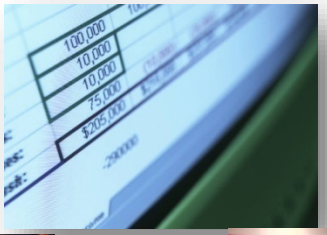


Cost Behavior: Analysis and Use

Chapter 1 (Part II)

Learning Objectives

- Understand how fixed and variable costs behave and predict total costs.
- Methods to analyze mixed costs.
- The contribution format for the income statement.

Management Accounting Classifications - Four Different Views (View 3)

View 3 - By Cost Behavior:

Variable (flexible) costs - those that vary with production or sales volumes (e.g. direct labor)

Fixed (committed) costs - those that do not vary with production or sales volumes (e.g. a new server to support data storage; a plant)

Semi-variable or **mixed costs** – those that contain both fixed and variable costs [e.g. the cost of supplying phone includes fixed costs for equipment (phones), labor (support, engineering, and monitoring staff), maintenance, and depreciation (of PBX hardware and voice circuits) as well as more variable costs for items such as voice usage].

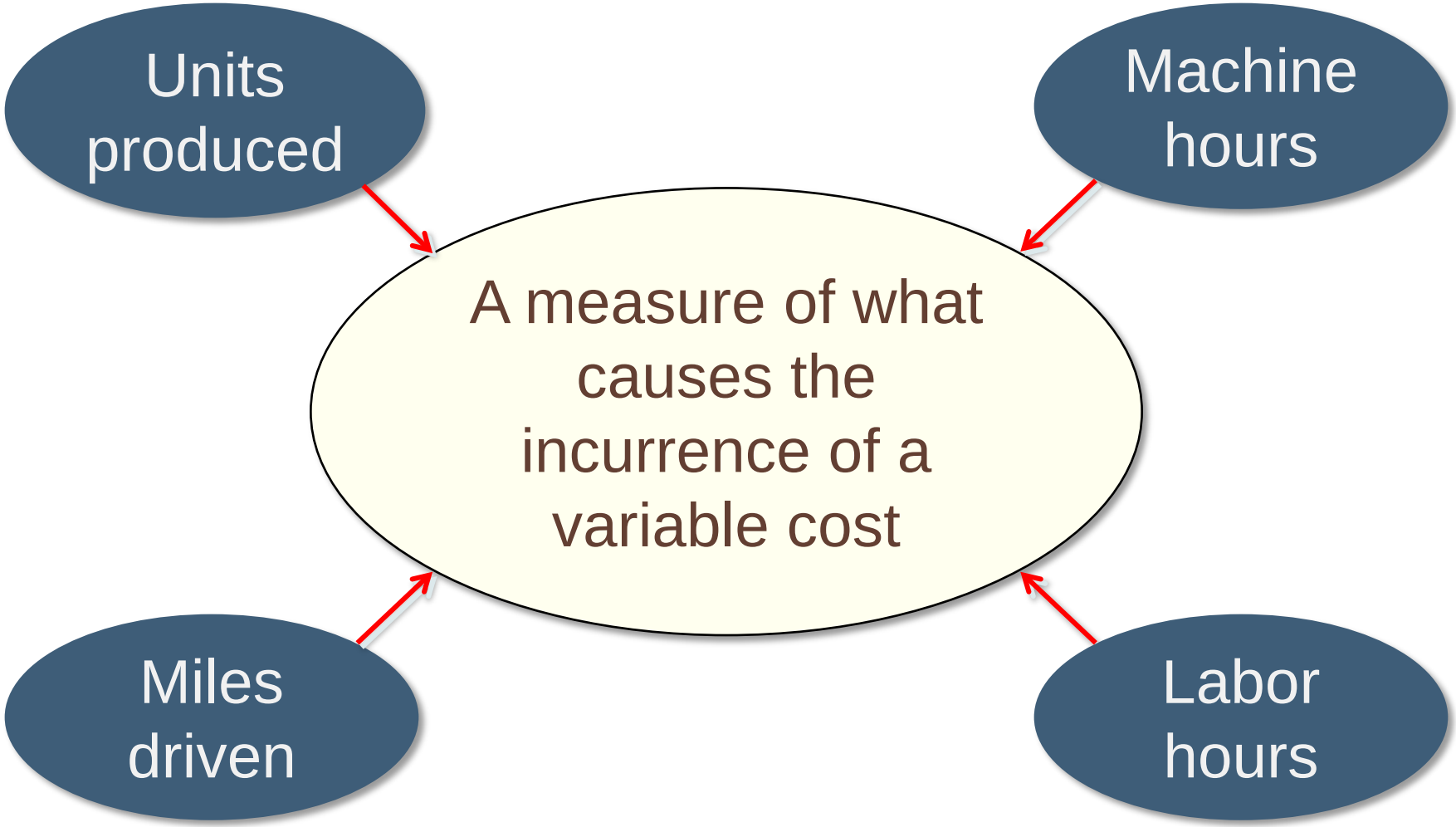
Cost Structure the relative proportions of fixed (committed) and variable (flexible) costs that make up the total costs of an organizational unit.

Cost Behavior

How a cost reacts to the changes in the level of activity within the relevant range.

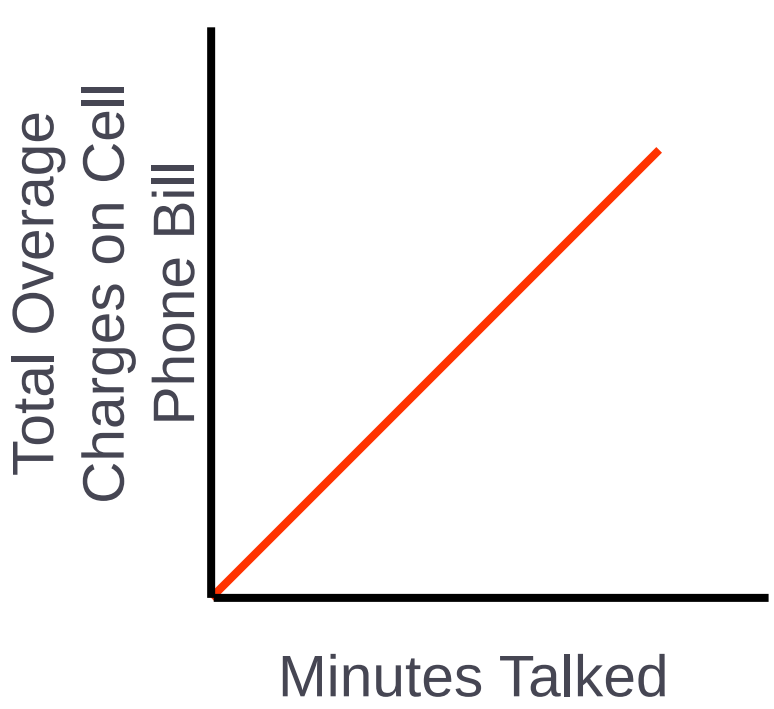
- Total **variable costs** change when activity changes.
- Total **fixed costs** remain unchanged when activity changes.

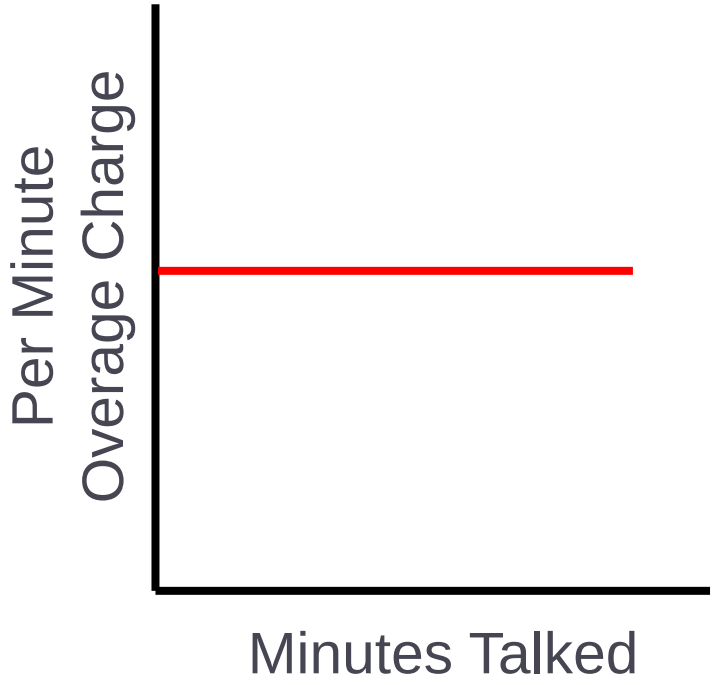
The Activity Base (also called a cost driver)



True Variable Cost – An Example

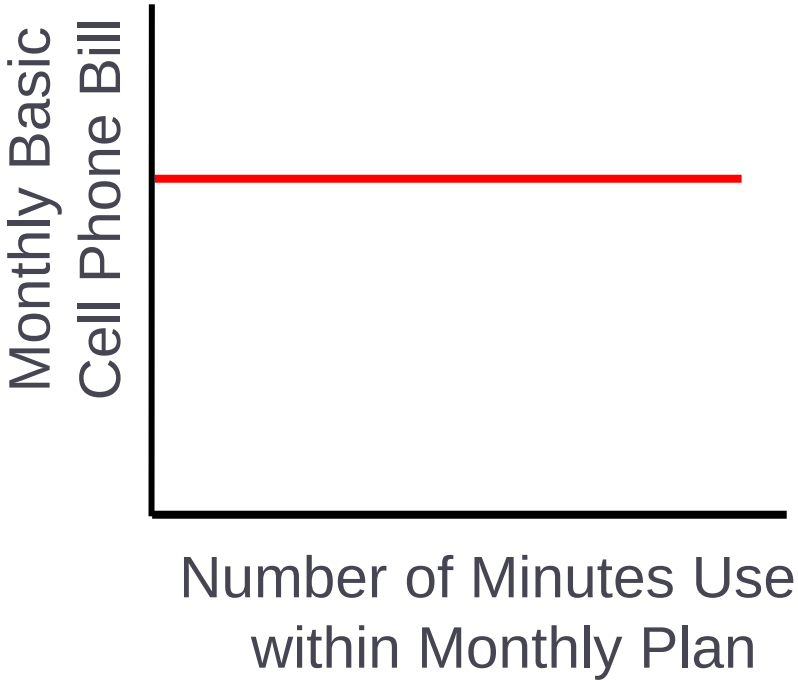
As an example of an activity base, consider the total cost vs. cost-per-minute on a cell phone bill.





Total Fixed Cost – An Example

For example, your cell phone bill probably includes a fixed amount related to the total minutes allowed in your calling plan. The amount does not change when you use more or less allowed minutes.



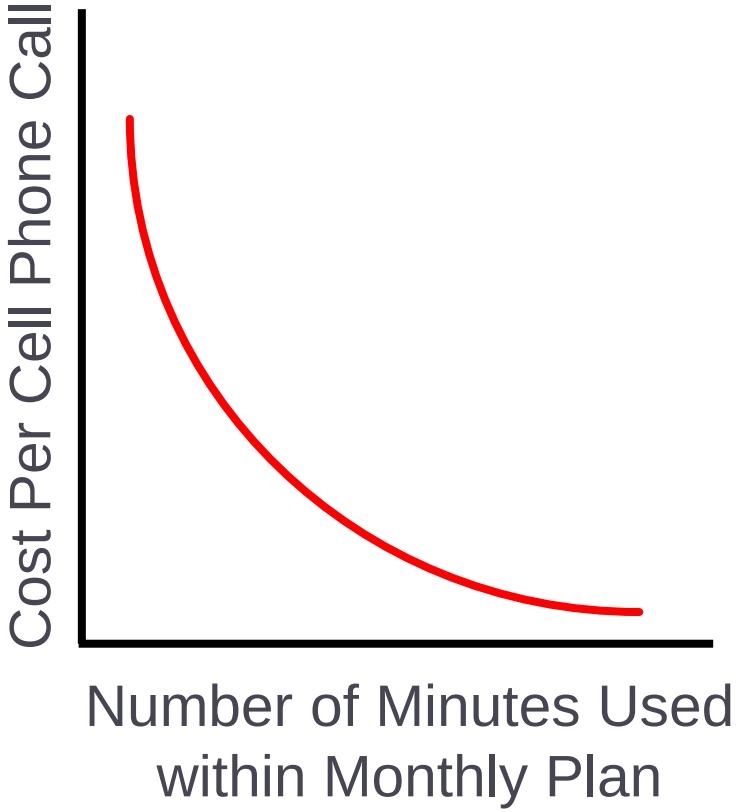
Question:

How does the cost-per-unit graph look like for the fixed costs?

Fixed Cost Per Unit Example

For example, the fixed cost per minute used decreases as more allowed minutes are used.

"Economies of Scale": Lower cost per unit with a larger scale of sales or production.



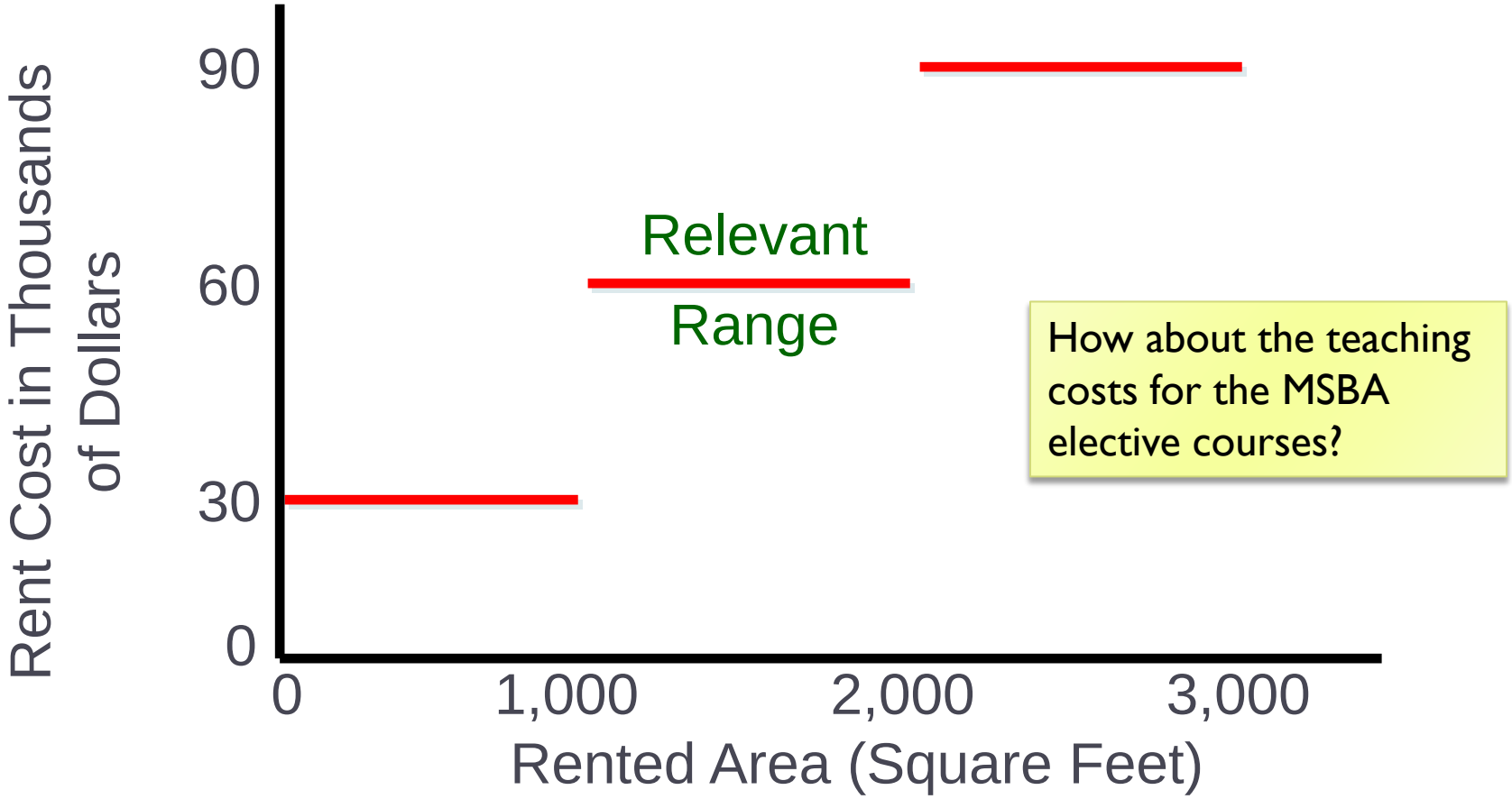
Fixed Costs and the Relevant Range

For example, assume office space is available at a rental rate of $30,000 per year in increments of 1,000 square feet.

Fixed costs would increase in a step-function at a rate of $30,000 for each additional 1,000 square feet.

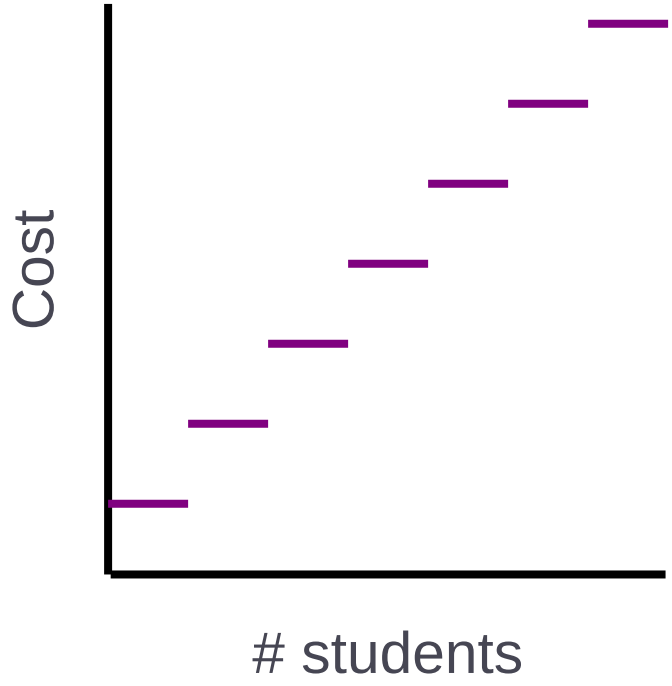
Fixed Costs and the Relevant Range

The relevant range of activity for a fixed cost is the range of activity over which the graph of the cost is flat.



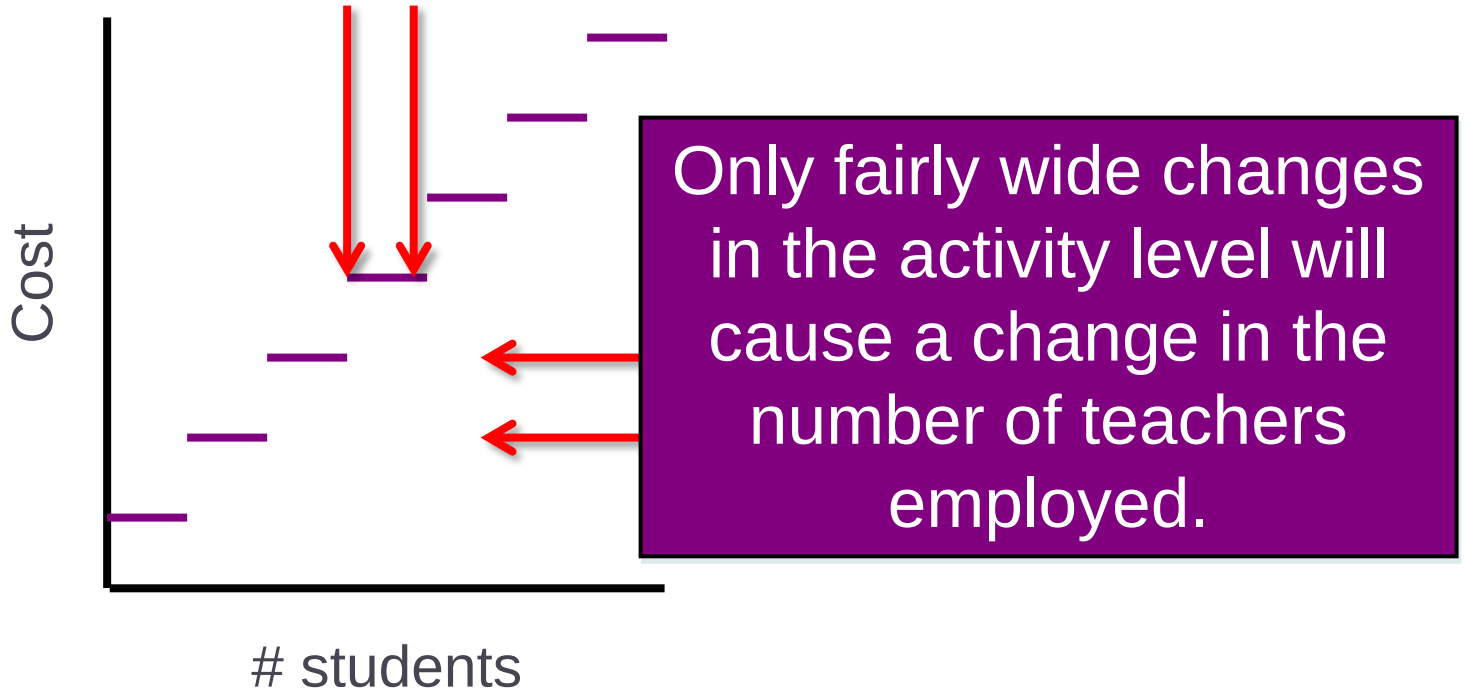
Step-Variable Costs

A *step-variable cost* is a resource that is obtainable only in large chunks (such as teaching costs for Master's programs) and whose costs change only in response to fairly wide changes in activity.

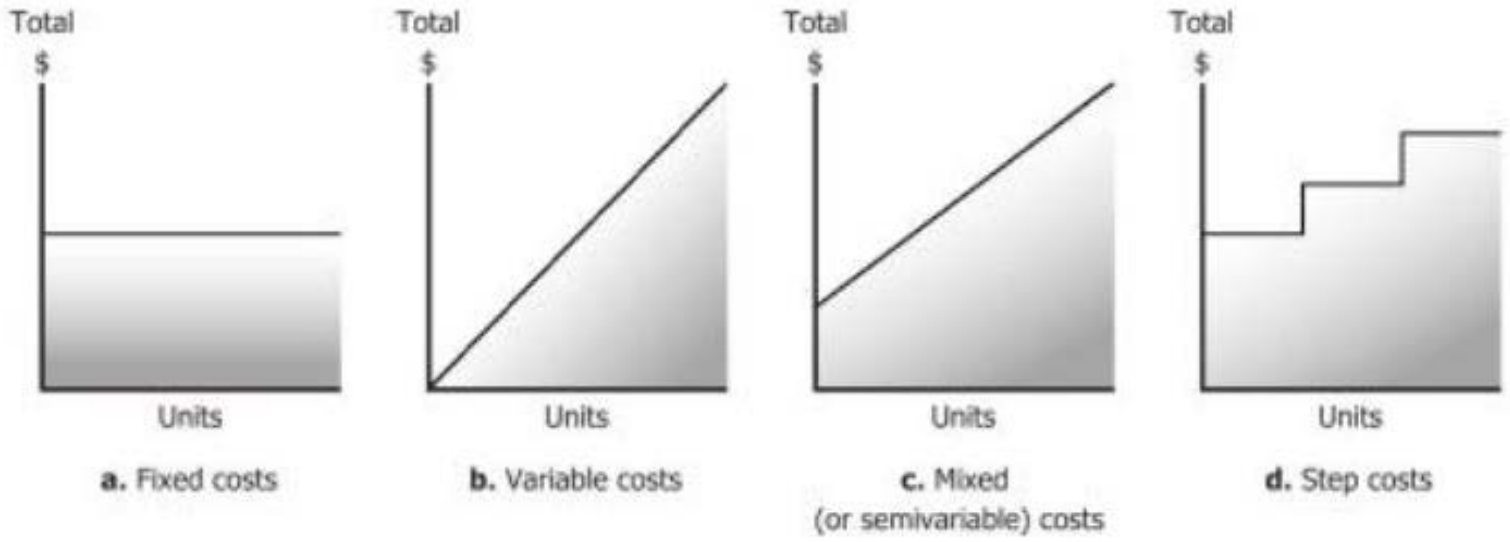


Step-Variable Costs

Small changes in the number of students are not likely to have any effect on the number of teaching hours needed for lectures.



Basic Cost Behavior Patterns

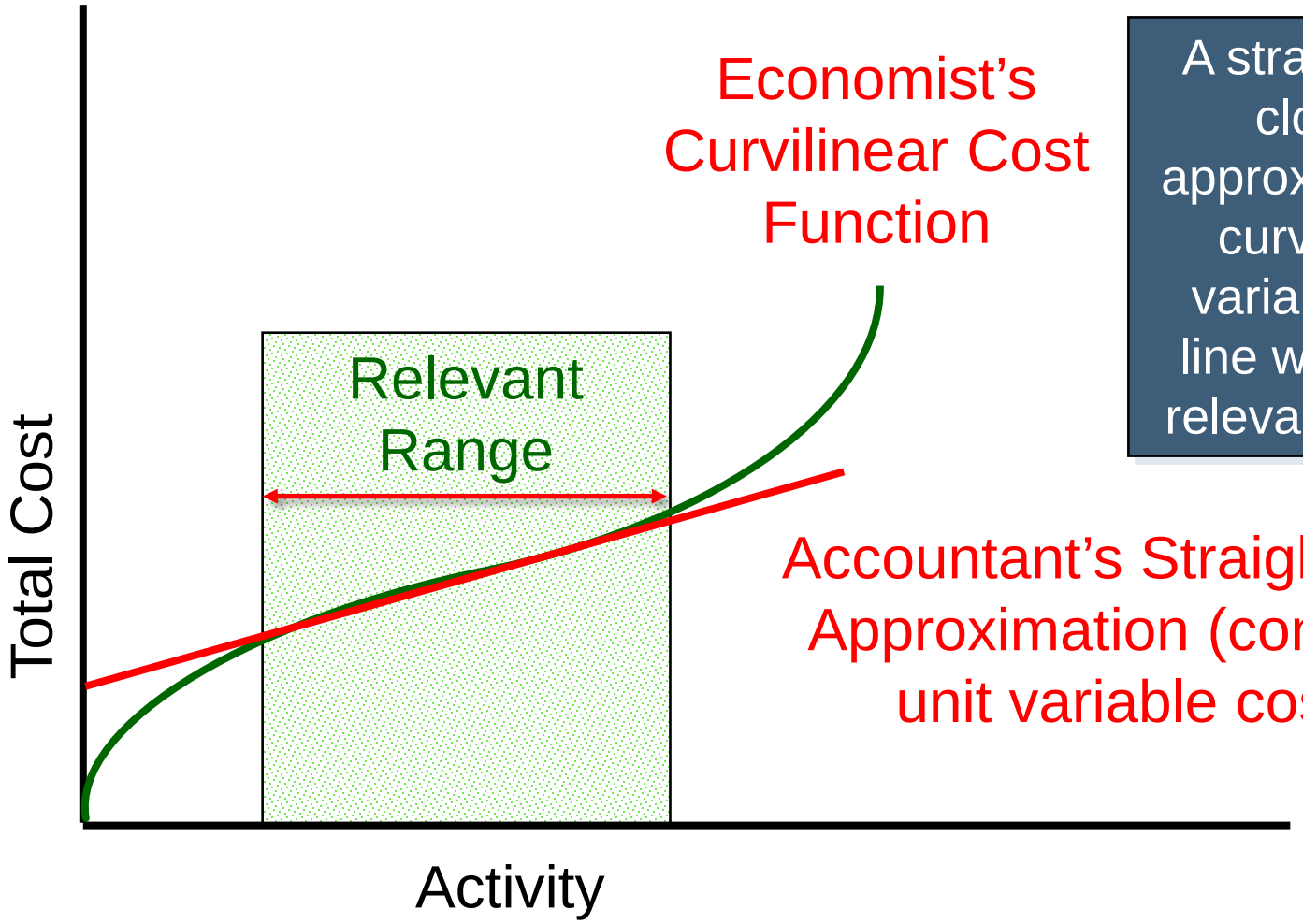


Y=a **Y=bX** **Y=a+bX** **Y=a1 or a2 (range-specific)**

Why and how to reduce fixed costs or switch them to variable costs?

- Typical fixed costs: production facilities, rentals etc.
  Converting them into variable costs: reduce risk of financial commitment and provide the flexibility of capacity utilization.
  - **Outsourcing**
    - Business with fast and regular change and/or large varieties of products most likely will benefit from this approach (e.g. Nike and Apple)
    - Non-core business functions with lower value-add to majority customers (e.g. call centers for enquiries, 3rd party logistics, broker-dealers' securities back office operations)
  - **Offshoring (reduced fixed costs)**
    - Honda and Toyota Thailand plants
    - HSBC back office functions in China

The Linearity Assumption and the Relevant Range



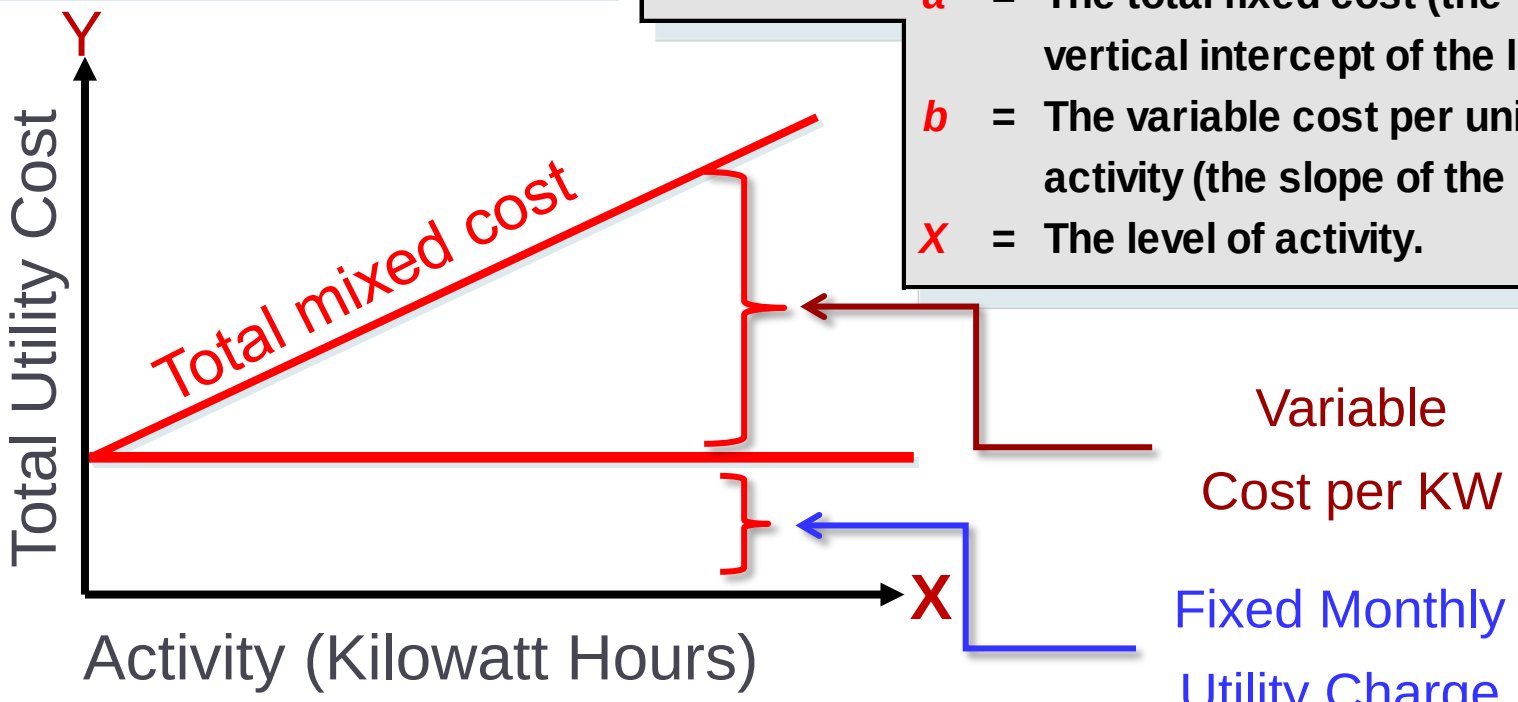
Mixed Costs

A mixed cost contains both variable and fixed elements. Consider the example of utility cost.

The total mixed cost line can be expressed as an equation: $Y = a + bX$

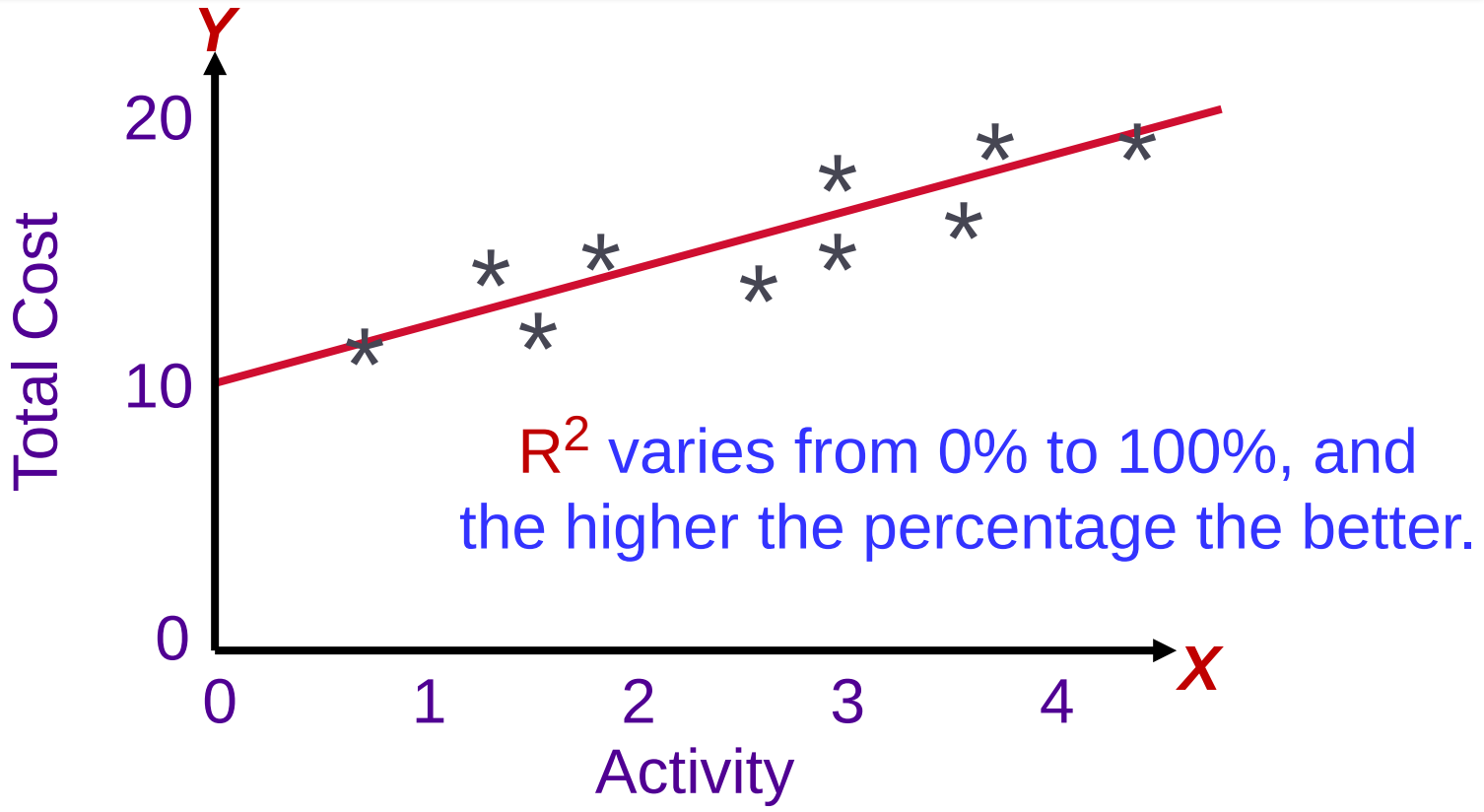
Where:

- Y = The total mixed cost.
- a = The total fixed cost (the vertical intercept of the line).
- b = The variable cost per unit of activity (the slope of the line).
- X = The level of activity.



Least-Squares Regression Method

R^2 is the percentage of the variation in the dependent variable (total cost) that is explained by variation in the independent variable (revenue-generating activity).



Exercise: Identify cost behavior: VC, FC, or MC???

	At 5,000 units		*At 6,000 units*	
	Total Cost	Cost per Unit	Total Cost	Cost per Unit
Cost A	$30,000	$6.00	$36,000	$6.00
Cost B	$30,000	$6.00	$30,000	$5.00
Cost C	$30,000	$6.00	$33,000	$5.50

Cost A =

Cost B =

Cost C =

Total Cost and average cost (100 units)

Total cost = Fixed costs + (Variable cost per unit x # units)

Fixed costs = $20,000
Variable cost per unit = $50 per unit
Number of units = 100

Total Cost = $20,000 + ($50 x 100)
= $25,000

Average cost = Total cost ÷ number of units cost

$25,000/100 units = $250 per unit

Mixed cost behavior: the total & average cost

Assume that the capacity of the factory is to produce **200** units. The total & average cost at the capacity is:

Example:

Fixed costs = $20,000

Variable cost per unit = $50 per unit

Number of units = **200**

Total Cost = $20,000 + ($50 x **200**)

= **$30,000**

Average cost = $30,000/200 = **$150**

Caution about the use of average cost

- Suppose the owner mistakenly uses the average cost per unit at full capacity to predict total costs at a volume of 100 units. Would she overestimate or underestimate total costs?

Extended discussions

- The choice of business models and the cost behavior

1. Compensation structure
   - Salary; bonus;
   - Granted stock options; Employee stock grants.

Q: what is the cost structure from the company's perspective?

Extended discussions

- Choice of business models and the cost behavior

2. Given a certain compensation structure, managers choose the overall cost structure of this firm.
   - ➢ Stock options motivate risk-taking behaviors;
   - ➢ Cost structure of *higher fixed cost* implies a *higher business risk*.

Q: How about the education business? High or low risk?

If a firm reduces the compensation of stock options, will the managers prefer a higher or lower percentage of fixed costs in the cost structure?

- o Aboody et al. (2018): managers tend to substitute fixed costs with variable costs after the adoption of FAS 123R in 2003
- o *Stronger positive correlation between costs and revenues in the post-FAS 123R period.*

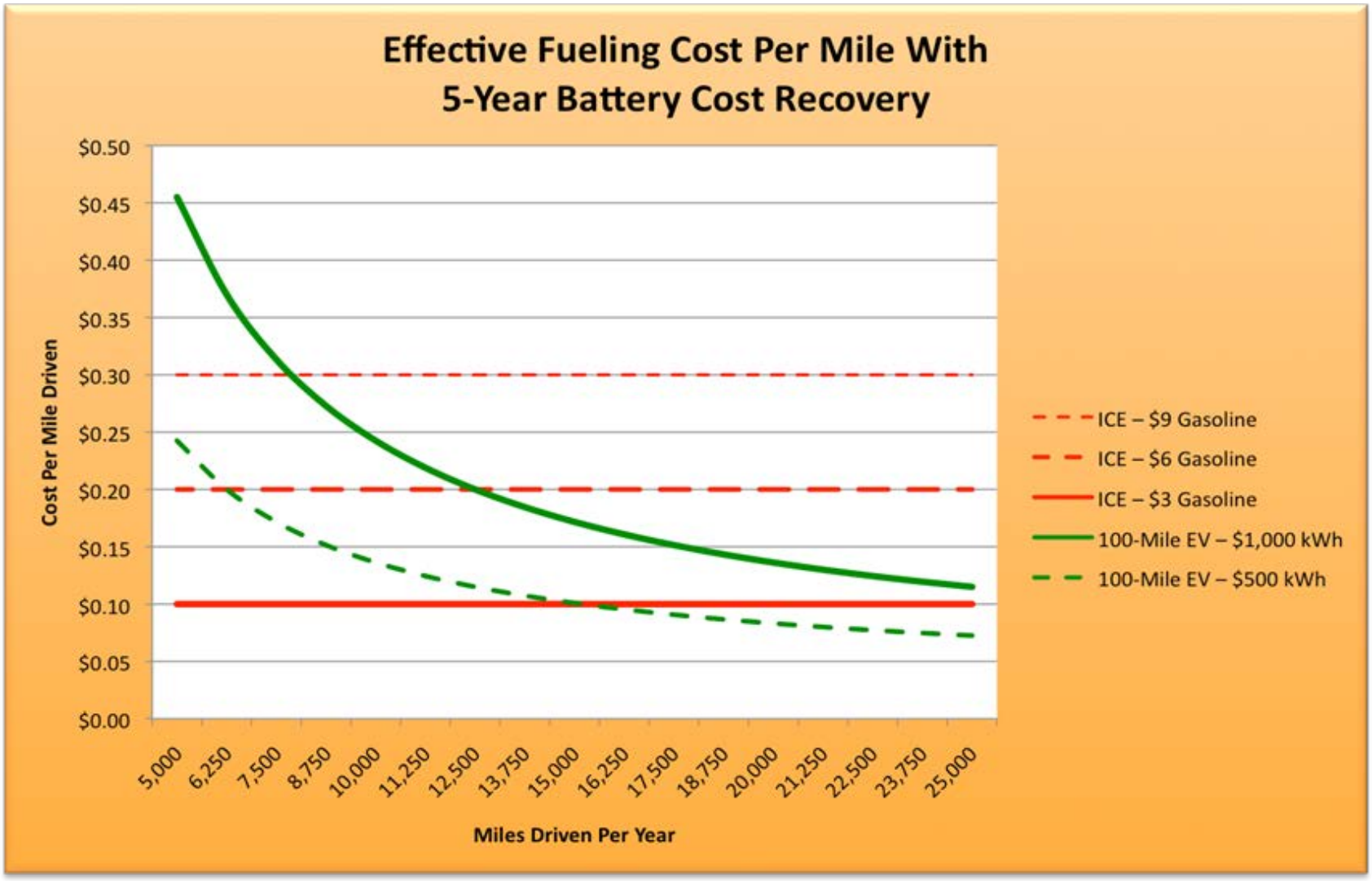
$$OC_t = \alpha + \beta_1 REV_t + \beta_2 D_t^{123R} + \beta_3 D_t^{123R} REV_t + \varepsilon_t.$$

Cost-revenue relationship (discussed later)

In-class discussion

- Article: *Electric Cars and the Fixed Cost Conundrum*

- Discuss the fixed vs variable costs for the use of traditional cars vs Electric cars
- Discuss the rationale behind the graph of fueling cost per mile;
- Discuss the conclusion drawn from the graph. Does it conform to the real practice? Why ? (any factors beyond cost ?) (see the graph on next slide)
- Discuss whether they consider the selling prices of cars in the graph; why?



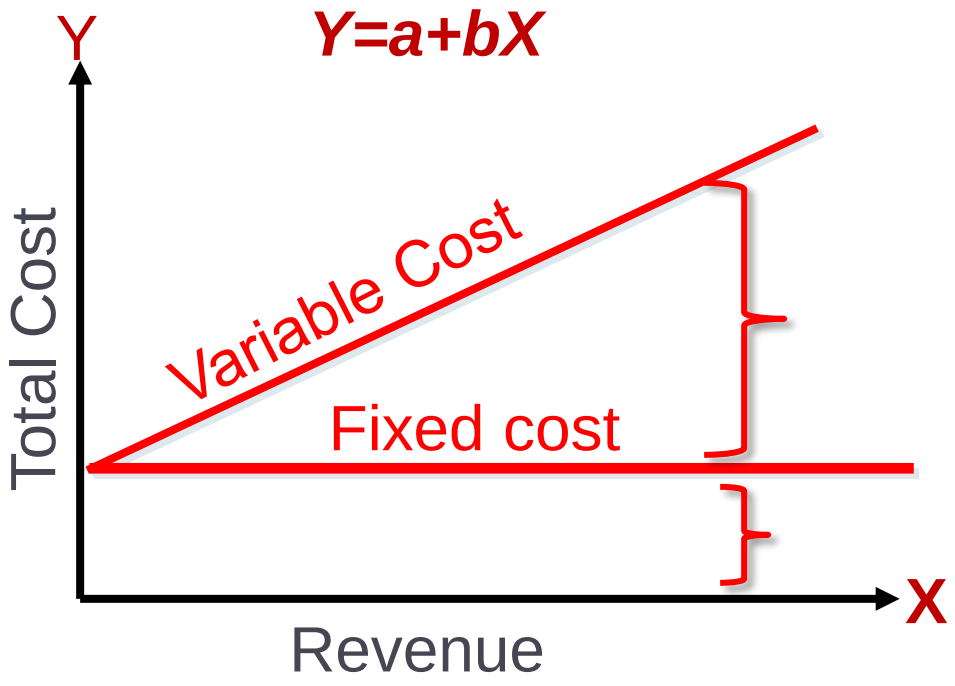
1 Gallon = 3.79 liters
1 mile = 1.6 KM

$3 per Gallon = RMB 5.3 per liter
$6 per Gallon = RMB 10.6 per liter

Estimating the cost-revenue relationship

Investors do not know the units of products manufactured in the current year; but we can check the cost-revenue relationship to better understand the cost structure of the listed companies.

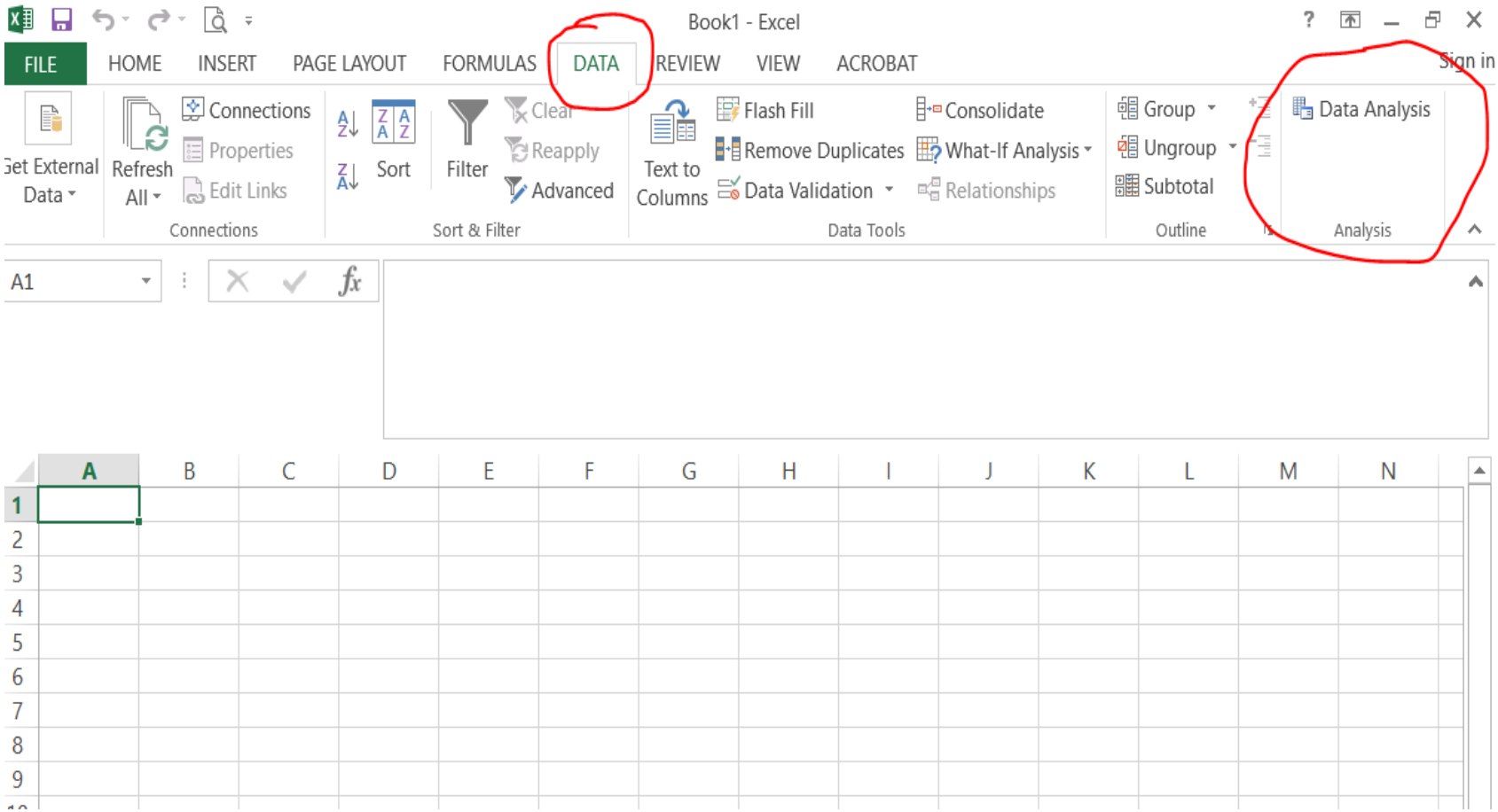
Income Statement provides a firm's sales revenue and all kinds of expenses items.



If total costs (Y) do not vary with sales revenue (X), the cost item is a fixed cost.

Data analytics practice

Find "regression function" in "Data Analysis" add-on



Data analytics practice

Use the company data in the excel file (see Moodle)

- It provides the major data items for two companies
- We have calculated the change from year t-1 to t for these items.
- 1990-2019 real data

Let's use the change values for the regression analysis:
Use the regression function in Excel worksheet

$$\Delta Y = a + b\,\Delta X \rightarrow \Delta Cost = a + b\,\Delta Rev$$

Company= Rockwell Automation

Cost item	b=
Δ operating cost	0.8247
Δ COGS	0.6988
Δ SG&A	0.1029
Δ Depreciation	0.0231

Company= Western Digital

Cost item	b=
Δ operating cost	0.6329
Δ COGS	0.3798
Δ SG&A	0.1516
Δ Depreciation	0.1015

Discuss the results

What are the main differences?

Sticky Cost

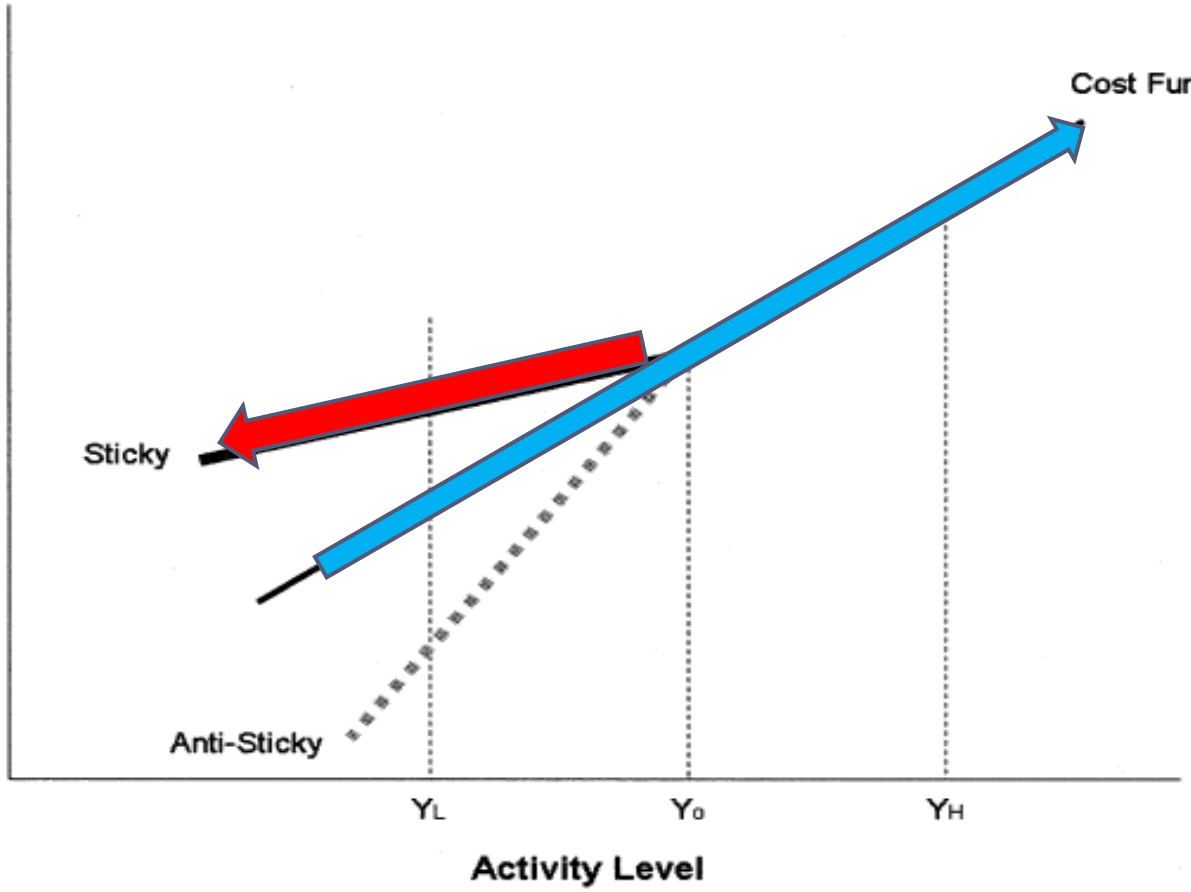
- Linear relationship does not consider the cost stickiness!
- Asymmetric change in the total costs when activities change
  - "Sticky Cost" concept

    -- Costs are "sticky" if they increase more when activity rises than they decrease when activity falls.
  - An increase in activity level under high-capacity utilization is likely to cross the available resource threshold and trigger an increase in resources supply;
  - Later, managers are not likely to immediate cut resources in response to a decrease in activity level;
  - Note that firms (such as hospitals) might not have control over the volume of activities.

Cost behavior and analyst forecasts (Weiss 2010)

- Sticky cost makes it easier or more difficult to predict firms' earnings ?

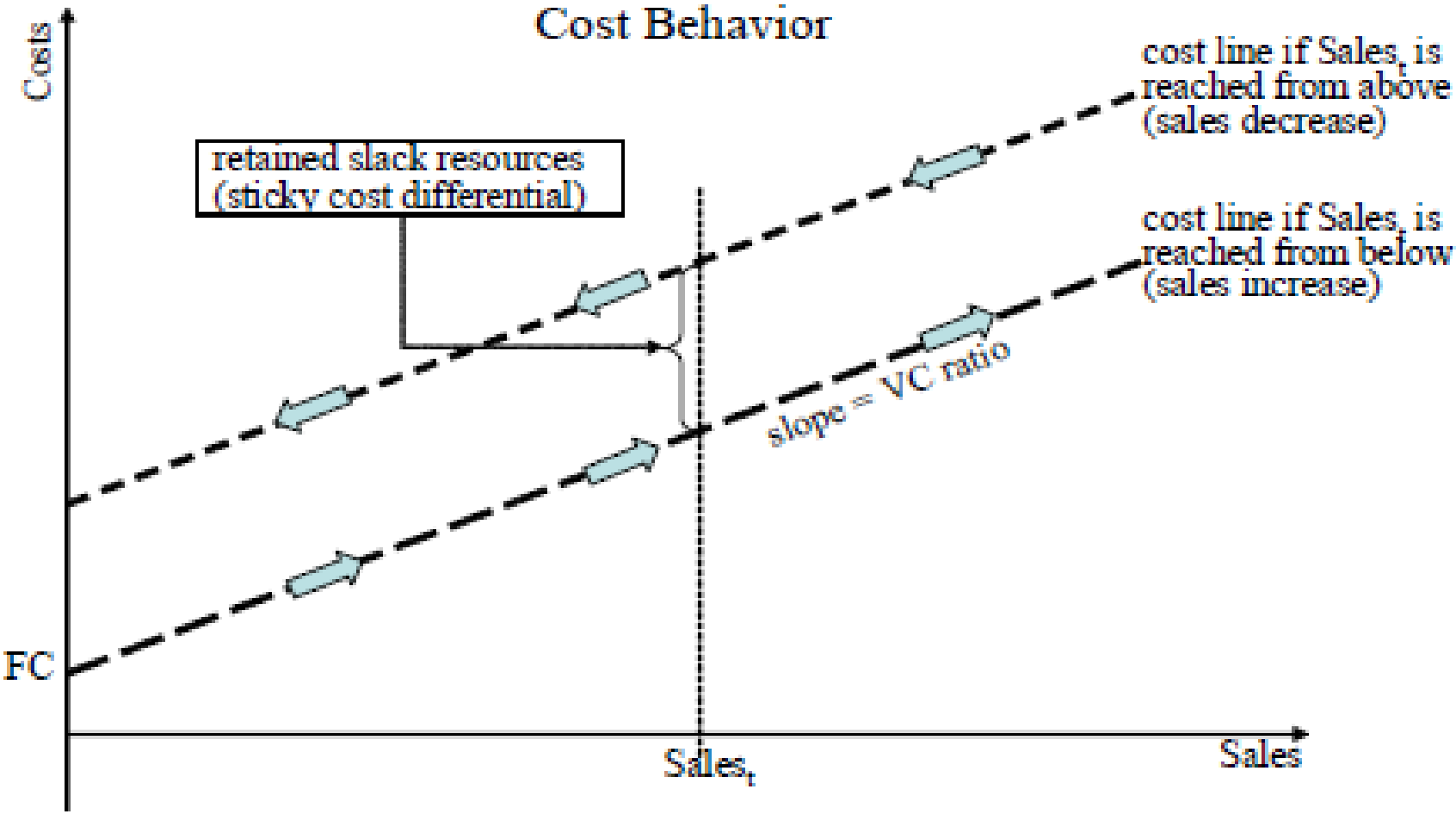
FIGURE 1
Cost Asymmetry



Cost stickiness is due to the fact:
Some cost is a variable one when sales increase; but it becomes a fixed one when sales decrease.

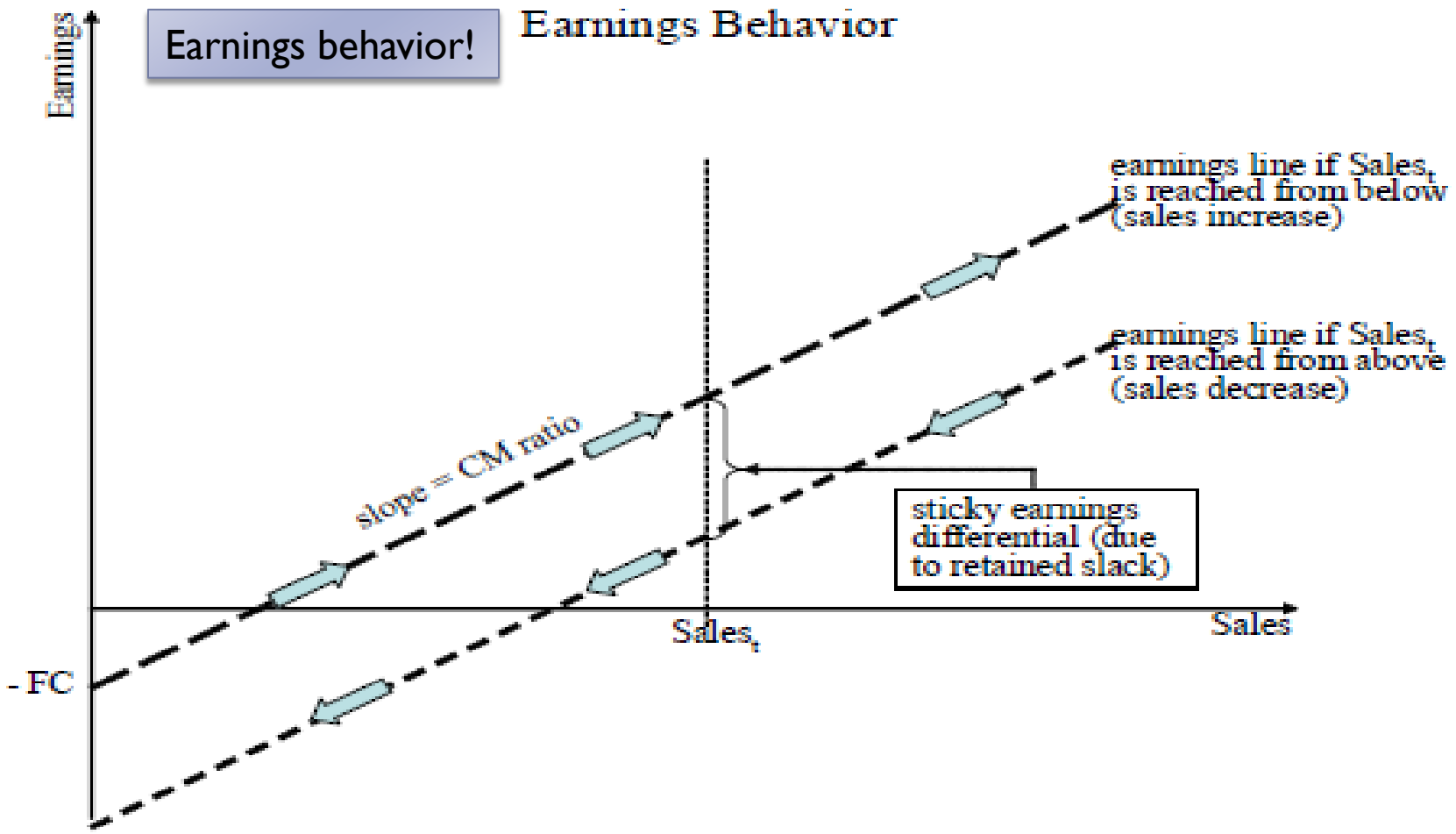
Implication for Cost behavior: sales increase vs decrease

- **For example:** labor cost is largely a variable cost in the expanding period; but it might not be easily cut and hence becomes a (seemingly) fixed cost in the shrinking period. Therefore, we see two linear cost functions for two periods.



- *Asymmetric Cost-Volume-Profit Analysis (ACVP)*

Implication for Cost behavior: sales increase vs decrease

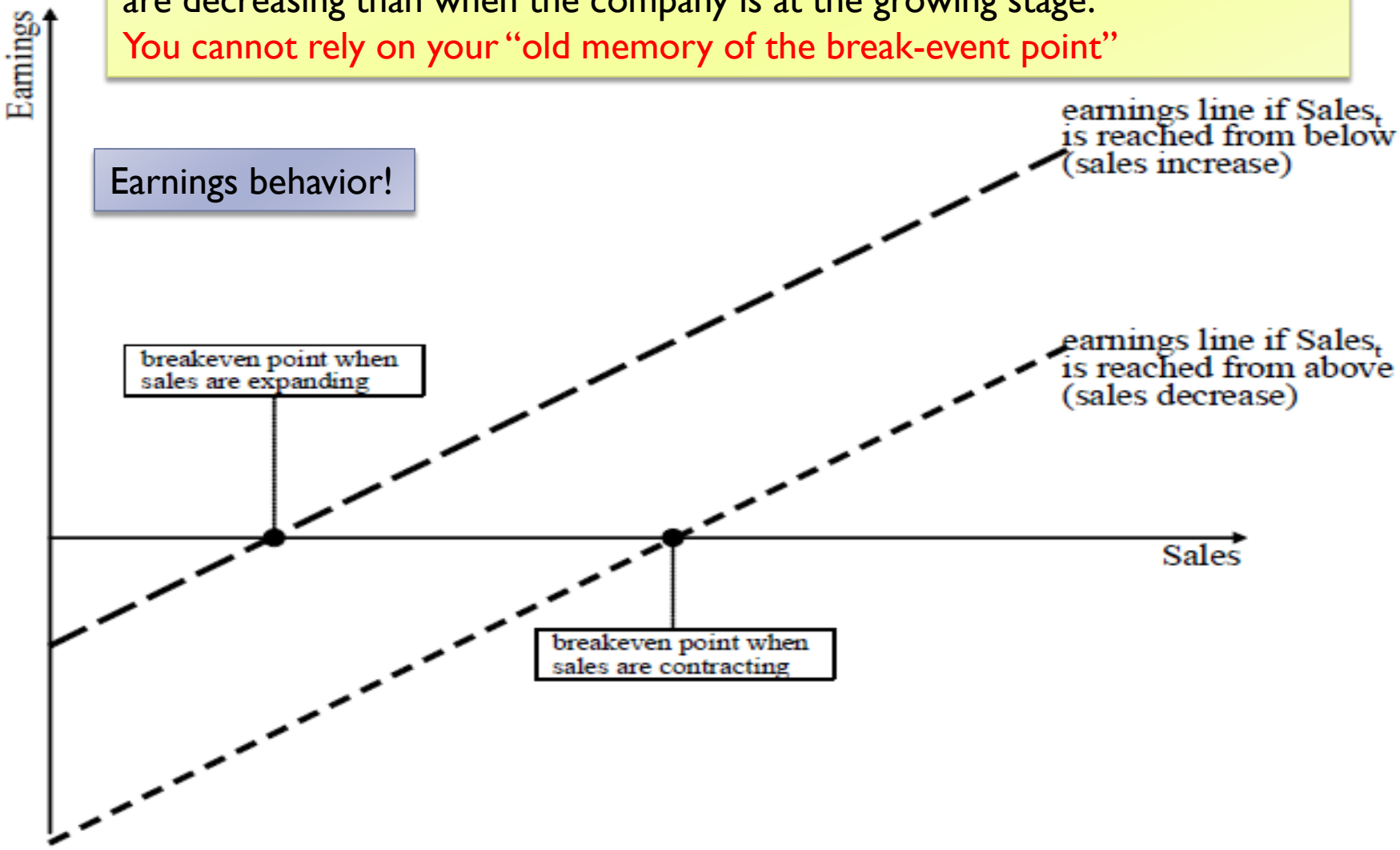


- *Asymmetric Cost-Volume-Profit Analysis (ACVP)*

Implication for Cost behavior: sales increase vs decrease

- *Different break-event points*

Takeaway: the break-event point is higher (i.e., easier to reach) when the sales are decreasing than when the company is at the growing stage.
You cannot rely on your "old memory of the break-event point"



Data analytics practice

Use the company data in the excel file (see Moodle)

- D(*sales_decrease*)=1 for years with sales decrease (i.e., ΔRev <0).
- Generate a new data item: ***D*ΔRev***

Use the regression function in Excel worksheet

$$\Delta Cost = a + b_1 * \Delta Rev + b_2 * D + b_3 * D * \Delta Rev$$

Given b1>0, cost stickiness suggests that b3<0.

Company= Rockwell Automation

Y = Δ Operating_cost	
ΔRev	b1=0.8833
D*ΔRev	b3=−0.041

Discuss the results

Company= Western Digital

Y = Δ Operating_cost	
ΔRev	b1=0.7891
D*ΔRev	b3=−0.5865

Which has a stickier cost?

Prepare an income statement using the contribution format.

The Contribution Format

	Total	Unit
Sales Revenue	$100,000	$ 50
Less: Variable costs	60,000	30
Contribution margin	$ 40,000	$ 20
Less: Fixed costs	30,000	
Net operating income	$ 10,000	

CM per unit

The contribution margin format emphasizes cost behavior.

For each additional unit sold to customers, the company has *an increase of $20 in net income*.

The Contribution Format

Comparison of the Contribution Income Statement with the Traditional Income Statement

Traditional Approach (costs organized by *function*)		Contribution Approach (costs organized by *behavior*)	
Sales	$100,000	Sales	$100,000
Less cost of goods sold	70,000	Less variable expenses	60,000
Gross margin	$ 30,000	Contribution margin	$ 40,000
Less operating expenses	20,000	Less fixed expenses	30,000
Net operating income	$ 10,000	Net operating income	$ 10,000

Used primarily for external reporting.

Used primarily by management.

Variable expenses $60K vs. COGS $70K.
Not all COGS ($70K) are variable costs- the cost per unit as calculated for financial reports includes the allocated fixed cost per unit (i.e., the allocation of fixed costs to units produced in this period). Also, some "operating expense" are variable costs.

Exercise 1-15

The Alpine House, Inc, is a large retailer of snow skis

Item	Amount
Total Sales revenue	$150,000
Selling price per pair of skis	$750
Variable selling expenses per pair	$50
Variable administrative expenses per pair	$10
Total fixed selling expenses	$20,000
Total fixed administrative exopenses	$20,000
Beginning merchandise inventory	$30,000
Ending merchandise inventory	$40,000
Merchandise purchases	$100,000

Note: for merchandiser, all COGS is a variable cost.

Key: know how to deal with the mixed costs (variable & fixed components of a cost item)

Exercise 1-15

Requirement 1: Traditional income statement

The Alpine House, Inc.
Traditional Income Statement

Sales		$150,000
Cost of goods sold ($30,000 + $100,000 – $40,000)		90,000
Gross margin		60,000
Selling and administrative expenses:		
Selling expenses (($50 per unit × 200 pairs of skis*) + $20,000)	30,000	
Administrative expenses (($10 per unit × 200 pairs of skis) + $20,000)	22,000	52,000
Net operating income		$ 8,000

* Sold units: $150,000 sales ÷ $750 per pair = 200 pairs.

Exercise 1-15

Requirement 2: Contribution format income statement

The Alpine House, Inc.
Contribution Format Income Statement

Sales		$150,000
Variable expenses:		
Cost of goods sold ($30,000 + $100,000 – $40,000)	$90,000	
Selling expenses ($50 per unit × 200 pairs of skis)	10,000	
Administrative expenses ($10 per unit × 200 pairs of skis)	2,000	102,000
Contribution margin		48,000
Fixed expenses:		
Selling expenses	20,000	
Administrative expenses	20,000	40,000
Net operating income		$ 8,000

* Sold units: $150,000 sales ÷ $750 per pair = 200 pairs.

Exercise 1-15

Requirement 3: if the company sold one more pair of Skis, what was the contribution toward the profits?

- We use Contribution Margin (CM) rather than Gross Profits (GP):
- CM for each pair is simply $240 (= 48,000/200);
- Therefore, the sale of one more pair will increase the net profit by $240.

Key:

- Some selling and administrative expenses are variable expenses; Some are fixed expenses.
- Here we use the setting of Merchandiser to simplify our analysis; For manufacturing company, some manufacturing overheads (MOH) are fixed costs while some are variable costs.

In-class exercise #2

Prepare income statement in contribution format

End of Chapter 1 (Part II)