Supply Chain Management (3rd Edition)

Chapter 12
Determining Optimal Level of Product Availability
Outline

- The importance of the level of product availability
- Factors affecting the optimal level of product availability
- Managerial levers to improve supply chain profitability
- Supply chain contracts and their impact on profitability
- Setting optimal levels of product availability in practice
Mattel, Inc. & Toys ‘R Us

Mattel was hurt last year by inventory cutbacks at Toys ‘R Us, and officials are also eager to avoid a repeat of the 1998 Thanksgiving weekend. Mattel had expected to ship a lot of merchandise after the weekend, but retailers, wary of excess inventory, stopped ordering from Mattel. That led the company to report a $500 million sales shortfall in the last weeks of the year ... For the crucial holiday selling season this year, Mattel said it will require retailers to place their full orders before Thanksgiving. And, for the first time, the company will no longer take reorders in December, Ms. Barad said. This will enable Mattel to tailor production more closely to demand and avoid building inventory for orders that don't come.

- Wall Street Journal, Feb. 18, 1999
Key Questions

- How much should Toys ‘R Us order given demand uncertainty?
- How much should Mattel order?
- Will Mattel’s action help or hurt profitability?
- What actions can improve supply chain profitability?
Importance of the Level of Product Availability

- Product availability measured by cycle service level or fill rate
- Also referred to as the customer service level
- Product availability affects supply chain responsiveness
- Trade-off:
  - High levels of product availability $\rightarrow$ increased responsiveness and higher revenues
  - High levels of product availability $\rightarrow$ increased inventory levels and higher costs
- Product availability is related to profit objectives, and strategic and competitive issues (e.g., Nordstrom, power plants, supermarkets, e-commerce retailers)
- What is the level of fill rate or cycle service level that will result in maximum supply chain profits?
Factors Affecting the Optimal Level of Product Availability

- Cost of overstocking
- Cost of understocking
- Possible scenarios
  - Seasonal items with a single order in a season
  - Continuously stocked items
  - Demand during stockout is backlogged
  - Demand during stockout is lost
Managerial Levers to Improve Supply Chain Profitability

◆ “Obvious” actions
  – Increase salvage value of each unit
  – Decrease the margin lost from a stockout
◆ Improved forecasting
◆ Quick response
◆ Postponement
◆ Tailored sourcing
Improved Forecasts

- Improved forecasts result in reduced uncertainty
- Less uncertainty (lower $\sigma_R$) results in either:
  - Lower levels of safety inventory (and costs) for the same level of product availability, or
  - Higher product availability for the same level of safety inventory, or
  - Both lower levels of safety inventory and higher levels of product availability
Impact of Improving Forecasts
(Example)

Demand: Normally distributed with a mean of $R = 350$ and standard deviation of $\sigma_R = 100$

Purchase price = $100
Retail price = $250
Disposal value = $85
Holding cost for season = $5

*How many units should be ordered as $\sigma_R$ changes?*
## Impact of Improving Forecasts

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<th>$O^*$</th>
<th>Expected Overstock</th>
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<th>Expected Profit</th>
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Quick Response

◆ Set of actions taken by managers to reduce lead time
◆ Reduced lead time results in improved forecasts
  – Typical example of quick response is multiple orders in one season for retail items (such as fashion clothing)
  – For example, a buyer can usually make very accurate forecasts after the first week or two in a season
  – Multiple orders are only possible if the lead time is reduced – otherwise there wouldn’t be enough time to get the later orders before the season ends
◆ Benefits:
  – Lower order quantities → less inventory, same product availability
  – Less overstock
  – Higher profits
Quick Response: Multiple Orders Per Season

- Ordering shawls at a department store
  - Selling season = 14 weeks
  - Cost per handbag = $40
  - Sale price = $150
  - Disposal price = $30
  - Holding cost = $2 per week
- Expected weekly demand = 20
- SD of weekly demand = 15
## Impact of Quick Response

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<thead>
<tr>
<th>Service Level</th>
<th>Order Size</th>
<th>Ending Invent.</th>
<th>Expect. Profit</th>
<th>Initial Order</th>
<th>OUL for 2\textsuperscript{nd} Order</th>
<th>Average Total Order</th>
<th>Ending Invent.</th>
<th>Expect. Profit</th>
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Forecast Improves for Second Order (SD=3 Instead of 15)

<table>
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<th>Service Level</th>
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<th>Ending Invent.</th>
<th>Expect. Profit</th>
<th>Initial Order</th>
<th>OUL for 2\textsuperscript{nd} Order</th>
<th>Average Total Order</th>
<th>Ending Invent.</th>
<th>Expect. Profit</th>
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</table>

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Postponement

- Delay of product differentiation until closer to the time of the sale of the product
- All activities prior to product differentiation require aggregate forecasts more accurate than individual product forecasts
- Individual product forecasts are needed close to the time of sale – demand is known with better accuracy (lower uncertainty)
- Results in a better match of supply and demand
- Valuable in e-commerce – time lag between when an order is placed and when customer receives the order (this delay is expected by the customer and can be used for postponement)
- Higher profits, better match of supply and demand
Value of Postponement: Benetton

- For each color
  - Mean demand = 1,000; SD = 500
- For each garment
  - Sale price = $50
  - Salvage value = $10
  - Production cost using Option 1 (long lead time) = $20
  - Production cost using Option 2 (uncolored thread) = $22
- What is the value of postponement?
  - Expected profit increases from $94,576 to $98,092
Value of Postponement with Dominant Product

- Color with dominant demand: Mean = 3,100, SD = 800
- Other three colors: Mean = 300, SD = 200
- Expected profit without postponement = $102,205
- Expected profit with postponement = $99,872
Tailored Postponement: Benetton

- Produce $Q_I$ units for each color using Option 1 and $Q_A$ units (aggregate) using Option 2
- Results:
  - $Q_I = 800$
  - $Q_A = 1,550$
  - Profit = $104,603$
- Tailored postponement allows a firm to increase profits by postponing differentiation only for products with the most uncertain demand; products with more predictable demand are produced at lower cost without postponement
Tailored Sourcing

- A firm uses a combination of two supply sources
- One is lower cost but is unable to deal with uncertainty well
- The other is more flexible, and can therefore deal with uncertainty, but is higher cost
- The two sources must focus on different capabilities
- Depends on being able to have one source that faces very low uncertainty and can therefore reduce costs
- Increase profits, better match supply and demand
Tailored Sourcing

- Sourcing alternatives
  - Low cost, long lead time supplier
    » Cost = $245, Lead time = 9 weeks
  - High cost, short lead time supplier
    » Cost = $250, Lead time = 1 week
## Tailored Sourcing Strategies

<table>
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<tr>
<th>Fraction of demand from overseas supplier</th>
<th>Annual Profit</th>
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<td>100%</td>
<td>$48,875</td>
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## Tailored Sourcing: Multiple Sourcing Sites

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<th>Characteristic</th>
<th>Primary Site</th>
<th>Secondary Site</th>
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<tr>
<td>Manufacturing Cost</td>
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<td>Low</td>
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<tr>
<td>Flexibility (Volume/Mix)</td>
<td>High</td>
<td>Low</td>
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<tr>
<td>Responsiveness</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Engineering Support</td>
<td>High</td>
<td>Low</td>
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## Dual Sourcing Strategies

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Primary Site</th>
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<td>Volume based dual sourcing</td>
<td>Fluctuation</td>
<td>Stable demand</td>
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<tr>
<td>Product based dual sourcing</td>
<td>Unpredictable products, Small batch</td>
<td>Predictable, large batch products</td>
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<tr>
<td>Model based dual sourcing</td>
<td>Newer products</td>
<td>Older stable products</td>
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</table>
Supply Chain Contracts and Their Impact on Profitability

- Contract
- Returns policy: Buyback contracts
- Quantity flexibility contracts
- Vendor-managed inventories
Contracts

- Specifies the parameters within which a buyer places orders and a supplier fulfills them
- Example parameters: quantity, price, time, quality
- Double marginalization: buyer and seller make decisions acting independently instead of acting together – gap between potential total supply chain profits and actual supply chain profits results
- Buyback contracts can be offered that will increase total supply chain profit
Returns Policy: Buyback Contracts

- A manufacturer specifies a wholesale price and a buyback price at which the retailer can return any unsold items at the end of the season.
- Results in an increase in the salvage value for the retailer, which induces the retailer to order a larger quantity.
- The manufacturer is willing to take on some of the cost of overstocking because the supply chain will end up selling more on average.
- Manufacturer profits and supply chain profits can increase.
Impact of Supply Chain Contracts on Profitability: Buyback Contracts

- Buybacks by publishers
- Tech Fiber produces jacket at $v = $10 and charges a wholesale price of $c = $100. Ski Adventure sells jacket for $p = $200. Unsold jackets have no salvage value. Should TF be willing to buy back unsold jackets? Why?
## Buyback Contracts

<table>
<thead>
<tr>
<th>Wholesale Price $c$</th>
<th>Buy Back Price $b$</th>
<th>Optimal Order size for SA</th>
<th>Expected Profit for SA</th>
<th>Expected Returns to TF</th>
<th>Expected Profit for TF</th>
<th>Expected Supply Chain Profit</th>
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Revenue Sharing Contracts

- The manufacturer charges the retailer a low wholesale price and shares a fraction of the revenue generated by the retailer
- The lower wholesale price decreases the cost to the retailer in case of an overstock
- The retailer therefore increases the level of product availability, which results in higher profits for both the manufacturer and the retailer
Quantity Flexibility Contracts

- Manufacturer allows retailer to change order quantity after observing demand
- No returns are required
- The manufacturer bears some of the risk of excess inventory
- Retailer increases order quantity
- Can result in higher manufacturer and supply chain profits
Quantity Flexibility Contracts

- If a retailer order $O$ units, the manufacturer commits to supplying up to $(1+\alpha)O$ and the retailer commits to buying $(1-\beta)O$

- How can quantity flexibility contracts help increase profitability?
## Quantity Flexibility Contracts

<table>
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<th>$\alpha$</th>
<th>$\beta$</th>
<th>Wholesale price c</th>
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<th>Expected purchase by SA</th>
<th>Expected sale by SA</th>
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Vendor-Managed Inventories (VMI)

- Manufacturer or supplier is responsible for all decisions regarding inventory at the retailer
- Control of replenishment decisions moves to the manufacturer
- Requires that the retailer share demand information with the manufacturer
- Manufacturer can increase its profits and total supply chain profits by reducing effects of double marginalization
- Having final customer demand data also helps manufacturer plan production more effectively
- Campbell’s Soup, Proctor & Gamble
- Potential drawback – when retailers sell products that are substitutes in customers’ minds
Setting Optimal Levels of Product Availability in Practice

- Use an analytical framework to increase profits
- Beware of preset levels of availability
- Use approximate costs because profit-maximizing solutions are very robust
- Estimate a range for the cost of stocking out
- Ensure that levels of product availability fit with the strategy
Summary of Learning Objectives

◆ What are the factors affecting the optimal level of product availability?
◆ How is the optimal cycle service level estimated?
◆ What are the managerial levers that can be used to improve supply chain profitability through optimal service levels?
◆ How can contracts be structured to increase supply chain profitability?