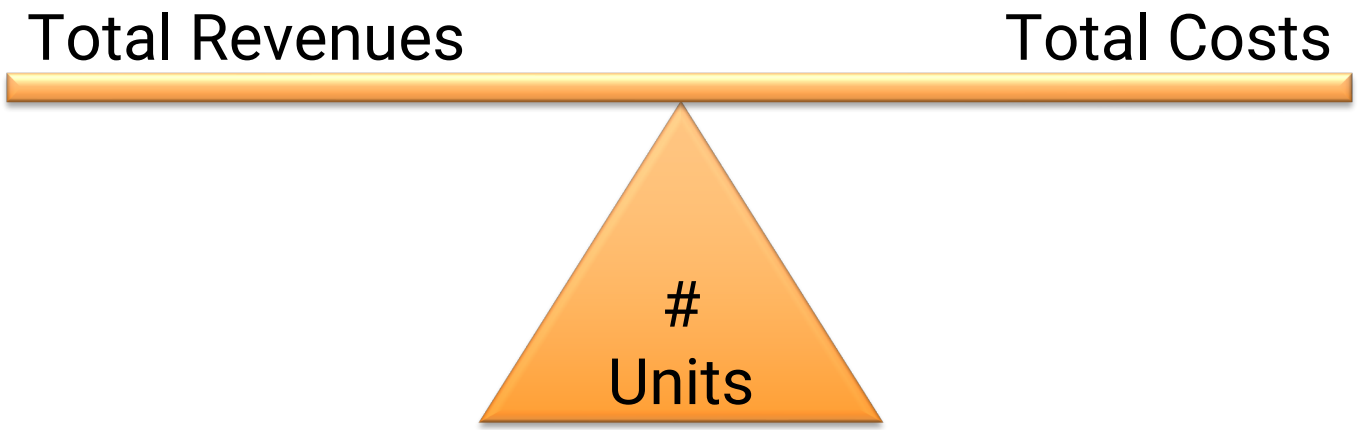
# *Break-Even Analysis*

The Break-Even (“BE”) point is the number of units sold when the Total Revenues equal Total Costs.



# Break-Even Analysis

**Total Cost = Fixed Costs + Variable Costs**

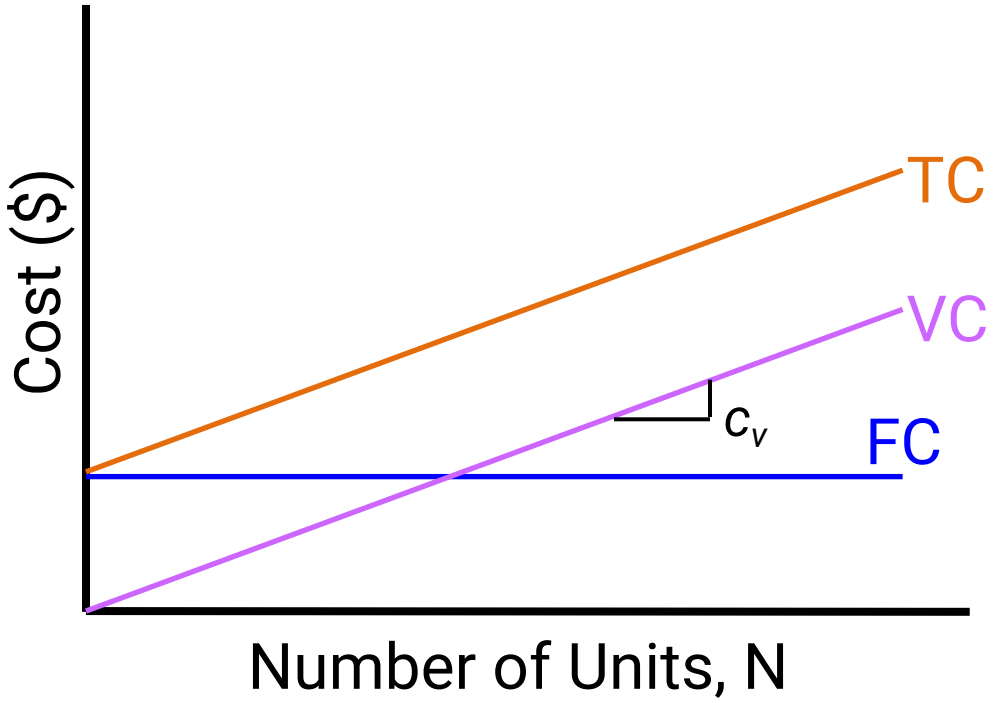
FC = a constant

*because its independent of production volume!*

$VC = c_v N$

*where $c_v$ = cost per unit*

$TC = FC + VC$



# Break-Even Analysis

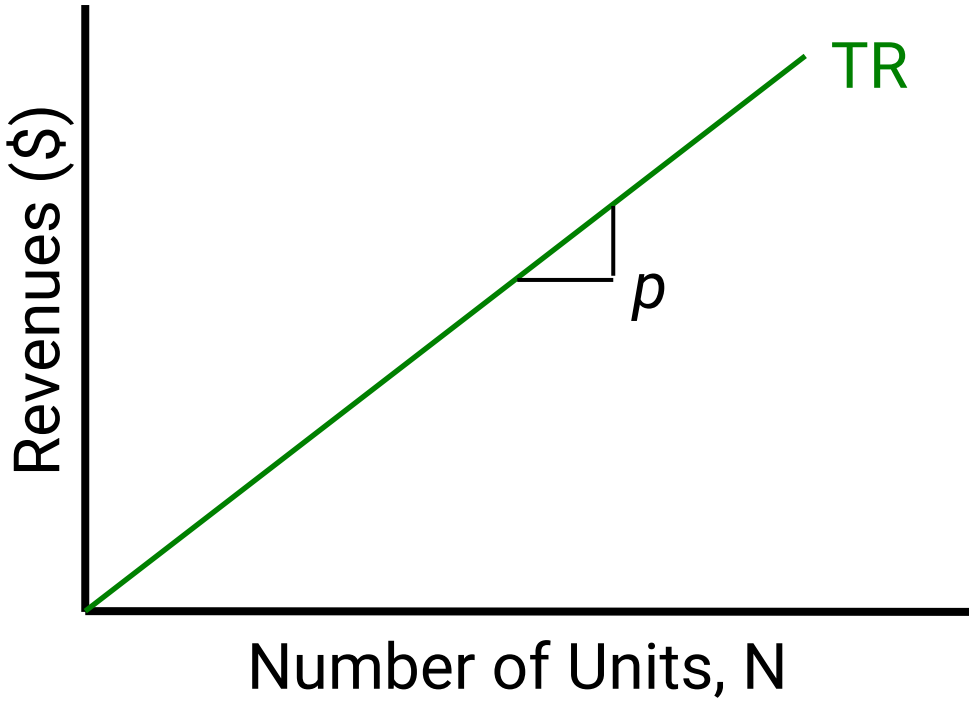
## Total Revenue = the $ generated from selling products & services

TR = pN

*where N = # of units sold*

*p = price per unit*

**TR = pN**



# Break-Even Analysis

- *At break-even (BE), the Total Revenues = Total Costs, TR = TC*

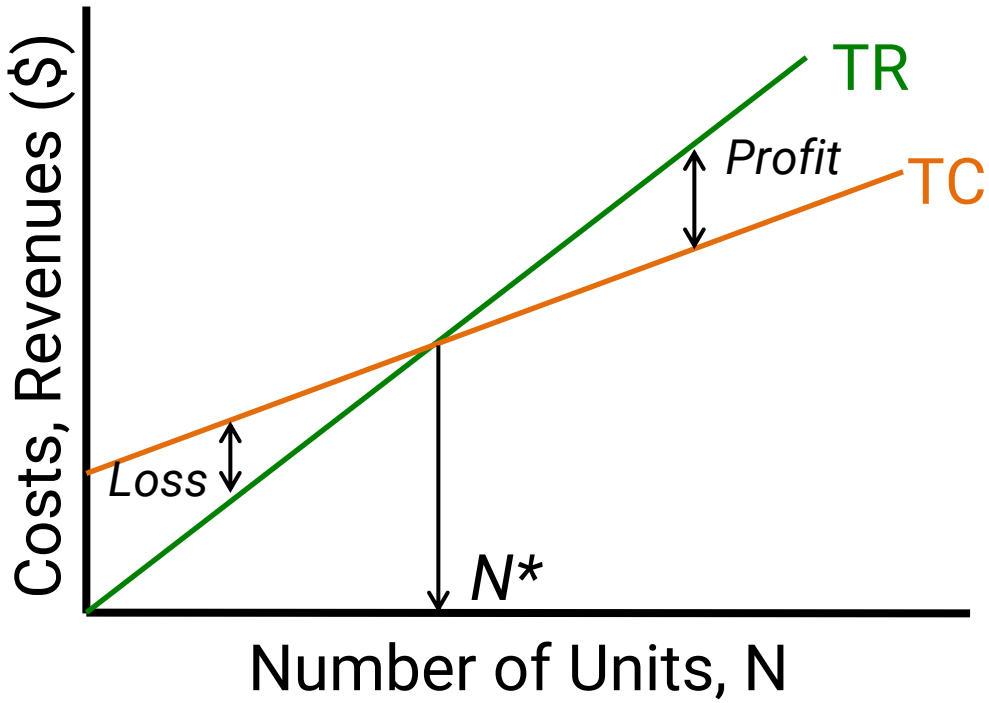
$$TR = pN \qquad TC = FC + c_v N$$

At BE, $TR = TC$, $N = N^*$

$$pN^* = FC + c_v N^*$$

$$pN^* - c_v N^* = FC$$

$$N^* = \frac{FC}{p - c_v}$$




*You're profitable when N > N**
*You're losing money when N < N**

# Break-Even Analysis

## Example: Environmental Engineering Consulting Firm

An engineering consulting firm measures its output in “billable (or ”chargeable”) service hours”.

Inputs:

- Avg Engineer Cost per Hour, $c_v$ = \$70/hr
- The Price to the Client, p = \$150/hr
- Fixed Costs of the firm are \$2,400,000 per year.

*How many hours are necessary for the firm to break-even?*

# Break-Even Analysis

## Example: Environmental Engineering Consulting Firm

At Break-Even, N = N*, TR = TC

Therefore:

$$pN^* = FC + c_v N^*$$

Rearranging,

$$N^* = FC / (p - c_v)$$

$$N^* = (\$2{,}400{,}000/yr) / (\$150/hr - \$70/hr)$$

**$N^* = 30{,}000$ billable hours per year**

# Break-Even Analysis

*As a manager of the firm, does sound reasonable to you?*

## Example: Environmental Engineering Consulting Firm

If the firm employees 25 engineers, each working about 2000 hours per year, then the maximum "capacity" of the firm = 50,000 hours per year

*What is the firm's utilization (%) at break-even (what % of the engineers' time is necessary to break-even)?*

Then:

Utilization = (30,000 hours per year) / (50,000 hours per year)

**Utilization = 60%**

# Your turn…

Aqua Boulder dispenses its product, "Primo$H_2O$" via vending machines on campus.
The average monthly fixed cost for the dispenser is $900.
Each gallon costs $0.18 to buy and purify and is sold for $0.30.

*How many gallons per month must be sold to break-even?*

$$FC = \$900$$
$$c_v = \$0.18$$
$$p = \$0.30$$

$$N^* = \frac{FC}{p - c_v}$$

$$N^* = \frac{\$900}{\$0.30/gal - \$0.18/gal}$$

$$N^* = 7500 \text{ gallons}$$

# Your turn…

## The Base Case Data:

| | |
|---|---|
| Monthly Fixed Cost: | $900 |
| Purification Costs: | $0.18 per gallon |
| Sales Price: | $0.30 per gallon |

*What happens if there is a 10% reduction in FC?*

$$FC = \$810 \rightarrow N^* = \frac{FC}{p - c_v}$$

$$N^* = \frac{\$810}{\$0.30/gal - \$0.18/gal}$$

$$N^* = 6750 \text{ gallons}$$

# Your turn…

## The Base Case Data:

| | |
|---|---|
| Monthly Fixed Cost: | $900 |
| Purification Costs: | $0.18 per gallon |
| Sales Price: | $0.30 per gallon |

*What happens if there is a 10% reduction in unit cost, $c_v$?*

$$c_v = \$0.162 \Rightarrow N^* = \frac{FC}{p - c_v}$$

$$N^* = \frac{\$900}{\$0.30/\text{gal} - \$0.162/\text{gal}}$$

$$N^* = 6522 \text{ gallons}$$

# Your turn…

## The Base Case Data:

| | |
|---|---|
| Monthly Fixed Cost: | $900 |
| Purification Costs: | $0.18 per gallon |
| Sales Price: | $0.30 per gallon |

*What happens if there is a 10% increase in price, p?*

$p = \$0.33$ → $N^* = \frac{FC}{p - c_v}$

$$N^* = \frac{\$900}{\$0.33/\text{gal} - \$0.18/\text{gal}}$$

$$N^* = 6000 \text{ gallons}$$

# Your turn…

*What would you focus on if Aqua Boulder were your company?*

## The Base Case Data:

Monthly Fixed Cost: $900
Purification Costs: $0.18 per gallon
Sales Price: $0.30 per gallon

| Situation | Break-Even Point |
|---|---|
| 1. Base Case: | 7500 gal/month |
| 2. 10% Reduction in Fixed Costs: | 6750 gal/month |
| 3. 10% Reduction in Variable Costs: | 6522 gal/month |
| 4. 10% Increase in Price: | 6000 gal/month |

# Main Takeaways…

- The Break-Even point determines the minimum sales volume of a product (or service) that must be sold before the company is profitable.
- The Break-Even point occurs when the Total Revenues = Total Costs
- Total Revenues are determined from the price multiplied by the number of products sold.
- The Total Cost is the sum of the Fixed Cost and Variable Costs, where the Variable Costs are determined from the unit cost multiplied by the number of products sold.

*Calculating the economic Break-Even point is a critical part of any financial evaluation!*

# Next Time…

*Cost Modeling Techniques*

# Credits & References

Slide 8 – 12:  Adapted from Automatic vending machine with drinking water by absent84, Adobe Stock (213900702.jpeg)

Slide 14: Business illustration showing the concept of cost estimation models vy OpturaDesign, Adobe Stock (192867247.jpeg).