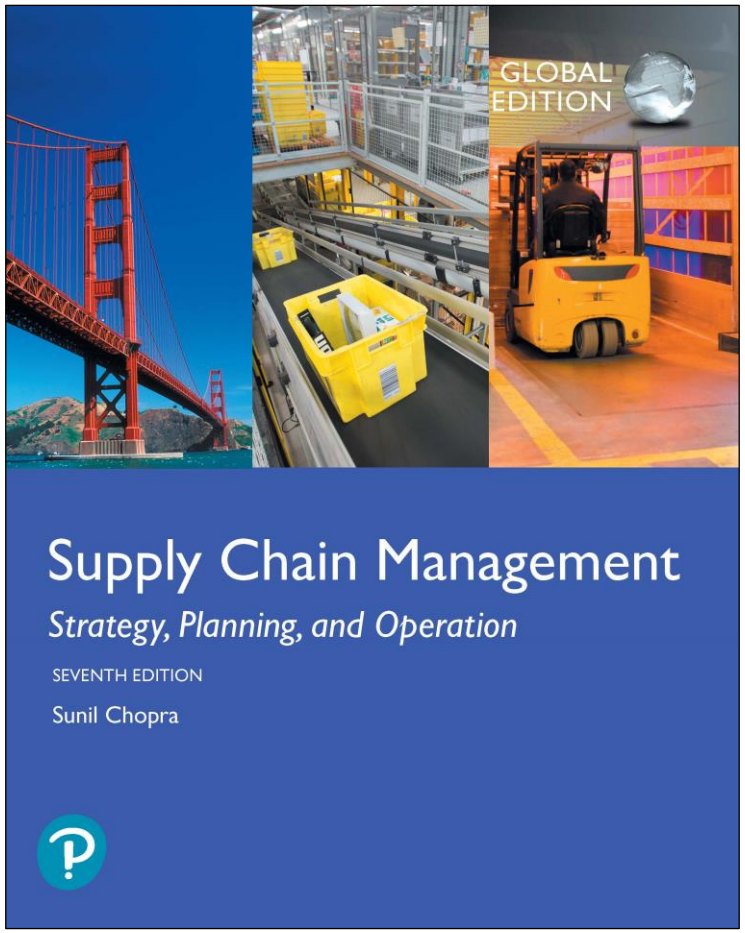
Supply Chain Management: Strategy, Planning, and Operation

Seventh Edition, Global Edition



Chapter 3

Supply Chain Drivers and Metrics

Learning Objectives (1 of 3)

3.1 Describe key financial measures of firm performance.

3.2 Identify the major drivers of supply chain performance.

3.3 Define the key performance metrics for facilities and discuss their role in creating strategic fit between the supply chain strategy and the competitive strategy.

Learning Objectives (2 of 3)

3.4 Define the key performance metrics for inventory and discuss its role in creating strategic fit between the supply chain strategy and the competitive strategy.

3.5 Define the key performance metrics for transportation and discuss its role in creating strategic fit between the supply chain strategy and the competitive strategy.

Learning Objectives (3 of 3)

3.6 Define the key performance metrics for information and discuss its role in creating strategic fit between the supply chain strategy and the competitive strategy.

3.7 Define the key performance metrics for sourcing and discuss its role in creating strategic fit between the supply chain strategy and the competitive strategy.

3.8 Define the key performance metrics for pricing and discuss its role in creating strategic fit between the supply chain strategy and the competitive strategy.

Financial Measures of Performance (1 of 7)

- From a shareholder perspective, return on equity (ROE) is the main summary measure of a firm's performance

$$\text{ROE} = \frac{\text{Net Income}}{\text{Average Shareholder Equity}}$$

Financial Measures of Performance (2 of 7)

- Return on assets (ROA) measures the return earned on each dollar invested by the firm in assets

$$\text{ROA} = \frac{\text{Earnings before interest}}{\text{Average Total Assets}}$$

$$= \frac{\text{Net Income} + \left[\text{Interest Expense} \times (1 - \text{Tax Rate})\right]}{\text{Average Total Assets}}$$

Financial Data for Amazon and Nordstrom (1 of 6)

Table 3-1 Selected Financial Data for Amazon.com and Nordstrom Inc.

	Amazon.com	Nordstrom Inc.
Period Ending	**31-Dec-13**	**2-Feb-13**
Total Revenue	74,452,000	12,148,000
Cost of Goods Sold	54,181,000	7,432,000
Gross Profit	20,271,000	4,716,000
Selling, General, and Administrative	19,526,000	3,371,000
Operating Income or Loss	745,000	1,345,000
Total Other Income/Expenses Net	–98,000	–
Earnings Before Interest and Taxes	647,000	1,345,000
Interest Expense	141,000	160,000

Financial Data for Amazon and Nordstrom (2 of 6)

Table 3-1 [Continued]

	Amazon.com	Nordstrom Inc.
Period Ending	**31-Dec-13**	**2-Feb-13**
Income Before Tax	506,000	1,185,000
Income Tax Expense	161,000	450,000
Minority Interest	–	–
Net Income	274,000	613,000
Assets		
Cash and Cash Equivalents	8,658,000	1,285,000
Short-Term Investments	3,789,000	–
Net Receivables	4,767,000	2,356,000
Inventory	7,411,000	1,360,000

Financial Data for Amazon and Nordstrom (3 of 6)

Table 3-1 [Continued]

	Amazon.com	Nordstrom Inc.
Period Ending	**31-Dec-13**	**2-Feb-13**
Other Current Assets	–	80,000
Total Current Assets	24,625,000	5,081,000
Property, Plant, and Equipment (PP&E)	10,949,000	2,579,000
Goodwill	2,655,000	175,000
Other Assets	1,930,000	254,000
Total Assets	40,159,000	8,089,000
Liabilities and Stockholder Equity		
Accounts Payable	21,821,000	1,415,000

Financial Data for Amazon and Nordstrom (4 of 6)

Table 3-1 [Continued]

	Amazon.com	Nordstrom Inc.
Period Ending	**31-Dec-13**	**2-Feb-13**
Short-/Current Long-Term Debt	–	7,000
Other Current Liabilities	1,159,000	804,000
Long-Term Debt	3,191,000	3,124,000
Other Liabilities	4,242,000	341,000
Deferred Long-Term Liability Charges	–	485,000
Total Liabilities	30,413,000	6,176,000
Total Stockholder Equity	9,746,000	1,913,000

Financial Data for Amazon and Nordstrom (5 of 6)

Table 3-2 A Comparison of Financial Metrics for Amazon.com and Nordstrom Inc.

Metric	Amazon.com	Nordstrom Inc.
ROE	$\frac{274}{9,746} = 2.81\%$	$\frac{735}{1913} = 38.42\%$
ROA	$\frac{274 + 141 \times (1 - 0.35)}{40,159} = 0.91\%$	$\frac{735 + 160 \times (1 - 0.35)}{8,089} = 10.37\%$
ROFL	1.90% **(Return on financial leverage)**	28.05%
Profit Margin	$\frac{274 + 141 \times (1 - 0.35)}{74,452} = 0.49\%$	$\frac{735 + 160 \times (1 - 0.35)}{12,148} = 6.91\%$
Asset Turnover	$\frac{74,452}{40,159} = 1.85$	$\frac{12,148}{8,089} = 1.50$

Financial Data for Amazon and Nordstrom (6 of 6)

Table 3-2 [Continued]

Metric	Amazon.com	Nordstrom Inc.
APT (Accounts payable turnover)	$\frac{54,181}{21,821} = 2.48$	$\frac{7,432}{1,011} = 7.35$
ART (Accounts receivable turnover)	$\frac{74,452}{4,767} = 15.62$	$\frac{12,148}{2,129} = 5.71$
INVT (Inventory turnover)	$\frac{54,181}{7,411} = 7.31$	$\frac{7,432}{1,360} = 5.46$
PPET (Property, plant, and equipment turnover)	$\frac{74,452}{10,949} = 6.80$	$\frac{12,148}{2,579} = 4.71$
C2C	$-\frac{1}{2.48} + \frac{1}{15.62} + \frac{1}{7.31}$ $= -0.20 \text{ years} = -10.53 \text{ weeks}$	$-\frac{1}{7.35} + \frac{1}{5.71} + \frac{1}{5.46}$ $= 0.22 \text{ years} = 11.56 \text{ weeks}$

Financial Measures of Performance (3 of 7)

- An important ratio that defines financial leverage is accounts payable turnover (APT)

$$\text{APT} = \frac{\text{Cost of Goods Sold}}{\text{Accounts Payable}}$$

Financial Measures of Performance (4 of 7)

- ROA can be written as the product of two ratios – profit margin and asset turnover

$$\text{ROA} = \frac{\text{Earnings before interest}}{\text{Sales Revenue}} \times \frac{\text{Sales Revenue}}{\text{Total Assets}}$$
$$= \text{Profit Margin} \times \text{Asset Turnover}$$

Financial Measures of Performance (5 of 7)

- Key components of asset turnover are accounts receivable turnover (ART); inventory turnover (INVT); and property, plant, and equipment turnover (PPET)

$$\text{ART} = \frac{\text{Sales Revenue}}{\text{Accounts Receivable}}; \quad \text{INVT} = \frac{\text{Cost of Goods sold}}{\text{Inventories}};$$

$$\text{PPET} = \frac{\text{Sales Revenue}}{\text{PP \& E}}$$

Financial Measures of Performance (6 of 7)

- Cash-to-cash (C2C) cycle roughly measures the average amount of time from when cash enters the process as cost to when it returns as collected revenue

$$C2C = -\text{Weeks Payable}\left(\frac{1}{APT}\right) + \text{Weeks in Inventory}\left(\frac{1}{INVT}\right) + \text{Weeks Receivable}\left(\frac{1}{ART}\right)$$

Selected Financial Metrics

Table 3-3 Selected Financial Metrics Across Industries, 2000–2012

Industry	Average Operating Margin	Average C2C Cycle	Average Inventory Turns	Average SG&A Cost/ Revenue
Pharmaceutical	0.25	190.3	2.0	0.31
Medical device manufacturers	0.18	211.6	2.2	0.36
Consumer packaged goods	0.17	28.3	5.6	0.31
Food	0.16	37.4	6.2	0.23
Consumer electronics	0.12	9.3	43.8	0.14
Apparel	0.10	127.7	3.2	0.35
Chemical	0.09	78.1	5.3	0.09
Automotive	0.04	75.9	9.9	0.13

Financial Measures of Performance (7 of 7)

- To measures not part of financial statements
  - **Markdowns**: discounts required to convince customers to buy excess inventory
  - **Lost sales**: represent customer sales that did not materialize because of the absence of products the customer wanted to buy

Summary of Learning Objective 1

The key financial metrics of firm performance include return on equity; return on assets; accounts payable turnover; profit margin; asset turnover; accounts receivable turnover; inventory turns; property, plant, and equipment turns; cash-to-cash cycle; and SG&A / revenue. Markdowns and lost sales are two important financial measures of supply chain performance that are not recorded in financial statements.

Framework for Supply Chain Decisions (1 of 2)

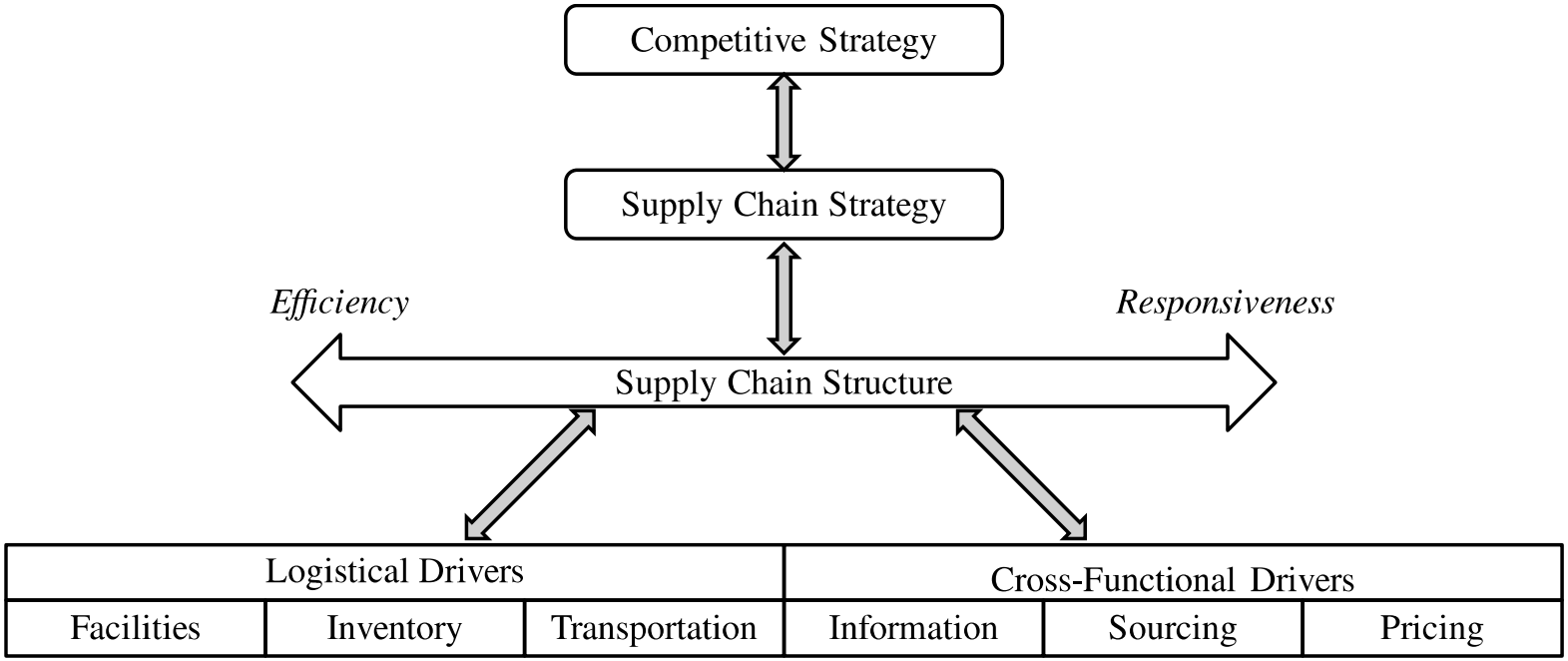


Figure 3-1 Supply Chain Decision-Making Frame work

Framework for Supply Chain Decisions (2 of 2)

- Logistical Drivers
  - Facilities
  - Inventory
  - Transportation
- Cross-Functional Drivers
  - Information
  - Sourcing
  - Pricing
- Interactions determine overall supply chain performance

Summary of Learning Objective 2

The major drivers of supply chain performance are facilities, inventory, transportation, information, sourcing, and pricing. Each driver affects the balance between responsiveness and efficiency and the resulting strategic fit. Thus, it is important for supply chain designers to structure the six drivers appropriately to achieve strategic fit.

Drivers of Supply Chain Performance (1 of 2)

1. Facilities
   - The physical locations in the supply chain network where product is stored, assembled, or fabricated
2. Inventory
   - All raw materials, work in process, and finished goods within a supply chain
3. Transportation
   - Moving inventory from point to point in the supply chain

Drivers of Supply Chain Performance (2 of 2)

4. Information
   - Data and analysis concerning facilities, inventory, transportation, costs, prices, and customers throughout the supply chain
5. Sourcing
   - Who will perform a particular supply chain activity
6. Pricing
   - How much a firm will charge for the goods and services that it makes available in the supply chain

Facilities (1 of 6)

- Role in the supply chain
  - Production sites and storage sites
  - Increase responsiveness by increasing the number of facilities, making them more flexible, or increasing capacity

Facilities (2 of 6)

- Tradeoffs between facility, inventory, and transportation costs
  - Increasing number of facilities increases facility and inventory costs, decreases transportation costs and reduces response time
  - Increasing the flexibility or capacity of a facility increases facility costs but decreases inventory costs and response time

Facilities (3 of 6)

- Components of facilities decisions
  - **Capability**
    - Flexible, dedicated, or a combination of the two
    - Product focus or a functional focus
  - **Location**
    - Where a company will locate its facilities
    - Centralize for economies of scale, decentralize for responsiveness
    - Consider macroeconomic factors, quality of workers, cost of workers and facility, availability of infrastructure, proximity to customers, location of other facilities, tax effects

Facilities (4 of 6)

- **Capacity**
  - A facility's capacity to perform its intended function or functions
  - Excess capacity – responsive, costly
  - Little excess capacity – more efficient, less responsive
- **Demand Allocation**
  - Markets each facility will serve
  - Revisited as conditions change

Facilities (5 of 6)

- **Facility-Related Metrics**
  - Capacity
  - Utilization
  - Processing/setup/down/idle time
  - Quality losses
  - Production cost per unit
  - Theoretical flow/cycle time of production
  - Actual average flow/cycle time

Facilities (6 of 6)

- Product variety
- Volume contribution of top 20 percent SKU's and customers
- Average production batch size
- Production service level

Summary of Learning Objective 3

The major facility related decisions include identifying the number of facilities, the extent of flexibility, the level of capacity, and the markets served by each facility. Increasing the number of facilities, their flexibility, or their excess capacity increases responsiveness but hurts efficiency. Key facility-related metrics are capacity, utilization, processing/setup/down/idle time, quality, theoretical flow/cycle time of production, actual flow/cycle time, product variety, volume contribution of top 20 percent SKUs/customers, average production batch size, and service level.

Inventory (1 of 3)

- **Role in the Supply Chain**
  - Mismatch between supply and demand
  - Exploit economies of scale
  - Reduce costs
  - Improve product availability
  - Affects assets, costs, responsiveness, material flow time

Inventory (2 of 3)

- **Overall Trade-Off**
  - Increasing inventory generally makes the supply chain more responsive
  - A higher level of inventory facilitates a reduction in production and transportation costs because of improved economies of scale
  - Inventory holding costs increase

Inventory (3 of 3)

- **Material flow time,** the time that elapses between the point at which material enters the supply chain to the point at which it exits
- **Throughput**, the rate at which sales occur
- Little's law

$$I = DT$$

where

I = flow time, T = throughput, D = demand

Components of Inventory Decisions (1 of 4)

- **Cycle Inventory**
  - Average amount of inventory used to satisfy demand between supplier shipments
  - Function of lot size decisions
- **Safety Inventory**
  - Inventory held in case demand exceeds expectations
  - Costs of carrying too much inventory versus cost of losing sales

Components of Inventory Decisions (2 of 4)

- **Seasonal Inventory**
  - Inventory built up to counter predictable variability in demand
  - Cost of carrying additional inventory versus cost of flexible production
- **Level of Product Availability**
  - The fraction of demand that is served on time from product held in inventory
  - Trade off between customer service and cost

Components of Inventory Decisions (3 of 4)

- **Inventory-Related Metrics**
  - C2C cycle time
  - Average inventory
  - Inventory turns
  - Products with more than a specified number of days of inventory
  - Average replenishment batch size

Components of Inventory Decisions (4 of 4)

- Average safety inventory
- Seasonal inventory
- Fill rate
- Fraction of time out of stock
- Obsolete inventory

Summary of Learning Objective 4

The major inventory related decisions include identifying the batch size, the safety inventory, the seasonal inventory, and the level of product availability. Increasing the safety inventory and level of product availability increases responsiveness but hurts efficiency. Increasing the batch size and seasonal inventory increases holding costs but may decrease production, transportation, and purchasing costs. Key inventory-related metrics are average inventory, turns, products with more than a specified number of days of inventory, average replenishment batch size, average safety inventory, seasonal inventory, fill rate, and fraction of time out of stock.

Transportation (1 of 5)

- **Role in the Supply Chain**
  - Moves inventory between stages in the supply chain
  - Affects responsiveness and efficiency
  - Faster transportation allows greater responsiveness but lower efficiency
  - Also affects inventory and facilities
  - Allows a firm to adjust the location of its facilities and inventory to find the right balance between responsiveness and efficiency

Transportation (2 of 5)

- **Components of Transportation Decisions**
  - **Design of transportation network**
    - Modes, locations, and routes
    - Direct or with intermediate consolidation points
    - One or multiple supply or demand points in a single run

Transportation (3 of 5)

- **Choice of transportation mode**
  - Air, truck, rail, sea, and pipeline
  - Information goods via the Internet
  - Different speed, size of shipments, cost of shipping, and flexibility

Transportation (4 of 5)

- **Transportation-Related Metrics**
  - Average inbound transportation cost
  - Average income shipment size
  - Average inbound transportation cost per shipment
  - Average outbound transportation cost
  - Average outbound shipment size
  - Average outbound transportation cost per shipment
  - Fraction transported by mode

Transportation (5 of 5)

- **Overall Trade-off: Responsiveness Versus Efficiency**
  - The cost of transporting a given product (efficiency) and the speed with which that product is transported (responsiveness)
  - Using fast modes of transport raises responsiveness and transportation cost but lowers the inventory holding cost

Summary of Learning Objective 5

The major transportation related decisions include designing the transportation network and selecting the transportation mode. Faster modes of transport are more expensive but can improve responsiveness while helping decrease inventory and facility costs. Key transportation-related metrics are average inbound transportation cost, average incoming shipment size, average inbound transportation cost per shipment, average outbound transportation cost, average outbound shipment size, average outbound transportation cost per shipment, and fraction transported by mode.

Information (1 of 2)

- **Role in the Supply Chain**
  - Improve the utilization of supply chain assets and the coordination of supply chain flows to increase responsiveness and reduce cost
  - Information is a key driver that can be used to provide higher responsiveness while simultaneously improving efficiency

Information (2 of 2)

- **Role in the Competitive Strategy**
  - Improves visibility of transactions and coordination of decisions across the supply chain
  - Right information can help a supply chain better meet customer needs at lower cost
  - More information increases complexity and cost of both infrastructure and analysis exponentially while marginal value diminishes
  - Share the minimum amount of information required to achieve coordination

Components of Information Decisions (1 of 3)

- **Demand Planning**
  - Best estimate of future demand
  - Include estimation of forecast error
- **Coordination and Information Sharing**
  - **Supply chain coordination,** all stages of a supply chain work toward the objective of maximizing total supply chain profitability based on shared information
  - Critical for success

Components of Information Decisions (2 of 3)

- **Sales and Operations Planning** (S&OP)
  - The process of creating an overall supply plan (production and inventories) to meet the anticipated level of demand (sales)
  - Can be used to plan supply chain needs and project revenues and profits

Components of Information Decisions (3 of 3)

- **Information-Related Metrics**
  - Forecast horizon
  - Frequency of update
  - Forecast error
  - Variance from plan
  - Ratio of demand variability to order variability

Summary of Learning Objective 6

The major information related decisions include coming up with a demand plan as well as a sales & operations plan that optimally matches supply and demand. It is important that information is shared across the supply chain to ensure that plans at different stages are coordinated. Key information-related metrics are forecast horizon, forecast error, variance from plan, and ratio of demand variability to order variability.

Sourcing (1 of 2)

- **Role in the Supply Chain**
  - Set of business processes required to purchase goods and services
  - Will tasks be performed by a source internal to the company or a third party
  - Should increase the size of the total surplus to be shared across the supply chain

Sourcing (2 of 2)

- **Role in the Competitive Strategy**
  - Sourcing decisions are crucial because they affect the level of efficiency and responsiveness in a supply chain
  - Outsource to responsive third parties if it is too expensive to develop their own
  - Keep responsive process in-house to maintain control

Components of Sourcing Decisions (1 of 3)

- **In-House or Outsource**
  - Perform a task in-house or outsource it to a third party
  - Outsource if it raises the supply chain surplus more than the firm can on its own
  - Keep function in-house if the third party cannot increase the supply chain surplus or if the outsourcing risk is significant

Components of Sourcing Decisions (2 of 3)

- **Supplier Selection**
  - Number of suppliers, criteria for evaluation and selection
- **Procurement**
  - Obtain goods and service within a supply chain
  - Goal is to decrease total cost of ownership and increase supply chain surplus

Components of Sourcing Decisions (3 of 3)

- **Sourcing-Related Metrics**
  - Days payable outstanding
  - Average purchase price
  - Range of purchase price
  - Average purchase quantity
  - Supply quality
  - Supply lead time
  - Percentage of on-time deliveries
  - Supplier reliability

Summary of Learning Objective 7

The major sourcing related decisions include deciding whether an activity will be insourced or outsourced, identifying key factors in supplier selection, and selecting the supplier port- folio. Key sourcing-related metrics are days payable outstanding, average purchase price, range of purchase price, average purchase quantity, percentage on-time deliveries, supply quality, and supply lead time.

Pricing

- **Role in the Supply Chain**
  - Pricing determines the amount to charge customers for goods and services
  - Affects the supply chain level of responsiveness required and the demand profile the supply chain attempts to serve
  - Pricing strategies can be used to match demand and supply
  - Objective should be to increase firm profit

Components of Pricing Decisions (1 of 3)

- **Pricing and Economies of Scale**
  - The provider of the activity must decide how to price it appropriately to reflect economies of scale
- **Everyday Low Pricing Versus High-Low Pricing**
  - Different pricing strategies lead to different demand profiles that the supply chain must serve

Components of Pricing Decisions (2 of 3)

- **Fixed Price Versus Menu Pricing**
  - If marginal supply chain costs or the value to the customer vary significantly along some attribute, it is often effective to have a pricing menu
  - Can lead to customer behavior that has a negative impact on profits

Components of Pricing Decisions (3 of 3)

- **Pricing-Related Metrics**
  - Profit margin
  - Days sales outstanding
  - Incremental fixed cost per order
  - Incremental variable cost per unit
  - Average sale price
  - Average order size
  - Range of sale price
  - Range of periodic sales

Summary of Learning Objective 8

The major pricing related decisions include deciding whether the firm will offer quantity discounts, whether it will offer everyday low pricing or prices that vary over time, and whether it will offer a fixed price or a menu of prices that vary along some dimension such as response time. Pricing-related metrics are profit margin, days sales outstanding, incremental fixed cost per order, incremental variable cost per unit, average sale price, average order size, range of sale price, and range of periodic sales.