Cost-Volume-Profit Analysis
Horngren, Datar & Rajan
(chapter 3)
CVP analysis studies the behavior and relationship among these elements as changes occur in the units sold, the selling price, the variable cost per unit, or the fixed costs of a product.
Example:

Emma is considering selling a test prep book and software package for the business school admission test, at college fair.

Emma knows she can purchase this package from wholesaler at $120 per package, with the privilege of returning all unsold packages and receiving a full $120 refund per package.

She also knows that she must pay $2,000 to the organizers for the booth rental at the fair.
She will occur no other costs. She must decide whether she should rent a booth?
.....works through a series of steps:

1. Identify the problem and uncertainties.
2. Obtain information.
3. Make predictions about the future.
4. Make decisions by choosing among alternatives.
5. Implement the decision, evaluate the performance, and learn.
Calculating operating income:

<table>
<thead>
<tr>
<th></th>
<th>5 packages sold</th>
<th>40 packages sold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenues</td>
<td>$1,000</td>
<td>$8,000</td>
</tr>
<tr>
<td>Variable costs</td>
<td>600</td>
<td>4,800</td>
</tr>
<tr>
<td>Fixed costs</td>
<td>2,000</td>
<td>2,000</td>
</tr>
<tr>
<td>Operating income</td>
<td>- $1,600</td>
<td>$1,200</td>
</tr>
</tbody>
</table>
Contribution Margin

Contribution Margin =

\[ \text{total revenues} - \text{total variable costs} \]

Contribution Margin per unit =

\[ \text{selling price per unit} - \text{variable cost per unit} \]
• Contribution Margin also equals contribution margin per unit multiplied by the number of units sold.
  \[ CM = CM_u \times Q \]

• Contribution Margin Ratio (percentage) equals contribution margin per unit divided by selling price.
  \[ CMR = \frac{CM_u}{SP} \]
Sales – VC – FC = Operating Income (OI)
(SP x Q) – (VC_u x Q) – FC = OI
Q (SP – VC_u) – FC = OI
Q (CM_u) – FC = OI
<table>
<thead>
<tr>
<th></th>
<th>5 packages sold</th>
<th>25 packages sold</th>
<th>40 packages sold</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Revenues</strong></td>
<td>$ 1,000</td>
<td>$ 5,000</td>
<td>$ 8,000</td>
</tr>
<tr>
<td><strong>Variable costs</strong></td>
<td>600</td>
<td>3,000</td>
<td>4,800</td>
</tr>
<tr>
<td><strong>Contribution margin</strong></td>
<td>400</td>
<td>2,000</td>
<td>3,200</td>
</tr>
<tr>
<td><strong>Fixed costs</strong></td>
<td>2,000</td>
<td>2,000</td>
<td>2,000</td>
</tr>
<tr>
<td><strong>Operating income</strong></td>
<td>- 1,600</td>
<td>0</td>
<td>1,200</td>
</tr>
</tbody>
</table>
Contribution margin percentage:
CM (% Sales)
= Unit CM/Unit Selling Price.
Multi-Step Income Statements:
Rev – VC = CM – FC = OI

* FC = Fixed Costs   OI = Operating Income
Basic Assumptions:

1. Changes in production/sales volume are the sole cause for cost and revenue changes.
2. Total costs consist of fixed costs and variable costs.
3. Revenue and costs behave and can be graphed as a linear function (a straight line).
4. Selling price, variable cost per unit, and fixed costs are all known and constant

5. In many cases only a single product will be analyzed. If multiple products are studied, their relative sales proportions are known and constant

6. The time value of money (interest) is ignored
Breakeven point (BEP) is the output level at which total revenues equals total costs, the point at which operating revenues is equal to zero.

Target operating income (TOI) is realized requires only modifying the basic breakeven equation to add target operating income to the fixed costs that need to be covered by contribution margin.
Breakeven Point (BEP) =

Fixed Costs ÷ Contribution Margin

TOI Point =

(Fixed Costs + TOI) ÷ Contribution Margin
Target Operating Income (TOI) =
   Target Net Income ÷ (1–Tax Rate)

Target Net Income Point =
(Fixed Costs +TNI/ (1–Tax Rate)) ÷ Contribution Margin
CVP analysis also helps managers in the decision-making process by allowing them to see how proposed changes in selling price and cost structure affect the breakeven point and target-income activity level.

CVP analysis is used by managers as a “what-if” sensitivity-analysis tool to determine how sensitive the model is to changes in the predicted data or if a key assumption changes.
For example, what is the impact on operating income if sales are 5% less than expected, or if variable cost per unit increases by 5%?
Breakeven Point

At this point, a firm has no profit or loss at a given sales level.

$$\text{BEQ} = \frac{\text{FC}}{\text{CM}_u}$$

• If per-unit values are not available, the Breakeven Point may be restated in its alternate format:

$$\text{BE Sales} = \frac{\text{FC}}{\text{CMR}}$$
The Breakeven Point formula can be modified to become a Profit Planning tool:

\[ Q = \frac{(FC + OI)}{CM} \]
CVP and Income Taxes

After-tax profit can be calculated by:

\[ \text{Operating Income} \times (1-\text{Tax Rate}) = \text{NI} \]

NI can substitute into the profit planning equation through this form:

\[ \text{OI} = \frac{\text{NI}}{(1-\text{Tax Rate})} \]
Sensitivity Analysis

- CVP provides structure to answer a variety of “what-if” scenarios

- “What” happens to profit “if”:
  - Selling price changes
  - Volume changes
  - Cost structure changes
    - Variable cost per unit changes
    - Fixed cost changes
Margin of Safety

• One indicator of risk, the Margin of Safety (MOS) measures the distance between budgeted sales and breakeven sales:
  – MOS = Budgeted Sales – BE Sales

• The MOS Ratio removes the firm’s size from the output, and expresses itself in the form of a percentage:
  – MOS Ratio = MOS ÷ Budgeted Sales
CVP analysis techniques can be utilized by managers to determine the impact of proposed changes to the current product mix. Multiplying contribution margin per product by the percentage of total sales for each product yields a single weighted-average contribution margin per unit which is then plugged into the CVP analysis to determine breakeven point and target-income activity levels.
Managers calculate the weighted-average contribution margin for each different proposed product mix and then compare the CVP analysis results for each proposed product mix to determine which product mix should be produced or sold.
Effects of Sales-Mix on CVP

- A weighted-average CM must be calculated (in this case, for two products)

\[
\text{Weighted Average CMu} = \frac{(\text{Product #1 CMu} \times \text{Product #1 Q}) + (\text{Product #2 CMu} \times \text{Product #2 Q})}{\text{Total Units Sold (Q) for Both Products}}
\]

- This new CM would be used in CVP equations

\[
\text{Product} = \text{Weighted Average CM per unit BE}
\]
Multiple Cost Drivers

- Variable costs may arise from multiple cost drivers or activities. A separate variable cost needs to be calculated for each driver. Examples include:
  - Customer or patient count
  - Passenger miles
  - Patient days
  - Student credit-hours
Contribution Margin vs. Gross Profit Statements

<table>
<thead>
<tr>
<th>Contribution Margin Income Statement (Internal-Use Only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenues: $200</td>
</tr>
<tr>
<td>Less:</td>
</tr>
<tr>
<td>Variable Cost of Goods Sold $120</td>
</tr>
<tr>
<td>Variable Operating Costs 45 165</td>
</tr>
<tr>
<td>Contribution Margin 35</td>
</tr>
<tr>
<td>Fixed Operating Costs 20</td>
</tr>
<tr>
<td>Operating Income $15</td>
</tr>
</tbody>
</table>
**Financial Accounting Income Statement**

**GAAP - Based**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenues:</td>
<td>$200</td>
</tr>
<tr>
<td>Less:</td>
<td></td>
</tr>
<tr>
<td>Cost of Goods Sold</td>
<td>$120</td>
</tr>
<tr>
<td>Gross Margin (Profit)</td>
<td>80</td>
</tr>
<tr>
<td>Fixed &amp; Variable Operating Costs</td>
<td>65</td>
</tr>
<tr>
<td>Operating Income</td>
<td>$15</td>
</tr>
</tbody>
</table>
The CVP analysis techniques discussed in this chapter all assume that there is a single cost driver – the number of products produced or sold. In many instances there are other cost drivers that impact the variable costs per unit calculation, one of which might be the number of different customers sold to.
In that instance, the variable cost per unit is a function of units sold and the number of customers sold to. CVP techniques can be modified to analyze the impact of various multiple-cost-drivers scenarios, similar to the manner in which CVP analysis was used for product-mix decisions,
but no *single* breakeven point or target-income activity level can be determined because the same operating income can be achieved by different cost-driver combinations.
Distinguish contribution margin from gross margin:

Financial income statements use the term gross margin; CVP analysis uses the term contribution margin. Although there are similarities between the two, gross margin and contribution margin are not the same.

Gross Margin = Revenues − Cost of Goods Sold
Contribution Margin = Revenues − Variable Costs
Gross margin and contribution margin both include sales revenues in their calculation, but gross margin subtracts cost of goods sold while contribution margin subtracts variable costs.

Gross margin includes fixed product costs while contribution margin excludes fixed product costs but includes all variable costs, some of which are not product costs.
Service-sector companies do not have a cost-of-goods-sold account so they can only use the contribution margin approach.
Lebih dari satu produk ......

<table>
<thead>
<tr>
<th></th>
<th>Do-All</th>
<th>Superword</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units sold</td>
<td>60</td>
<td>40</td>
<td>100</td>
</tr>
<tr>
<td>Revenues</td>
<td>$12,000</td>
<td>$4,000</td>
<td>$16,000</td>
</tr>
<tr>
<td>Variable costs</td>
<td>7,200</td>
<td>2,800</td>
<td>10,000</td>
</tr>
<tr>
<td>CM</td>
<td>4,800</td>
<td>1,200</td>
<td>6,000</td>
</tr>
<tr>
<td>Fixed costs</td>
<td></td>
<td></td>
<td>4,500</td>
</tr>
<tr>
<td>OI</td>
<td></td>
<td></td>
<td>1,500</td>
</tr>
</tbody>
</table>
• Harga jual per unit:
  - Do-All $ 200
  - Superword $ 100

Biaya variabel per unit:
  - Do-All $ 120
  - Superword $ 70

Contribution Margin per unit:
  - Do-All $ 80
  - Superword $ 30
Komposisi volume penjualan per paket terdiri dari:
3 unit Do-All + 2 unit Superword
Harga jual per paket:
\((3 \times \$ 200) + (2 \times \$ 100) = \$ 800\)
Contribution Margin per paket:
\((3 \times \$ 80) + (2 \times \$ 30) = \$ 300\)
Contribution Margin Ratio 37,5\%
Break Even Point:

$ 4,500

$ 300

Break Even Point:

$ 4,500

37.5%
Break even tercapai pada 15 paket, yaitu pada volume penjualan 75 unit dengan hasil penjualan sebesar $12,000.

Volume penjualan:
Do-All 45 unit
Superword 30 unit

Hasil penjualan:
Do-All $ 9,000
Superword $ 3,000