CHAPTER 15: INVENTORY MODELS

Outline

• Deterministic models
  – The Economic Order Quantity (EOQ) model
  – Sensitivity analysis
  – A price-break Model

• Probabilistic Inventory models
  – Single-period inventory models
  – A fixed order quantity model
  – A fixed time period model
Inventory Decision Issues

- Demand of various items
- Money tied up in the inventory
- Cost of storage space
- Insurance expense - risk of fire, theft, damage
- Order processing costs
- Loss of profit due to stock outs
Inventory Decision Questions

How Much?
When?
THE EOQ MODEL

Demand rate

Order qty, Q

Inventory Level

Reorder point, R

0

Lead time

Order Placed

Order Received

Lead time

Order Placed

Order Received

Time
The EOQ Model Cost Curves

Slope = 0

Annual cost ($)
Minimum total cost

Total Cost

Holding Cost = HQ/2

Ordering Cost = SD/Q

Optimal order
Q*

Order Quantity, Q
EOQ Cost Model

D - annual demand
Q - order quantity
S - cost of placing order
H - annual per-unit holding cost

Ordering cost = SD/Q
Holding cost = HQ/2

Total cost = SD/Q + HQ/2

\[ Q^* = \sqrt{\frac{2DS}{H}} \]
Example 1: R & B beverage company has a soft drink product that has a constant annual demand rate of 3600 cases. A case of the soft drink costs R & B $3. Ordering costs are $20 per order and holding costs are 25% of the value of the inventory. R & B has 250 working days per year, and the lead time is 5 days. Identify the following aspects of the inventory policy:

a. Economic order quantity
b. Reorder point

c. Cycle time
d. Total annual cost
## SENSITIVITY ANALYSIS

<table>
<thead>
<tr>
<th>D</th>
<th>I</th>
<th>S</th>
<th>Q*</th>
<th>Opt Cost</th>
<th>Q=438 Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>3600</td>
<td>25%</td>
<td>20</td>
<td>438</td>
<td>329</td>
<td>329</td>
</tr>
<tr>
<td>3400</td>
<td>25%</td>
<td>20</td>
<td>426</td>
<td>319</td>
<td>320</td>
</tr>
<tr>
<td>3600</td>
<td>35%</td>
<td>20</td>
<td>370</td>
<td>389</td>
<td>394</td>
</tr>
<tr>
<td>3600</td>
<td>25%</td>
<td>30</td>
<td>537</td>
<td>402</td>
<td>411</td>
</tr>
</tbody>
</table>
Some Important Characteristics of the EOQ Cost Function

- At EOQ, the annual holding cost is the same as annual ordering cost.

\[
\text{Annual holding cost} = \frac{HQ^*}{2} = \frac{H}{2} \sqrt{\frac{2DS}{H}} = \sqrt{\frac{DSH}{2}}
\]

\[
\text{Annual ordering cost} = \frac{DS}{Q^*} = \frac{DS}{\sqrt{2DS \sqrt{\frac{H}{2}}}} = \sqrt{\frac{DSH}{2}}
\]

\[
\text{Total annual cost} = \frac{HQ^*}{2} + \frac{DS}{Q^*} = \sqrt{2DSH}
\]
Some Important Characteristics of the EOQ Cost Function

- The total cost curve is flat near EOQ
  - So, the total cost does not change much with a slight change in the order quantity (see the total cost curve and the example on sensitivity)
EOQ WITH PRICE BREAKS

• Assumptions
  – Demand occurs at a constant rate of $D$ items per year.
  – Ordering Cost is $S$ per order.
  – Holding Cost is $H = \$C_i$ per item in inventory per year (note holding cost is based on the cost of the item, $C_i$).
  – Purchase Cost is $\$C_1$ per item if the quantity ordered is between 0 and $x_1$, $\$C_2$ if the order quantity is between $x_1$ and $x_2$, etc.
  – Delivery time (lead time) is constant.
EOQ with Price Breaks Formulae

• Formulae
  
  – Optimal order quantity: the procedure for determining $Q^*$ will be demonstrated
  – Number of orders per year: $D/Q^*$
  – Time between orders (cycle time): $Q^*/D$ years
  – Total annual cost: $[(1/2)Q^*H] + [DS/Q^*] + DC$
    (holding + ordering + purchase)
EOQ with Price Breaks Procedure

Steps

1. **Determine the largest (cheapest) feasible EOQ value:**
   The most efficient way to do this is to compute the EOQ for the lowest price first, and continue with the next higher price. Stop when the first EOQ value is feasible (that is, within the correct interval).

2. **Compare the costs:** Compare the value of the average annual cost at the largest feasible EOQ and at all of the price breakpoints that are greater than the largest feasible EOQ. The optimal Q is the point at which the average annual cost is a minimum.
Example 2: Nick's Camera Shop carries Zodiac instant print film. The film normally costs Nick $3.20 per roll, and he sells it for $5.25. Nick's average sales are 21 rolls per week. His annual inventory holding cost rate is 25% and it costs Nick $20 to place an order with Zodiac. If Zodiac offers a 7% discount on orders of 400 rolls or more and a 10% discount for 900 rolls or more, determine Nick's optimal order quantity.
\[ D = 21(52) = 1092; \quad H = .25(C_i); \quad S = 20 \]

**Step 1: Determine the largest (cheapest) feasible EOQ**
Step 2: Compare the costs

Compute the total cost for the most economical, feasible order quantity in each price category for which a $Q^*$ was computed.
PROBABILISTIC MODELS

Outline

• Probabilistic inventory models
• Single- and multi- period models
• A single-period model with uniform distribution of demand
• A single-period model with normal distribution of demand
Probabilistic Inventory Models

• The demand is not known. Demand characteristics such as mean, standard deviation and the distribution of demand may be known.

• Stockout cost: The cost associated with a loss of sales when demand cannot be met. For example, if an item is purchased at $1.50 and sold at $3.00, the loss of profit is $3.00-1.50 = $1.50 for each unit of demand not fulfilled.
Single- and Multi-Period Models

• The classification applies to the probabilistic demand case.

• In a single-period model, the items unsold at the end of the period is not carried over to the next period. The unsold items, however, may have some salvage values.

• In a multi-period model, all the items unsold at the end of one period are available in the next period.

• In the single-period model and in some of the multi-period models, there remains only one question to answer: how much to order.
SINGLE-PERIOD MODEL

• Computer that will be obsolete before the next order
• Perishable product
• Seasonal products such as bathing suits, winter coats, etc.
• Newspaper and magazine
Trade-offs in a Single-Period Models

Loss resulting from the items unsold
ML = Purchase price - Salvage value

Profit resulting from the items sold
MP = Selling price - Purchase price

Trade-off
Given costs of overestimating/underestimating demand and the probabilities of various demand sizes how many units will be ordered?
Consider an order quantity $Q$
Let $P =$ probability of selling all the $Q$ units
  $= \text{probability (demand} \geq \text{Q)}$

Then, $(1-P) =$ probability of not selling all the $Q$ units

We continue to increase the order size so long as

$$P(MP) \geq (1 - P)ML$$

or, $P \geq \frac{ML}{MP + ML}$
Decision Rule:

Order maximum quantity Q such that

\[ P \geq \frac{ML}{MP + ML} \]

where \( P = \) probability \((\text{demand} \geq Q)\)
Demand for cookies:

<table>
<thead>
<tr>
<th>Demand</th>
<th>Probability of Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,800 dozen</td>
<td>0.05</td>
</tr>
<tr>
<td>2,000</td>
<td>0.10</td>
</tr>
<tr>
<td>2,200</td>
<td>0.20</td>
</tr>
<tr>
<td>2,400</td>
<td>0.30</td>
</tr>
<tr>
<td>2,600</td>
<td>0.20</td>
</tr>
<tr>
<td>2,800</td>
<td>0.10</td>
</tr>
<tr>
<td>3,000</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Selling price=$0.69, cost=$0.49, salvage value=$0.29

a. Construct a table showing the profits or losses for each possible quantity

b. What is the optimal number of cookies to make?

c. Solve the problem by marginal analysis.
<table>
<thead>
<tr>
<th>Demand (dozen)</th>
<th>Prob (Demand)</th>
<th>Prob (Selling all the units)</th>
<th>Expected Number Sold</th>
<th>Revenue From Sold Items</th>
<th>Revenue From Unsold Items</th>
<th>Total Revenue</th>
<th>Cost</th>
<th>Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1800</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>0.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2200</td>
<td>0.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2400</td>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2600</td>
<td>0.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2800</td>
<td>0.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3000</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sample computation for order quantity = 2200:
Expected number sold = 1800(0.05) + 2000(0.10) + 2200(0.85) = 2160
Revenue from sold items = 2160(0.69) = $1490.4
Revenue from unsold items = (2200 - 2160)(0.29) = $11.6
Total revenue = 1490.4 + 11.6 = $1502
Cost = 2200(0.49) = $1078
Profit = 1502 - 1078 = $424
<table>
<thead>
<tr>
<th>Demand (dozen)</th>
<th>Prob (Demand)</th>
<th>Prob (Selling all the units)</th>
<th>Expected Number Sold</th>
<th>Revenue From Sold Items</th>
<th>Revenue From Unsold Items</th>
<th>Total Revenue</th>
<th>Cost</th>
<th>Profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1800</td>
<td>0.05</td>
<td>1</td>
<td>1800</td>
<td>1242.0</td>
<td>0.0</td>
<td>1242</td>
<td>882</td>
<td>360</td>
</tr>
<tr>
<td>2000</td>
<td>0.1</td>
<td>0.95</td>
<td>1990</td>
<td>1373.1</td>
<td>2.9</td>
<td>1376</td>
<td>980</td>
<td>396</td>
</tr>
<tr>
<td>2200</td>
<td>0.2</td>
<td>0.85</td>
<td>2160</td>
<td>1490.4</td>
<td>11.6</td>
<td>1502</td>
<td>1078</td>
<td>424</td>
</tr>
<tr>
<td><strong>2400</strong></td>
<td><strong>0.3</strong></td>
<td><strong>0.65</strong></td>
<td><strong>2290</strong></td>
<td><strong>1580.1</strong></td>
<td><strong>31.9</strong></td>
<td><strong>1612</strong></td>
<td><strong>1176</strong></td>
<td><strong>436</strong></td>
</tr>
<tr>
<td>2600</td>
<td>0.2</td>
<td>0.35</td>
<td>2360</td>
<td>1628.4</td>
<td>69.6</td>
<td>1698</td>
<td>1274</td>
<td>424</td>
</tr>
<tr>
<td>2800</td>
<td>0.1</td>
<td>0.15</td>
<td>2390</td>
<td>1649.1</td>
<td>118.9</td>
<td>1768</td>
<td>1372</td>
<td>396</td>
</tr>
<tr>
<td>3000</td>
<td>0.05</td>
<td>0.05</td>
<td>2400</td>
<td>1656.0</td>
<td>174.0</td>
<td>1830</td>
<td>1470</td>
<td>360</td>
</tr>
</tbody>
</table>
Solution by marginal analysis:

\[ MP = .69 - .49 = $0.20, \quad ML = .49 - .29 = $0.20 \]

Order maximum quantity, \( Q \) such that

\[ P = \text{Probability}(\text{demand} \geq Q) \geq \frac{ML}{MP + ML} = \frac{0.20}{0.20 + 0.20} = 0.50 \]

Demand, \( Q \)  Probability(demand)  Probability(demand\( \geq Q \)), \( p \)
Demand Characteristics

Suppose that the historical sales data shows:

<table>
<thead>
<tr>
<th>Quantity</th>
<th>No. Days sold</th>
<th>Quantity</th>
<th>No. Days sold</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>1</td>
<td>21</td>
<td>11</td>
</tr>
<tr>
<td>15</td>
<td>2</td>
<td>22</td>
<td>9</td>
</tr>
<tr>
<td>16</td>
<td>3</td>
<td>23</td>
<td>6</td>
</tr>
<tr>
<td>17</td>
<td>6</td>
<td>24</td>
<td>3</td>
</tr>
<tr>
<td>18</td>
<td>9</td>
<td>25</td>
<td>2</td>
</tr>
<tr>
<td>19</td>
<td>11</td>
<td>26</td>
<td>1</td>
</tr>
<tr>
<td>20</td>
<td>12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Demand Characteristics

Mean = 20
Standard deviation = 2.49
Demand Characteristics

Number of times sold

Quantity Sold in a Day
Example 3: The J&B Card Shop sells calendars. The once-a-year order for each year’s calendar arrives in September. The calendars cost $1.50 and J&B sells them for $3 each. At the end of July, J&B reduces the calendar price to $1 and can sell all the surplus calendars at this price. How many calendars should J&B order if the September-to-July demand can be approximated by

a. uniform distribution between 150 and 850
Solution to Example 3:

Loss resulting from the items unsold
ML = Purchase price - Salvage value =

Profit resulting from the items sold
MP = Selling price - Purchase price =
\[ P \geq \frac{ML}{MP + ML} = \]

Now, find the Q so that \( P(\text{demand} \geq Q) = \)

\[ Q^* = \]
Example 4: The J&B Card Shop sells calendars. The once-a-year order for each year’s calendar arrives in September. The calendars cost $1.50 and J&B sells them for $3 each. At the end of July, J&B reduces the calendar price to $1 and can sell all the surplus calendars at this price. How many calendars should J&B order if the September-to-July demand can be approximated by
b. normal distribution with μ = 500 and σ=120.
Solution to Example 4: ML=$0.50, MP=$1.50 (see example 3)

\[ P \geq \frac{ML}{MP + ML} = \]

Now, find the Q so that P =
We need $z$ corresponding to area = 
From Appendix D, p. 780

$z = \phantom{...}$

Hence, $Q^* = \mu + z \sigma =$
Example 5: A retail outlet sells a seasonal product for $10 per unit. The cost of the product is $8 per unit. All units not sold during the regular season are sold for half the retail price in an end-of-season clearance sale. Assume that the demand for the product is normally distributed with $\mu = 500$ and $\sigma = 100$.

a. What is the recommended order quantity?

b. What is the probability of a stockout?

c. To keep customers happy and returning to the store later, the owner feels that stockouts should be avoided if at all possible. What is your recommended quantity if the owner is willing to tolerate a 0.15 probability of stockout?

d. Using your answer to part c, what is the goodwill cost you are assigning to a stockout?
Solution to Example 5:
a. Selling price=$10, 
Purchase price=$8 
Salvage value=\( \frac{10}{2} = $5 \) 
\( MP = 10 - 8 = $2 \), \( ML = 8 - \frac{10}{2} = $3 \) 
Order maximum quantity, Q such that 
\[
P \geq \frac{ML}{ML + MP} = \frac{3}{2 + 3} = 0.6
\]
Now, find the Q so that 
\( P = 0.6 \) 
or, area (2)+area (3) = 0.6 
or, area (2) = 0.6-0.5=0.10
Find $z$ for area = 0.10 from the standard normal table given in Appendix D, p. 736

$z = 0.25$ for area = 0.0987, $z = 0.26$ for area = 0.1025

So, $z = 0.255$ (take -ve, as $P = 0.6 > 0.5$) for area = 0.10

So, $Q^* = \mu + z \sigma = 500 + (-0.255)(100) = 474.5$ units.

b. $P(\text{stockout}) = P(\text{demand} \geq Q) = P = 0.6$

c. $P(\text{stockout}) = \text{Area}(3) = 0.15$

From Appendix D, find $z$ for

Area (2) = 0.5 - 0.15 = 0.35
\begin{align*}
z &= 1.03 \text{ for area } = 0.3485 \\
z &= 1.04 \text{ for area } = 0.3508 \\
\text{So, } z &= 1.035 \text{ for area } = 0.35 \\
\text{So, } Q^* &= \mu + z \sigma = 500 + (1.035)(100) = 603.5 \text{ units.}
\end{align*}

d. $P = P(\text{demand} \geq Q) = P(\text{stockout}) = 0.15$

For a goodwill cost of $g$

$MP = 10 - 8 + g = 2 + g$, $ML = 8 - 10/2 = 3$

Now, solve $g$ in $p = \frac{ML}{ML + MP} = \frac{3}{2 + g + 3} = 0.15$

Hence, $g = $15.
MULTI-PERIOD MODELS

Outline

- A fixed order quantity model
- A fixed time period model
A FIXED ORDER QUANTITY MODEL

Purchase-order can be placed at any time
On-hand inventory count is known always

Lead time for a high speed modem is two weeks and it has the following sales history in the last 25 weeks:

<table>
<thead>
<tr>
<th>Quantity/Week</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>75-80</td>
<td>1</td>
</tr>
<tr>
<td>70-75</td>
<td>3</td>
</tr>
<tr>
<td>65-70</td>
<td>9</td>
</tr>
<tr>
<td>60-65</td>
<td>8</td>
</tr>
<tr>
<td>55-60</td>
<td>4</td>
</tr>
</tbody>
</table>

Will you order now if number of items on hand is:

a. 200
b. 150
c. 100
A Fixed Order Quantity Model

- The same quantity, $Q$ is ordered when inventory on hand reaches a reorder point, $R$
A Fixed Order Quantity Model

• An order quantity of EOQ works well

• If demand is constant, reorder point is the same as the demand during the lead time.

• If demand is uncertain, reorder point is usually set above the expected demand during the lead time.

• Reorder point = Expected demand + Safety stock
Safety Stock

Expected demand during lead time

Reorder Point

Safety stock

Lead Time

Time
Trade-Off with Safety Stock

- **Safety Stock** - Stock held in excess of expected demand to protect against stockout during lead time.

  - Safety stock ↑  Holding cost ↑  Stockouts ↓
  - Safety stock ↓  Holding cost ↓  Stockouts ↑
Acceptable Level of Stockout

Ask the manager!!

Acceptable level of stockout reflects management’s tolerance

A related term is service level.

Example: if 20 orders are placed in a year and management can tolerate 1 stockout in a year, acceptable level of stockout = \( \frac{1}{20} = 0.05 = 5\% \) and the service level = \( 1 - 0.05 = 0.95 \).
Computation of Safety Stock

- Probability of stockout = Acceptable level of stockouts
- Mean demand during the lead time
- Safety Stock
Example 6: B&S Novelty and Craft Shop sells a variety of quality handmade items to tourists. B&S will sell 300 hand-made carved miniature replicas of a Colonial soldier each year, but the demand pattern during the year is uncertain. The replicas sell for $20 each, and B&S uses a 15% annual inventory holding cost rate. Ordering costs are $5 per order, and demand during the lead time follows a normal probability distribution with $\mu = 15$ and $\sigma = 6$.

a. What is the recommended order quantity?

b. If B&S is willing to accept a stockout roughly twice a year, what reorder point would you recommend? What is the probability that B&S will have a stockout in any one order-cycle?

c. What are the inventory holding and ordering costs?
A FIXED TIME PERIOD MODEL

• Purchase-order is issued at a fixed interval of time

A distributor of soft drinks prepares a purchase order for beverages once a week on every Monday. The beverages are received on Thursdays (the lead time is three days). Choose a method for finding order quantity for the distributor:

a. Mean demand for 7 days + safety stock
b. Mean demand for 10 days + safety stock
c. Mean demand for 10 days + safety stock — inventory on hand
Replenishment Level and Safety Stock

• Replenishment level, $M$
  $= \text{Desired inventory to cover review period \& lead time}$
  $= \text{Expected demand during review period \& lead time +}$
  $\text{Safety stock}$

• Order quantity, $Q = M - H$
  $H = \text{inventory on hand}$

• Trade-off with safety stock
  
  Safety stock $\uparrow$  Holding cost $\uparrow$  Stockouts $\downarrow$
  Safety stock $\downarrow$  Holding cost $\downarrow$  Stockouts $\uparrow$
The Fixed Time Period Model
Computation of Replenishment Level

Probability of stockout = Acceptable level of stockouts

Mean demand during the lead time and review period

Safety Stock
## Comparison Between P and Q models

<table>
<thead>
<tr>
<th></th>
<th><strong>Fixed Quantity</strong></th>
<th><strong>Fixed Period</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantage</strong></td>
<td>Not large safety stock, good for expensive item.</td>
<td>Ease of coordination, Less work, good for inexpensive items</td>
</tr>
<tr>
<td><strong>Safety stock</strong></td>
<td>$r - \mu_L$</td>
<td>$M - \mu_{T+L}$</td>
</tr>
<tr>
<td><strong>Average inventory, regular</strong></td>
<td>$\frac{1}{2}Q$</td>
<td>$\frac{1}{2}\mu_T$</td>
</tr>
<tr>
<td><strong>Order quantity</strong></td>
<td>$EOQ=\sqrt{\frac{2DS}{H}}$</td>
<td>$M-I$</td>
</tr>
<tr>
<td><strong>Reorder point</strong></td>
<td>$r = \mu_L + z\sigma_L$</td>
<td></td>
</tr>
<tr>
<td><strong>Replenishment level</strong></td>
<td></td>
<td>$M = \mu_{T+L} + z\sigma_{T+L}$</td>
</tr>
<tr>
<td><strong>Annual number of orders</strong></td>
<td>$\frac{D}{Q}$</td>
<td>$\frac{1}{T}$ $T$ is in years</td>
</tr>
</tbody>
</table>

Annual number of orders is calculated as the ratio of annual demand $D$ to order quantity $Q$. The reorder point $r$ is calculated as the average demand during the lead time $\mu_L$ plus a safety factor $z\sigma_L$. Replenishment level is typically set at the level of demand during the lead time plus a safety stock. Annual orders are the ratio of annual demand to order quantity, and the reorder point is expressed in terms of the annual lead time $T$.
Example 7: Statewide Auto parts uses a 4-week periodic-review system to reorder parts for its inventory stock. A 1-week lead time is required to fill the order. Demand for one particular part during the 5-week replenishment period is normally distributed with a mean of 18 units and a standard deviation of 6 units.

a. At a particular periodic review, 8 units are in inventory. The parts manager places an order for 16 units. What is the probability that this part will have a stockout before an order that is placed at the next 4-week review period arrives?

B. Assume that the company is willing to tolerate a 2.5% chance of stockout associated with a replenishment decision. How many parts should the manager have ordered in part (a)? What is the replenishment level for the 4-week periodic review system?
Example 8: Rose Office Supplies, Inc., uses a 2-week periodic review for its store inventory. Mean and standard deviation of weekly sales are 16 and 5 respectively. The lead time is 3 days. The mean and standard deviation of lead-time demand are 8 and 3.5 respectively.

A. What is the mean and standard deviation of demand during the review period plus the lead-time period?

B. Assuming that the demand has a normal probability distribution, what is the replenishment level that will provide an expected stockout rate of one per year?

C. If there are 18 notebooks in the inventory, how many notebooks should be ordered?
Example 9: Foster Drugs, Inc., handles a variety of health and beauty products. A particular hair conditioner product costs Foster Drugs $2.95 per unit. The annual holding cost rate is 20%. A fixed-quantity model recommends an order quantity of 300 units per order.

a. Lead time is one week and the lead-time demand is normally distributed with a mean of 150 units and a standard deviation of 40 units. What is the reorder point if the firm is willing to tolerate a 1% chance of stockout on any one cycle?

b. What safety stock and annual safety stock cost are associated with your recommendation in part (a)?

c. The fixed-quantity model requires a continuous-review system. Management is considering making a transition to a fixed-period system in an attempt to coordinate ordering
for many of its products. The demand during the proposed two-week review period and the one-week lead-time period is normally distributed with a mean of 450 units and a standard deviation of 70 units. What is the recommended replenishment level for this periodic-review system if the firm is willing to tolerate the same 1% chance of stockout associated with any replenishment decision?

d. What safety stock and annual safety stock cost are associated with your recommendation in part (c)?

e. Compare your answers to parts (b) and (d). The company is seriously considering the fixed-period system. Would you support the decision? Explain.

f. Would you tend to favor the continuous-review system for more expensive items? For example, assume that the product in the above example sold for $295 per unit. Explain.
Text Problem 5, Chapter 15: Charlie’s Pizza orders all of its pepperoni, olives, anchovies, and mozzarella cheese to be shipped directly from Italy. An American distributor stops by every four weeks to take orders. Because the orders are shipped directly from Italy, they take three weeks to arrive.

Charlie’s Pizza uses an average of 150 pounds of pepperoni each week, with a standard deviation of 30 pounds. Charlie’s prides itself on offering only the best-quality ingredients and a high level of service, so it wants to ensure a 98 percent probability of not stocking out on pepperoni.

Assume that the sales representative just walked in the door and there are currently 500 pounds of pepperoni in the walk-in cooler. How many pounds of pepperoni would you order?
Text Problem 10, Chapter 15: The annual demand for a product is 15,600 units. The weekly demand is 300 units with a standard deviation of 90 units. The cost to place an order is $31.20, and the time from ordering to receipt is four weeks. The annual inventory carrying cost is $0.10 per unit. Find the reorder point necessary to provide a 98 percent service probability.

Suppose the production manager is asked to reduce the safety stock of this item by 50 percent. If she does so, what will the new service probability be?
Reading and Exercises

• Chapter 15 pp. 586-609
• Exercises:
  Chapter end problems 4, 5, 6, 10, 12, 14 and 20
  Examples 5, 8 and 9