table above we can see that the smallest order quantity Q for which $P(\text{Demand} \leq Q) \geq 0.4$ is 20.

iv) Let's break down the Demand scenarios.
Scenario 1 (Demand = 0):
Sales = 0 so profit from sales = 0
Unsold baskets = 20 (since considering optimal ordering quantity) so loss from unsold baskets = 20 * ML = 20*30 = \$600
Probability(Demand = 0) = 0.2
Scenario 2 (Demand = 20):
Sales = 20 so profit = 20*MP = 20*20 = \$400
Unsold Baskets = 0, so loss = 0
Probability(Demand = 20) = 0.2
Scenario 3 (Demand = 40 or more):
Sales = 20 so profit = 20*MP = 20*20 = \$400
Unsold Baskets = 0, so loss = 0
Probability(Demand >= 40) = 1-(0.2+0.2) = 0.6 (or sum up the remaining demand scenarios)

Thus, optimal expected profit is 0.2*(-600) + 0.2*(400) + 0.6*(400) = -120+80+240 = \$200

(c) Suppose that Organic Tea believes that there is significant loss of customer goodwill if it cannot meet demand, and for gift baskets, Organic Tea estimates this loss to be \$20 per customer who is turned away.

(i) What is Organic Tea's marginal profit?

\$40

(ii) What is Organic Tea's marginal loss?

\$30

(iii) How many gift baskets should Organic Tea order from Bessmer?

60

Work for question 1's part (c):

i) Given the new information, there is an additional $20 loss per unmet demand (Loss of goodwill) if a customer is turned away. So, if we meet the demand, we can add this loss of goodwill in the previously calculated marginal profit. Thus, new marginal profit is $20+$20 = $40

ii) The new Marginal Loss will be the inventory cost of the unmet baskets. Each basket costs $30 for Organic Tea thus ML = $30.

iii) Recalculating the Critical Ratio -> MP/(MP+ML) = 40/70 = 0.571. Now, from the provided probabilities we get the cumulative probabilities as following:
P(Demand<=0) = 0.2; P(Demand<=20) = 0.2+0.2 = 0.4
P(Demand <= 40) = 0.4+0.15 = 0.55; P(Demand <=60) = 0.55+0.15 = 0.7
Given the critical ratio of 0.571 the smallest order quantity should be 60.

Question 2. You run a small business that produces queso from local ingredients. Because you receive orders in advance, you can produce exactly the amount ordered, but the time required for the cook varies. On average, you receive $3,000 revenue (net of variable cost) for the batch produced. Each time you produce, you need to reserve capacity in an industrial kitchen.

- The kitchen charges $400 per hour (in increments of 0.25 hours) that you reserve.
- There are no refunds if you do not need the entire time that you reserve.
- If your cooking time exceeds the reserved time, then you pay $600/hour for the time by which you exceed the length of the reservation.

If you reserve Q = 5.5 hours, and it takes t hours to complete your cooking, then the amount you have to pay is as follows:

➔ For $t \leq 5.5$ hours, you pay $400 x 5.5 = $2200.

➔ For $t > 5.5$ hours, you pay $2200 + (t – 5.5) x $600.

The following is your best estimate of the cooking time:

Time (hours)	4.25	4.5	4.75	5	5.25	5.5	5.75	6
Probability	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125

How many hours should you reserve? (Show your work.)

Answer 2:

We need to find such reservation time in hours which minimizes the expected cost. That time will be the optimum to reserve the kitchen. Let that time be Q.
So, we need find such value of R that minimizes the expected cost = Reservation Cost + Excess cooking time cost. For t <= R hours, reservation cost = Q*$400 and for t > Q hours we have to pay the reservation cost as well hence total cost becomes Q*$400 + (t-Q)*$600.
To find the expected cost, we need to calculate it for each possible cooking time and then take weighted average based on the probabilities given in the table.

Let's calculate the expected cost for each time

i) For Q = 4.25, cost of reservation = 4.25 * 400 = $1700
Expected extra cost for overtimes:

P(4.5hrs) * (4.5-4.25)*600 + P(4.75hrs) * (4.75-4.25)*600 + P(5hrs) * (5-4.25)*600 + P(5.25hrs) * (5.25-4.25)*600 + P(5.5hrs) * (5.5-4.25)*600 + P(5.75hrds) * (5.75-4.25)*600 + P(6hrs) * (6-4.25)*600 = 0.125*600*(0.25+0.5+0.75+1+1.25+1.5+1.75) = 75*7 = $525
Therefore, total cost will be $1700+$525 = $2225

ii) For Q = 4.5, cost of reservation = 4.5 * 400 = $1800
Expected extra cost for overtimes:
P(4.75hrs) * (4.75-4.5)*600 + P(5hrs) * (5-4.5)*600 + P(5.25hrs) * (5.25-4.5)*600 + P(5.5hrs) * (5.5-4.5)*600+P(5.75hrds)*(5.75-4.5)*600+P(6hrs)*(6-4.5)*600=
0.125*600*(0.25+0.5+0.75+1+1.25+1.5) = 75*5.25 = $393.75
Therefore, total cost will be $1800+$393.75 = $2193.75

iii) For Q = 4.75, cost of reservation = 4.75 * 400 = $1900
Expected extra cost for overtimes:
P(5hrs) * (5-4.75)*600 + P(5.25hrs) * (5.25-4.75)*600 + P(5.5hrs) * (5.5-4.75)*600+P(5.75hrds)*(5.75-4.75)*600+P(6hrs)*(6-4.75)*600=
0.125*600*(0.25+0.5+0.75+1+1.25) = 75*3.75 = $281.25
Therefore, total cost will be $1900+$281.25 = $2181.25

iv) For Q = 5, cost of reservation = 5 * 400 = $2000
Expected extra cost for overtimes:
P(5.25hrs) * (5.25-5)*600 + P(5.5hrs) * (5.5-5)*600+P(5.75hrds)*(5.75-5)*600+P(6hrs)*(6-5)*600=
0.125*600*(0.25+0.5+0.75+1) = 75*2.5 = $187.5
Therefore, total cost will be $2000+$187.5 = $2187.5

v) For Q = 5.25, cost of reservation = 5.25 * 400 = $2100
Expected extra cost for overtimes:
P(5.5hrs) * (5.5-5.25)*600+P(5.75hrds)*(5.75-5.25)*600+P(6hrs)*(6-5.25)*600=
0.125*600*(0.25+0.5+0.75) = 75*1.5 = $112.5
Therefore, total cost will be $2100+$112.5 = $2212.5

vi) For Q = 5.5, cost of reservation = 5.5 * 400 = $2200
Expected extra cost for overtimes:
P(5.75hrs)*(5.75-5.5)*600+P(6hrs)*(6-5.5)*600= 0.125*600*(0.25+0.5) = 75*0.75 = $56.25
Therefore, total cost will be $2200+$56.25 = $2256.25

vii) For Q = 5.75, cost of reservation = 5.75 * 400 = $2300
Expected extra cost for overtimes:
P(6hrs)*(6-5.75)*600= 0.125*600*(0.25) = 75*0.25 = $18.75
Therefore, total cost will be $2300+$18.75= $2318.75

viii) For Q = 6, cost of reservation = 6 * 400 = $2400
Expected extra cost for overtimes will be 0

Here we can see we get the minimum expected value of $2181.25 for 4.75 hours. Hence, we should reserve for **4.75 hours.**