Inventories

15.511 Corporate Accounting
Summer 2004

Professor SP Kothari
Sloan School of Management
Massachusetts Institute of Technology

June 24, 2004
Inventory

Definition: Inventory is defined as goods held for sale in the normal course of business or items used in the manufacture of products that will be sold in the normal course of business.
Inventory

- **Definition:** Inventory is defined as goods held for sale in the normal course of business or items used in the manufacture of products that will be sold in the normal course of business.

- Inventory is recorded on the balance sheet at the lower of the cost or the market value of the inventory.
Inventory: Lower of cost or market. Why?

$B/S Inventory value

Inventory value on the balance sheet

Cost

Market value of Inventory
Inventory

- **Definition**: Inventory is defined as goods held for sale in the normal course of business or items used in the manufacture of products that will be sold in the normal course of business.
- The inventory is recorded on the balance sheet at the lower of the cost or the market value of the inventory.
- The cost of inventory includes all costs necessary to bring the inventory to a saleable condition.
The “Ins” and “Outs” of Inventory Accounting

The “ins” of inventory accounting

The “outs” of inventory accounting

Acquisition costs

Beginning inventory

Cost of goods available for sale

Cost of goods sold

Ending inventory

BInv + Purchases = COGAS = COGS + EInv
Which costs ($) come out?

BInv + Purchases = COGAS = COGS + EInv

- How do we determine
  - which costs are expensed in COGS and
  - which costs remain in EInv?

⇒ Need a cost flow assumption
# The Key Equation

<table>
<thead>
<tr>
<th>Inventory</th>
<th>Cost of goods sold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beg. Inventory</td>
<td></td>
</tr>
<tr>
<td>Purchases/Production</td>
<td></td>
</tr>
<tr>
<td>End. Inventory</td>
<td></td>
</tr>
</tbody>
</table>

\[ \text{Beg. inventory + purchases/production} - \text{COGS} = \text{End. inventory} \]
Which costs go in?

- **What units to include**
  - FOB shipping point or destination: who owns goods in transit?

- **What costs to attach to the units**
  - The cost of inventory includes all costs necessary to bring the inventory to a saleable condition.
  - All costs to acquire, manufacture, prepare
  - Includes shipping costs for retailers
  - Includes overhead costs (as well as direct labor and materials) for manufacturers

- **More on this in managerial accounting …**
Inventory in a Manufacturing Firm

- Materials
- Direct Labor
- Overhead
- Work in Process
- Cash or Payables
- Finished Goods
Inventory in a Manufacturing Firm

- Materials
- Direct Labor
- Overhead

Cash or Payables

Work in Process

Finished Goods
Inventory in a Manufacturing Firm

Buying of inputs

Direct Material  xx
Direct Labor  xx
Overhead  xx
Payables or cash  xx
(payment of salaries, purchase of materials)
Inventory in a Manufacturing Firm

- Materials
- Direct Labor
- Overhead
- Work in Process
- Finished Goods
- Cash or Payables
Inventory in a Manufacturing Firm

Use inputs to manufacture goods

Work in Process  xx
Direct Material  xx
Direct Labor  xx
Overhead  xx
(Use of inputs in production)
Inventory in a Manufacturing Firm

- Materials
- Direct Labor
- Overhead
- Cash or Payables
- Work in Process
- Finished Goods

15
Inventory in a Manufacturing Firm

Transfer finished products from shop floor to warehouse

Finished Goods \( xx \)

Work in Process \( xx \)

(production of goods completed)
Inventory in a Manufacturing Firm

- Materials
- Direct Labor
- Overhead
- Cash or Payables
- Work in Process
- Finished Goods

Cost of Goods Sold
Inventory in a Manufacturing Firm

Sell goods to customers

Cost of Goods Sold $xx
Finished Goods $xx

(finished goods are sold to customers)
Keeping track of inventory quantities: Perpetual vs. Periodic Inventory Systems

How do we know how much has been sold?

- *Perpetual system*: tracks units sold directly
  - more accurate, more timely, potentially more costly

- *Periodic system*: infer quantities sold by using purchases/production, beginning and ending inventories.
  - Units sold = Beg. Units + Production – End. Units
  - harder to detect inventory “shrinkage” (e.g., theft, spoilage) as well as management fraud
Which costs ($) come out?

- BInv + Purchases = COGAS = COGS + EInv
- How do we determine
  - which costs are expensed in COGS and
  - which costs remain in EInv?
- Need a cost flow assumption
LIFO vs FIFO example

LIFO and FIFO are two assumptions about the physical flow of inventory used to determine cost of goods sold and the ending inventory account balance.

The actual physical flow of inventory need not correspond to these assumptions.
LIFO vs FIFO example

FIFO -- First In First Out

LIFO -- Last In First Out
LIFO vs FIFO example

The accountant must separate goods available for sale into End. Inv. and COGS. This separation is done based on the physical flow assumption.
FIFO – Conveyer Belt

FIFO (conveyor belt)

If 4 units are sold, COGS is the purchase price of the first 4 units put on the conveyor belt.
LIFO vs FIFO example

FIFO (conveyor belt)

Purchases

Beg. inventory

End. inventory
(recent prices)

Cost of goods sold
(older prices)

physical flow
LIFO – Cookie Jar

LIFO (cookie jar) -- If 4 units sold, COGS is the purchase price of last 4 units put in the jar.

physical flow

Purchases

Beg. inventory

Cost of goods sold (recent prices)

End. inventory (older prices)
LIFO vs FIFO example

Transactions:
1) Owners invest $24
2) Buy 1 unit of inventory in March for $10
3) Buy 1 unit of inventory in April for $12
4) Sell 1 unit in May for $21
5) Pay other expenses for $6
### LIFO vs FIFO example - FIFO

<table>
<thead>
<tr>
<th>Cash</th>
<th>Inventory</th>
<th>Liabilities</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>(10)</td>
<td>10</td>
<td>24</td>
</tr>
<tr>
<td>(12)</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(6)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**FIFO cost of goods sold?**
### LIFO vs FIFO example - FIFO

<table>
<thead>
<tr>
<th>Cash</th>
<th>+</th>
<th>Inventory</th>
<th>=</th>
<th>Liabilities</th>
<th>+</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>24</td>
</tr>
<tr>
<td>(10)</td>
<td></td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(12)</td>
<td></td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>21</td>
</tr>
<tr>
<td>(6)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(6)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(10)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(10)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>17</td>
<td>12</td>
<td>29</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
LIFO vs FIFO example - FIFO

FIFO

income statement and balance sheet
### LIFO vs FIFO example – FIFO

<table>
<thead>
<tr>
<th>LIFO</th>
<th>Sales 21</th>
<th>Cash 17</th>
</tr>
</thead>
<tbody>
<tr>
<td>COGS</td>
<td>10</td>
<td>Inventory 12</td>
</tr>
<tr>
<td>GM</td>
<td>11</td>
<td>TA 29</td>
</tr>
<tr>
<td>Oper. Exp</td>
<td>6</td>
<td>S. E. 29</td>
</tr>
<tr>
<td>Pretax Inc.</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

- Recent costs on B/S
- Old costs on the I/S
LIFO vs FIFO example - LIFO

Cash + Inventory = Liabilities + SE

24 + 10 = 24 + 10
(10) 10
(12) 12
21 + (6) = 21 + (6)

LIFO cost of goods sold?
LIFO vs FIFO example - LIFO

\[
\begin{array}{ccc}
\text{Cash} & + & \text{Inventory} \\
24 & & 10 \\
(10) & & (12) \\
(12) & & 21 \\
21 & & (6) \\
(12) & & (12) \\
\hline
17 & 10 & 27 \\
\end{array}
\]
LIFO vs FIFO example - LIFO

LIFO

income statement and balance sheet
LIFO vs FIFO example - LIFO

LIFO income statement and balance sheet

Sales  21  
COGS   12  
GM     9
Oper. X  6  
Pretax Inc. 3

Cash  17  
Inventory 10  
TA 27
S. E. 27

• Recent costs on I/S  
• Old costs on the B/S
## LIFO versus FIFO

<table>
<thead>
<tr>
<th></th>
<th>LIFO</th>
<th>FIFO</th>
</tr>
</thead>
<tbody>
<tr>
<td>COGS</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>End Inv</td>
<td>10</td>
<td>12</td>
</tr>
</tbody>
</table>
LIFO

- Recent costs are on the income statement; LIFO matches current costs with current revenues.
- Old costs are on the balance sheet.
- Assuming increasing inventory costs, using LIFO results in a tax savings.
- Using LIFO can reduce the political visibility.
# LIFO vs FIFO example

## Weighted Average

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>21</td>
</tr>
<tr>
<td>COGS</td>
<td>11</td>
</tr>
<tr>
<td>GM</td>
<td>10</td>
</tr>
<tr>
<td>Oper. Exp</td>
<td>6</td>
</tr>
<tr>
<td>Pretax Inc.</td>
<td>4</td>
</tr>
<tr>
<td>Cash</td>
<td>17</td>
</tr>
<tr>
<td>Inventory</td>
<td>11</td>
</tr>
<tr>
<td>TA</td>
<td>28</td>
</tr>
<tr>
<td>S. E.</td>
<td>28</td>
</tr>
</tbody>
</table>

- Mixture of old and new costs on the balance sheet and income statement
LIFO Layers example

Beginning

2000: 100 units @$1

2001: 50 units @$1.1

2002: 30 units @$1.2
LIFO layers and transactions

**Beginning**
- 2002: 30 units @$1.2 each
- 2001: 50 units @$1.1 each
- 2000: 100 units @$1 each

**Purchase** 340 units @$2 each

**Sell** 500 units @$3 each

**What is LIFO COGS?**
What is LIFO COGS?

**Beginning**
- 2002: 30 units @$1.2 each
- 2001: 50 units @$1.1 each
- 2000: 100 units @$1 each

Price per unit is in $'000

**Purchase**
- 340 units @$2 each

**Sell**
- 500 units @$3 each

What is LIFO COGS? Cumulative units

<table>
<thead>
<tr>
<th>Units</th>
<th>Price</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>340</td>
<td>@ $2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>+30</td>
<td>@ $1.2</td>
</tr>
<tr>
<td></td>
<td>+50</td>
<td>@ $1.1</td>
</tr>
<tr>
<td></td>
<td>+80</td>
<td>@ $1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>= $851,000</td>
</tr>
</tbody>
</table>

Cumulative units:
- 340 units
- 370 units
- 420 units
- 500 units
### What is LIFO COGS?

**Beginning**
- 2002: 30 units @ $1.2 each
- 2001: 50 units @ $1.1 each
- 2000: 100 units @ $1 each

**Purchase**
- 340 units @ $2 each

**Sell**
- 500 units @ $3 each

**What is LIFO COGS?**

<table>
<thead>
<tr>
<th>Units</th>
<th>Cost</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>340</td>
<td>$2</td>
<td>$680</td>
</tr>
<tr>
<td>+30</td>
<td>$1.2</td>
<td>$36</td>
</tr>
<tr>
<td>+50</td>
<td>$1.1</td>
<td>$55</td>
</tr>
<tr>
<td>+80</td>
<td>$1</td>
<td>$80</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>$851,000</strong></td>
</tr>
</tbody>
</table>

**Ni**

<table>
<thead>
<tr>
<th>Income/Expense</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>1500</td>
</tr>
<tr>
<td>COGS</td>
<td>(851)</td>
</tr>
<tr>
<td>EXPs</td>
<td>(500)</td>
</tr>
<tr>
<td>Pretax NI</td>
<td>149</td>
</tr>
</tbody>
</table>

**Given**
LIFO Layers example

Beg inventory of 2003

- 2002: 30 units @$1.2
- 2001: 50 units @$1.1
- 2000: 100 units @$1

End inventory

- 2003: 20 units @$1
What is LIFO COGS?

340 @ $2
+30 @ $1.2
+50 @ $1.1
+80 @ $1

= $851,000

Assuming a 60% corporate tax rate taxes paid are $89.4 (149 X 0.6).
What is LIFO COGS?

340 @ $2  
+30 @ $1.2  
+50 @ $1.1  
+80 @ $1

= $851,000

Assuming a 60% corporate tax rate taxes paid are $89.4 (149 X 0.6).

Company has liquidated LIFO layers and thus allowed old costs to enter into the income statement.
## LIFO Inventory Incentives

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Price</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>340</td>
<td>$2</td>
<td>$680</td>
</tr>
<tr>
<td>+30</td>
<td>$1.2</td>
<td>$36</td>
</tr>
<tr>
<td>+50</td>
<td>$1.1</td>
<td>$55</td>
</tr>
<tr>
<td>+80</td>
<td>$1</td>
<td>$80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$851,000</td>
</tr>
</tbody>
</table>

If purchases had been 500 units (i.e., equal to current sales), then LIFO COGS would have been $1,000,000 ($2 × 500).

Difference: $1,000,000 - $851,000 = $149,000
LIFO Inventory Incentives

500 @ $2 = $1,000,000

If purchases had been 500 units (i.e., equal to current sales), then LIFO COGS would have been $1,000,000 ($2 X 500). Pretax profits would be zero.
LIFO Inventory Incentives

<table>
<thead>
<tr>
<th>NI</th>
<th>NI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales 1500</td>
<td>Sales 1500</td>
</tr>
<tr>
<td>COGS (851)</td>
<td>COGS (1000)</td>
</tr>
<tr>
<td>EXPs (500)</td>
<td>EXPs (500)</td>
</tr>
<tr>
<td>Pretax NI 149</td>
<td>Pretax NI 0</td>
</tr>
</tbody>
</table>

Company seems to lose money by purchasing inventory. If we do not liquidate any of the old inventory layers, we will have $149 less income. Thus, we had $149 of income resulting from LIFO liquidation.
LIFO Liquidation Profits

Another way to compute LIFO liquidation profits (profits resulting from old costs appearing on the income statement):

\[
\begin{align*}
&= (\$2 - \$1.2) \times 30,000 \\
&\quad + (\$2 - \$1.1) \times 50,000 \\
&\quad + (\$2 - \$1.0) \times 80,000 \\
&= $149,000
\end{align*}
\]

[Units in beg. inv. sold] \times [Current costs - Old Costs]
LIFO vs. FIFO--Which is a Better Measure of Future Income

- If one wants to predict future cost of good sold, one would prefer the most recent measure of inventory cost of goods sold.
- LIFO provides a more recent measure of cost of goods sold than FIFO if no LIFO liquidation occurs.
Conversion from LIFO to FIFO --

The LIFO reserve

The LIFO reserve is the difference between inventory value under FIFO and the value of inventory under LIFO.

LIFO reserve = FIFO value - LIFO value

Companies using LIFO must disclose this reserve.

The LIFO reserve allows for comparison of LIFO and FIFO companies.
What is FIFO Inventory?

Beginning
- 2002: 30 units @$1.2 each
- 2001: 50 units @$1.1 each
- 2000: 100 units @$1 each

Purchase
- 340 units @ $2 each

Sell
- 500 units @ $3 each

What is FIFO COGS?  

<table>
<thead>
<tr>
<th>Units</th>
<th>Cost per Unit</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>$1</td>
<td>$100</td>
</tr>
<tr>
<td>+ 50</td>
<td>$1.1</td>
<td>$55</td>
</tr>
<tr>
<td>+ 30</td>
<td>$1.2</td>
<td>$36</td>
</tr>
<tr>
<td>+320</td>
<td>$1</td>
<td>$320</td>
</tr>
<tr>
<td>= 320</td>
<td>$831,000</td>
<td></td>
</tr>
</tbody>
</table>

Cumulative units
- 100
- 150
- 180
- 320
FIFO Inventory & LIFO reserve

- FIFO Ending Inventory:
  - 20 units @ $2.00 = $40

- Recall LIFO Ending Inventory:
  - 20 units @ $1.00 = $20

- LIFO reserve: $40-$20 = $20
Conversion from LIFO to FIFO --
The LIFO reserve example

In the previous example, the company had 20 units of inventory at a LIFO value of $1 each. The FIFO value of these units would have been $2 each.

LIFO reserve = [20 X $2] - [20 X $1] 
= $20,000

If inventory prices do not decrease, a decrease in the LIFO reserve indicates that old costs are appearing on the income statement.
LIFO versus FIFO COGS

Remember:
EndInv = BegInv + Purchases – COGS
=>

Purchases_{LIFO} = (EndInv_{LIFO} – BegInv_{LIFO}) + COGS_{LIFO}
Purchases_{FIFO} = (EndInv_{FIFO} – BegInv_{FIFO}) + COGS_{FIFO}

- Key: The cost of “Purchases” does not differ across LIFO/FIFO =>
  Purchases_{LIFO} = Purchases_{FIFO}
LIFO versus FIFO COGS

- Equating right hand side of LIFO and FIFO equations,

\[
\text{COGS}_{\text{LIFO}} - \text{COGS}_{\text{FIFO}} = (\text{EndInv}_{\text{FIFO}} - \text{EndInv}_{\text{LIFO}}) - (\text{BegInv}_{\text{FIFO}} - \text{BegInv}_{\text{LIFO}}) + \\
= \text{End LIFO reserve} - \text{Beg LIFO reserve}
\]
Footnote Disclosures

- **Kmart, 2001**

  “Inventories are stated at the lower of cost or market, primarily using the retail method. The last-in, first-out ("LIFO") method, utilizing internal inflation indices, was used to determine the cost for $5,537, $6,104 and $6,690 of inventory as of fiscal year end 2001, 2000 and 1999, respectively.

  Inventories valued on LIFO were $269, $194 and $202 lower than amounts that would have been reported using the first in, first out ("FIFO") method at fiscal year end 2001, 2000 and 1999, respectively.”


- **Vacu-Dry, 1996**

  “During 1996, the company liquidated certain LIFO inventories that were carried at lower costs prevailing in prior years. The effect of this liquidation was to increase earnings before income taxes by $642,000 ($384,000 increase in net earnings).”

Analyzing Footnote Disclosures

- **Kmart**
  - What is the value of tax savings to Kmart from using LIFO?
  - \[(\text{COGS}_{\text{LIFO}} - \text{COGS}_{\text{FIFO}}) \times (\text{tax rate}) = \]
  - \[(\text{Change in LIFO reserve}) \times \text{tax rate} = \]
  - \[(269 - 194) \times 0.40 = 30\]

  Given: tax rate = 40%

- **Vacu-Dry**
  - Assume change in LIFO reserve = $100,000
  - What is the difference between \(\text{COGS}_{\text{LIFO}}\) and \(\text{COGS}_{\text{FIFO}}\) that solely reflects a change in costs of goods produced?
  - \[(\text{COGS}_{\text{LIFO}} - \text{COGS}_{\text{FIFO}}) = 100,000\]
  - What \((\text{COGS}_{\text{LIFO}} - \text{COGS}_{\text{FIFO}})\) would have been without LIFO liquidation =
  - \[(100 + 642) = 742,000\]
LIFO and FIFO Inventory Turnover

Inventory turnover =

\[
\text{Cost of Goods Sold} / \text{Average Inventory}
\]
LIFO and FIFO Inventory Turnover

Inventory turnover = \[
\frac{\text{Cost of Goods Sold}}{\text{Average Inventory}}
\]

New Inventory turnover = \[
\frac{\text{COGS}(\text{LIFO})}{\text{Average Inventory (FIFO)}}
\]
Summary for Inventories

- Inventories are carried on the balance sheet at lower of cost or market

- Alternative cost flow assumptions
  - FIFO and LIFO
  - FIFO shows balance sheet at relatively current values, but income statement cost of goods sold at stale values
  - Converse for LIFO
  - LIFO layer liquidation affects income and sometimes distorts incentives.