Chapter 2:

Cost Behavior, Activity Analysis, and Cost Estimation

Agenda

- History of Cost Accounting
- Cost Formulas
- Cost Estimation Techniques
- New School – Nonunit-Level Data

Cost Accounting

- First developed by General Motors 80 years ago
- Postulates that the total manufacturing cost is the sum of the costs of individual operations
- We've come a long way since then ….

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Why do we care about costs?

- To evaluate past performance
- To predict future performance
- Old-School:
  - Add up the costs
  - Add up the units produced
  - Determine the average cost/unit

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What's wrong with "old school"?

- It's simple and you've included all possible costs into your analysis.
- But what if one type of product consumes a disproportionate share of the production function compared to other types?
- What if the plant is not running at full capacity?
- This method provides a starting point, however, we've greatly improved "cost" accounting in subsequent decades.

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Uh-oh … here comes the math

- Y = Total Costs
- X = Total Activity

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Hold on, 'pardner' … *it's about to get bumpy …*

- But what if total costs (Y) don't vary proportionately with (X)?
  - Costs that vary in proportion to activity are called "variable" costs
  - Costs that don't vary with activity are called "fixed" costs
  - Costs that vary with activity, but *not proportionately*, are a mixture of the two

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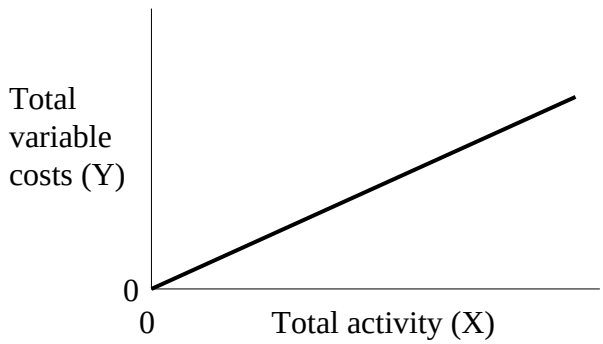
Variable Costs

Total variable costs increase in proportion to increases in unit level cost drivers.



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Variable Costs

- Notice the intercept is always zero
- Costs vary proportionately with production
- The slope of the line (b) is the variable rate/unit
  - Formula: $Y = bX$
  - Examples: direct labor, direct materials

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(*Show me some numbers …)*

- Consider the following data for Beverage Of Your Choice Corporation:

	Last Month		Current Month	
Production	400,000 bottles	Per Unit	480,000 bottles	Per Unit
Variable Costs:				
Cost of Bottles	$120,000	$0.30	$144,000	$0.30
Ingredient Cost	32,000	0.08	38,400	0.08
Water	12,000	0.03	14,400	0.03
Labor Cost	24,000	0.06	28,800	0.06
Total Var. Cost	$188,000	$0.47	$225,600	$0.47

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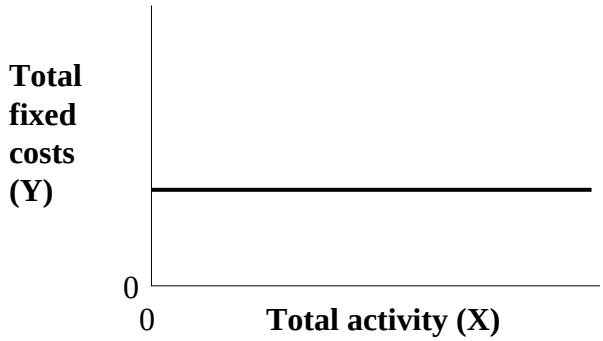
Fixed Costs

Total fixed costs do not respond to changes in unit-level cost drivers.



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Fixed Costs

- The intercept is the amount of fixed cost (a)
- The slope of the line is zero
  - Formula: Y = a (notice that X does not enter the equation)
  - Examples: fixed-rate debt, property taxes, corporate salaries and insurance (fixed in the short run)

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(*Less talk, more numbers …)*

- Consider the following data for Beverage Of Your Choice Corporation:
  - Notice the ***unit*** cost of a fixed cost varies with production, but ***not the total***.

	Last Month		Current Month	
Production	400,000 bottles	Per Unit	480,000 bottles	Per Unit
Fixed Costs:				
Rent	$5,000	$0.0125	$5,000	$0.0104
Depreciation	6,667	0.0167	6,667	0.0139
Other	8,333	0.0208	8,333	0.0174
Total Fix. Cost	$20,000	$0.0500	$20,000	$0.0417

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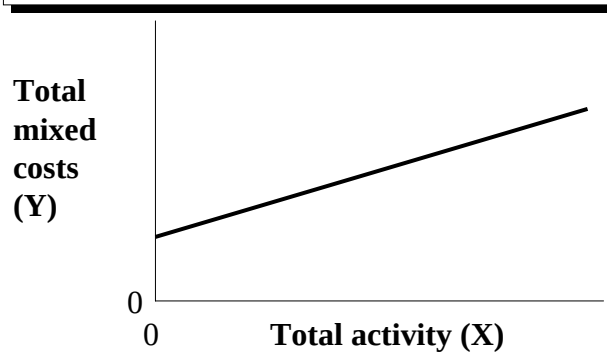
Mixed Costs

Total mixed costs contain fixed and variable cost elements. They increase, but not in direct proportion to increases in unit level cost drivers.



Sometimes called **semivariable costs**

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Mixed Costs

- The intercept is the fixed portion of cost
- The slope is the variable rate/unit
  - Formula: $Y = a + bX$ (note that this is the mathematical equation of a straight line)
  - Examples: utility bills, salesperson compensation (usually base plus commission)

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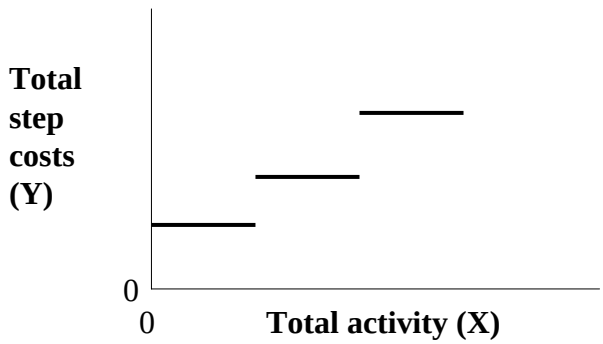
Step Costs

Total step costs are constant over a range of activity for a unit-level cost driver but move to a different amount at different ranges.



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Step Costs

- Costs are fixed for a narrow range of production, but the fixed levels vary with overall production
- Can identify the fixed cost over a relevant range of production.
  - Note: most fixed costs are actually step costs in the long run.
  - Formula: $Y = a_i$ where i is the current level of activity
  - Examples: Wages (Fixed for 40 hours of work, steps up if paid overtime)
- Put our knowledge to the test … E2-14

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Which type of cost would you prefer as manager?

Variable!!!

You're not assessed a charge if you don't produce.

What happens if you abandon a business segment that is made up of fixed costs? Those costs persist …

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It's all relevant …

- Relevant range: If you sufficiently ***expand*** your time horizon, there are no fixed costs (contracts expire, facilities can be constructed, etc.).
  - This means that all costs are ***variable*** in the long run.

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Hold the line ….

- The previous graphs were all linear (with the exception of the step costs).
- Is that descriptive of reality?
- Law of diminishing marginal returns states that as more of something becomes available, the less it will be in demand.
  - This induces curvature into the mathematical function and this curvature is prevalent in almost every revenue or cost function.

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(*So what good were those goofy graphs*?)

- Relevant range: If you sufficiently ***contract*** your time horizon, the segment of the nonlinear graph will be linear

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Not all costs are created equal …

- Suppose the total cost of producing machines is as follows:

Number of Machines	Total Cost
1	$50,000
2	98,000
3	144,000
4	184,000
5	225,000
6	270,000
7	315,000
8	368,000
9	423,000
10	480,000

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Total, Marginal and Average Cost

- Determine the Marginal and Average Cost at each Output Level:

Number of Machines	Total Cost	Marginal Cost	Average Cost
1	$50,000	$50,000	$50,000
2	98,000	48,000	49,000
3	144,000	46,000	48,000
4	184,000	40,000	46,000
5	225,000	41,000	45,000
6	270,000	45,000	45,000
7	315,000	45,000	45,000
8	368,000	53,000	46,000
9	423,000	55,000	47,000
10	480,000	57,000	48,000

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(*Ey-yi-yi … Too much information*!)

- Which cost do I use?
  - Variable costs are usually the only relevant costs to determine marginal pricing
  - Average cost should be used for evaluation
  - Total costs should be used for prediction

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(*We need a drink ….*)

- Return to Beverage of Your Choice Corp.
- Suppose that the company is approached by a potential customer who would like to buy 200,000 bottles for $0.75 per bottle. Should you accept or decline?

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It's a "marginal" thing …

Incremental revenue ($0.75 x 200,000 bottles)	$150,000
Incremental cost ($0.47 x 200,000 bottles)	(94,000)
Incremental profit	$ 56,000

- Is it that simple?
- How does capacity level figure into this decision?
- Are there any other ramifications of this pricing policy?
- Cannibalization of other higher margin customers

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Back to the machine example:

- The plant is currently making and selling eight machines per month.
- The company can sell another machine for $53,000.
- Should the company accept the offer?

  No, because the offered price < marginal cost; do not use average cost in this situation or you will lose money.

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Back to the future …

- Using cost information to predict future costs and/or profitability:
  - Total costs are best metric to use for prediction
  - How good is predictive accuracy when firm is nonstable (i.e., growing or contracting)?

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Let's recap

- Variable – total variable cost varies with number of units produced
- Fixed – total fixed cost remains constant regardless of number of units produced

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Applying what we've learned:

- Labor – fixed or variable?
- Depends on where you are:
  - U.S. culture – treat labor as a variable cost
  - Some countries like Japan and Korea, labor is considered a fixed cost.
    - Japanese and Korean companies are hesitant to lay off workers when business decreases (just as they are hesitant to increase labor when business increases).

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Cost Estimation Techniques:

- Relatively easy to identify strictly fixed and strictly variable costs.
- Mixed costs present a challenge:
  - High-Low Estimation
  - Scatter Diagrams
  - Least Squares Regression Analysis

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[Sing: Y*ou say "high", I say "low"*]

- High-Low Estimation – estimates the fixed and variable components in a mixed cost:
  - Organize observations in order of activity level (production, etc.)
  - Choose a representative high and low activity point and gather the associated costs for each point
    - Absolute highest and lowest may not be representative due to extreme events such as equipment breakdowns, materials outages, labor strikes, interruption of production due to natural or manmade disasters, etc.

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[Sing: Y*ou say "high", I say "low"*]

- High-Low Estimation – Continued
  - Estimate the variable portion of the mixed cost as:
    - Variable cost per unit = (High activity cost – low activity cost)/(High activity level – low activity level)
  - Compute fixed costs based on the estimation of variable cost:
    - Fixed costs = Total costs – (variable cost per unit * activity level)
    - You can apply this formula to either the high or low point (assuming fixed costs are constant at both activity levels)

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(*Draw us a picture …*)

- Scatter Diagrams – graph of historical data (cost versus activity level)
  - Graph points
  - Fit a straight line (visually)
  - Choose two points on the line and perform high-low cost analysis

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(*We're paying tuition and you're teaching us how to draw?*)

- Least Squares Regression Analysis – produces a mathematically-derived line (not visual line-fitting) that minimizes the distance between the line and the data points.
  - Uses more data points to produce the line (model will perform better if outliers are eliminated).
  - The intercept of the line is the total fixed cost amount, and the slope of the line is the variable cost per unit.
    - Coefficient of determination (R^2) indicates the explanatory power of the fitted line (would like an R^2 close to 1.00)
    - Can extend simple regression to several activity drivers to arrive a more complex cost and product function.

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Complicating Factors in Analyzing Cost Data:

- Changing technology
- Changing input prices (goods used in production or delivery of services)
  - All prices are dynamic (i.e., changing frequently at different rates of change)
- Time lags between activity and cost [activity can precede cost (utility bills) or vice versa (operation of a machine]
- Establishing causal links between activity and cost (i.e., units produced and cost of corporate legal department)
  - This becomes more difficult in complex organizations (multi-product, diversification into other industries or geographic areas, etc.)

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The result …[*drum roll*]

- Inaccurate costs which may lead to faulty decisions.
- A possible solution:

Using non-unit level data

(Say what?????)

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Manufacturing Cost Hierarchy :

- Unit-level – an activity performed on each unit produced (Variable)
- Batch-level – an activity performed on each batch of units produced (machine setup, handling, inspection) (Variable); larger batch sizes generally result in smaller per unit costs.
- Product-level – an activity performed in support of a product (engineering and design, prototypes, testing) (Variable); product complexity generally increases per unit costs.
- Facility-level – an activity performed in support of the facility (management, maintenance, taxes, utilities) (Fixed)

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Customer Cost Hierarchy :

- Unit-level
- Order-level – performed for each sales order
- Customer-level – performed to obtain and maintain each customer
- Facility-level

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