Supply Chain Drivers and Metrics
Learning Objectives

1. Describe key financial measures of firm performance.
2. Identify the major drivers of supply chain performance.
3. Discuss the role of each driver in creating strategic fit between the supply chain strategy and the competitive strategy.
4. Define the key metrics that track the performance of the supply chain in terms of each driver.
Financial Measures Of Performance

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

\[ ROE = \frac{Net \text{ Income}}{Average \text{ Shareholder Equity}} \]
Financial Measures Of Performance

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

\[
ROA = \frac{Earnings \ before \ interest}{Average \ Total \ Assets}
\]

\[
= \frac{Net \ Income + [Interest \ Expense \ (1 - Tax \ Rate)]}{Average \ Total \ Assets}
\]
### TABLE 3-1

<table>
<thead>
<tr>
<th>Financial Data for Amazon and Nordstrom</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Period Ending</th>
<th>Amazon.com</th>
<th>Nordstrom Inc.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>31-Dec-13</td>
<td>2-Feb-13</td>
</tr>
<tr>
<td>Total Revenue</td>
<td>74,452,000</td>
<td>12,148,000</td>
</tr>
<tr>
<td>Cost of Goods Sold</td>
<td>54,181,000</td>
<td>7,432,000</td>
</tr>
<tr>
<td>Gross Profit</td>
<td>20,271,000</td>
<td>4,716,000</td>
</tr>
<tr>
<td>Selling, General, and Administrative</td>
<td>19,526,000</td>
<td>3,371,000</td>
</tr>
<tr>
<td>Operating Income or Loss</td>
<td>745,000</td>
<td>1,345,000</td>
</tr>
<tr>
<td>Total Other Income/Expenses Net</td>
<td>-98,000</td>
<td>-</td>
</tr>
<tr>
<td>Earnings Before Interest and Taxes</td>
<td>647,000</td>
<td>1,345,000</td>
</tr>
<tr>
<td>Interest Expense</td>
<td>141,000</td>
<td>160,000</td>
</tr>
<tr>
<td>Income Before Tax</td>
<td>506,000</td>
<td>1,185,000</td>
</tr>
<tr>
<td>Income Tax Expense</td>
<td>161,000</td>
<td>450,000</td>
</tr>
<tr>
<td>Minority Interest</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Net Income</strong></td>
<td>274,000</td>
<td>613,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash and Cash Equivalents</td>
</tr>
<tr>
<td>Short-Term Investments</td>
</tr>
<tr>
<td>Net Receivables</td>
</tr>
<tr>
<td>Inventory</td>
</tr>
<tr>
<td>Other Current Assets</td>
</tr>
<tr>
<td><strong>Total Current Assets</strong></td>
</tr>
<tr>
<td>Property, Plant, and Equipment (PP&amp;E)</td>
</tr>
<tr>
<td>Goodwill</td>
</tr>
<tr>
<td>Other Assets</td>
</tr>
<tr>
<td><strong>Total Assets</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Liabilities and Stockholder Equity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accounts Payable</td>
</tr>
<tr>
<td>Short-/Current Long-Term Debt</td>
</tr>
<tr>
<td>Other Current Liabilities</td>
</tr>
<tr>
<td>Long-Term Debt</td>
</tr>
<tr>
<td>Other Liabilities</td>
</tr>
<tr>
<td>Deferred Long-Term Liability Charges</td>
</tr>
<tr>
<td><strong>Total Liabilities</strong></td>
</tr>
<tr>
<td><strong>Total Stockholder Equity</strong></td>
</tr>
</tbody>
</table>
Financial Measures Of Performance

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

\[ APT = \frac{\text{Cost of Goods Sold}}{\text{Accounts Payable}} \]
Financial Measures Of Performance

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

\[
ROA = \frac{\text{Earnings before interest}}{\text{Sales Revenue}} \times \frac{\text{Sales Revenue}}{\text{Total Assets}}
\]

\[
= \text{Profit Margin} \times \text{Asset Turnover}
\]
Financial Measures Of Performance

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

\[
ART = \frac{Sales \ Revenue}{Accounts \ Receivable}; \quad INVT = \frac{Cost \ of \ Goods \ Sold}{Inventories}; \quad PPET = \frac{Sales \ Revenue}{PP \ & \ E}
\]
Financial Measures Of Performance

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

\[
C2C = - \text{Weeks Payable} \cdot \frac{1}{\text{APT}} + \text{Weeks in Inventory} \cdot \frac{1}{\text{INVT}} + \text{Weeks Receivable} \cdot \frac{1}{\text{ART}}
\]
### Selected Financial Metrics Across Industries, 2000–2012

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

**TABLE 3-2**
Financial Measures Of Performance

- 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
Drivers of Supply Chain Performance

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

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
Framework for Structuring Drivers

Figure 3-1
Facilities

• Role in the supply chain
  – Increase responsiveness by increasing the number of facilities, making them more flexible, or increasing capacity
Facilities

• Role in the supply chain
  – 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

• Components of facilities decisions
  – Role
    • 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

• Components of facilities decisions
  – Capacity
    • A facility’s capacity to perform its intended function or functions
    • Excess capacity – responsive, costly
    • Little excess capacity – more efficient, less responsive
Facilities

- Components of facilities decisions
  - Facility-related metrics
    - Capacity
    - Utilization
    - Processing/setup/down/idle time
    - Production cost per unit
    - Quality losses
    - Theoretical flow/cycle time of production
    - Actual average flow/cycle time
Facilities

• Components of facilities decisions
  – Facility-related metrics
    • Flow time efficiency
    • Product variety
    • Volume contribution of top 20 percent SKU's and customers
    • Average production batch size
    • Production service level
Inventory

- **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

• 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

– *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

\[ I = \text{flow time}, \quad T = \text{throughput}, \quad D = \text{demand} \]
Components of Inventory Decisions

• **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

• **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

• **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

• **Inventory-related metrics**
  – Average safety inventory
  – Seasonal inventory
  – Fill rate
  – Fraction of time out of stock
  – Obsolete inventory
Transportation

• **Role in the Supply Chain**
  – Moves the product 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

• **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

• Components of Transportation Decisions
  – 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

- **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

• 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
Information

• 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

• **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

• Push versus Pull
  – Different information requirements and uses

• 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

• 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)
Components of Information Decisions

• **Enabling technologies**
  1. Electronic data interchange (EDI)
  2. The Internet
  3. Enterprise resource planning (ERP) systems
  4. Supply chain management (SCM) software
  5. Radio frequency identification (RFID)
Components of Information Decisions

• **Information-related metrics**
  – Forecast horizon
  – Frequency of update
  – Forecast error
  – Seasonal factors
  – Variance from plan
  – Ratio of demand variability to order variability
Sourcing

• **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
  – Increase the size of the total surplus to be shared across the supply chain
Sourcing

• **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

• 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

• **Supplier selection**
  – Number of suppliers, criteria for evaluation and selection

• **Procurement**
  – Obtain goods and service within a supply chain
  – Goal is to increase supply chain surplus
Components of Sourcing Decisions

• **Sourcing-related metrics**
  – Days payable outstanding
  – Average purchase price
  – Range of purchase price
  – Average purchase quantity
  – Supply quality
  – Supply lead time
  – Fraction of on-time deliveries
  – Supplier reliability
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

• **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

- **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

• **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 Objectives

1. Describe key financial measures of firm performance
2. Identify the major drivers of supply chain performance
3. Discuss the role of each driver in creating strategic fit between the supply chain strategy and the competitive strategy
4. Define the key metrics that track the performance of the supply chain in terms of each driver