Cost Accounting – ACCT 362/562

Basic Cost Behavior

Cost behavior is a very important topic in cost and managerial accounting. What we are talking about is the amount spent in relation to some measure of quantity or activity.

There are two ways of looking at cost behavior: total cost and average cost per unit. The four most common cost patterns are variable, fixed, mixed and step. However, there are dozens of patterns. The graphic on the right shows a few examples.

Why knowing about cost behavior is important

The quest for profit—the excess of revenue over expense—drives the business world we live in. The owner of a business wants the business to make a profit, as the increase in money from that profit adds to the owner’s wealth. The manager of a business wants it to be profitable, because he/she will benefit from bonuses from that profit. The employees of a business want it to be profitable, as do lenders to that business, as do customers, as do taxing governmental agencies.

There are two ways to make more profit: sell more and pay less. It is much easier to increase profitability through controlling costs because selling more is constrained by customer taste and market competition. The amount spent in business operations is a function of various cost behavior patterns.

Let’s say that a company manufacturing tables has the opportunity to fill an unexpected order for tables. Whether the company accepts the order depends on if the order is profitable and if it is profitable enough. The profit potential of this order depends on the amount received from the customer and the amount spent to produce the tables and deliver them. The amount spent to produce the table depends on the interaction between production needs and cost behavior. It is not always easy to understand this interaction, that is why the different types of cost behavior need to be studied.

Variable cost

A cost is variable if the total amount spent varies in direct proportion to the amount of activity (usually production or sales). Because it varies in direct proportion, the average cost per unit remains constant. Modeled as an equation, it is:

\[ \text{Average Cost} = \frac{\text{Total Cost}}{\text{Quantity}} \]
total variable cost = V*X  

Where:

V = variable cost per unit
X = units of product or activity

For example, bottles of drinking water are variable costs for consumers. Let’s say that one bottle of drinking water costs $1.00. If one bottle is purchased, the total amount spent is $1.00. But if two bottles are purchased, the total amount spent is $2.00. If ten bottles are purchased, the total amount spent is $10.00. The total amount spent increases for each additional bottle of water purchased, and the average per unit cost is always $1.00 per bottle.

Graphically, total variable and average variable cost per unit appear on the right.

In business, there are many examples of variable costs. The cost of direct material per manufactured item is typically considered to be a variable cost because the total amount spent on materials increases proportionately to the number of units manufactured. The total cost of sales commissions is another good example of a variable cost because the total spent on sales commissions varies proportionately to the amount of sales revenue.

Theoretically, variable costs are thought to behave in a curvilinear fashion. Starting out at low amounts of quantity, the total amounts spent increases rapidly. After getting into a routine, the total amount spent increases at a lower, constant rate. Eventually, over consumption means that resources become relatively scarce and total costs again increase rapidly.

There are a number of ways to organize numeric problems dealing with variable costs, but they all revolve around the contrast between total amount spent and the average cost per unit. Recall that the average cost per unit is the total amount spent divided by the number of units of activity. Therefore, the total amount spent is the product of the average cost per unit multiplied by the number of units of activity.

For example, if a variable cost has an average cost of $3 per unit for all units, and we want to know the total amount spent at 5,000, 10,000 and 20,000 units, we can easily complete a table showing this.

<table>
<thead>
<tr>
<th>At this level of activity</th>
<th>5,000</th>
<th>10,000</th>
<th>20,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total costs</td>
<td>$15,000</td>
<td>$30,000</td>
<td>$60,000</td>
</tr>
<tr>
<td>Average cost per unit</td>
<td>$3</td>
<td>$3</td>
<td>$3</td>
</tr>
</tbody>
</table>
Fixed Cost

A cost is **fixed** if the total amount spent does not vary at all in relation to the amount of quantity. That is to say that the total amount spent does not change. Because the total amount does not change, the average cost per unit decreases (eventually approaching zero) as the fixed cost is spread over more and more units. Modeled as an equation, it is:

\[
\text{total fixed cost} = F
\]

Where:

\[
F = \text{total dollar amount of lump-sum expenditure}
\]

For example, a golf membership is a fixed cost. The membership is a specified amount, paid before any golf is played. For the 2014 golfing season, a membership at a local golf course is $400. After paying this amount, the member is entitled to golf as many times as desired. If a membership is purchased for $400, but it turns out that by the end of the season the member only played golf once, then the average cost for that time was $400 ($400 ÷ 1 = $400). However, if it turns out that the member played golf ten times, then the average cost for golf was $40 per time ($400 ÷ 10 = $40). Continuing in this vein, if the member played golf one hundred times, then the average cost for a golfing session was $4.00 per session ($400 ÷ 100 = $4.00).

Graphically, total fixed and average fixed cost per unit appear in a graphic on the right.

In business, there are many examples of fixed costs. The cost of a building or equipment and the cost of equipment are typically considered to be variable because a specific amount is spent, and then amount of activity follows.

There are a number of ways to organize numeric problems dealing with fixed costs, but they all revolve around the contrast between total amount spent and the average cost per unit. Recall that the average cost per unit is the total amount spent divided by the number of units of activity. Therefore, the total amount spent is the product of the average cost per unit multiplied by the number of units of activity.

For example, if a fixed cost is $40,000 for all levels of activity, and we want to know the total amount spent at 5,000, 10,000 and 20,000 units as well as the average per unit at each quantity of activity, we can easily complete a table showing this.

<table>
<thead>
<tr>
<th>At this level of activity</th>
<th>5,000</th>
<th>10,000</th>
<th>20,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total costs</td>
<td>$40,000</td>
<td>$40,000</td>
<td>$40,000</td>
</tr>
<tr>
<td>Average cost per unit</td>
<td>$8</td>
<td>$4</td>
<td>$2</td>
</tr>
</tbody>
</table>
Mixed Costs

A cost is **mixed** or **semivariable** if it has both variable and fixed elements. This means that a mixed cost increases as quantity increases, but not proportionately. The average cost per unit decreases (eventually approaching the variable cost per unit) as quantity increases. This can be seen in the graphic image at the right. Modeled as an equation, it is:

\[
\text{total mixed cost} = V \times X + F
\]  

(3)

Where:
- \( V \) = variable cost per unit
- \( X \) = units of product or activity
- \( F \) = total dollar amount of lump-sum expenditure

There are many practical examples mixed. Perhaps the most common mixed cost is that of utilities such as electrical power. Many companies continue to run lights and equipment even if no activity is going on. However, as activity increases, the amount of electrical power consumed increases. The mixed cost pattern is a good conceptualization of how all costs added together for an organization behave.

It is essential to have the cost equation for mixed cost patterns. Since there are both variable and fixed elements, the mixed cost equation can be written as total mixed cost = \( V \times X + F \). The values for \( V \) (variable cost per unit) and \( F \) (total fixed cost) can be derived via the high-low method, where first the slope (variable cost per unit) of the function is computed and then the Y-intercept (total fixed cost).

There are a number of ways to organize numeric problems dealing with mixed costs, but they all revolve around the contrast between total amount spent and the average cost per unit. Recall that the average cost per unit is the total amount spent divided by the number of units of activity. Therefore, the total amount spent is the product of the average cost per unit multiplied by the number of units of activity.

For example, if a mixed cost equation is $3 per unit plus $20,000, and we want to know the total amount spent at 5,000, 10,000 and 20,000 units as well as the average per unit at each quantity of activity, we can easily complete a table showing this.

<table>
<thead>
<tr>
<th>At this level of activity</th>
<th>5,000</th>
<th>10,000</th>
<th>20,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total costs</td>
<td>$35,000</td>
<td>$50,000</td>
<td>$80,000</td>
</tr>
<tr>
<td>Average cost per unit</td>
<td>$7</td>
<td>$5</td>
<td>$4</td>
</tr>
</tbody>
</table>
Step Costs

A step cost is a fixed cost with increments (or steps) of additional fixed cost. This is represented graphically on the right.

A step cost pattern occurs in practice whenever a series of additional investments are needed. Another example of a step cost is for supervisors, where a full-time supervisor is needed for 1-10 employees, a second full-time supervisor is needed for any additional employees 11-20.

\[
\text{total step cost} = \sum F_n
\]

Where:
\[F_n = \text{total dollar amount of lump-sum expenditure at } X_n\]

For example, if a project requires an initial investment of $10,000, plus additional expenditures of $6,000 after the 10,000th unit and $3,000 after the 25,000th unit, then the total step cost at 3,500 units is $10,000. The total step cost at 14,000 units is $16,000. The total step cost at 38,122 units is $19,000.

Total Costs

Adding all types of costs (variable and fixed) together results in a total cost equation of

\[
\text{total cost} = V*X + F
\]

Where:
\[V = \text{variable cost per unit}\]
\[X = \text{units of product or activity}\]
\[F = \text{total dollar amount of lump-sum expenditure}\]
Cost Equations

There are many ways in which costs behave, and an equation can be constructed to describe each behavior. Summarizing for the cost patterns we’ve talked about so far, the cost equations are:

1. Total variable cost \( = V*X + 0 \) (\( 0 \leq X \leq \infty \))
2. Total fixed cost \( = 0*X + F \) (\( 0 \leq X \leq \infty \))
3. Total mixed cost \( = V*X + F \) (\( 0 \leq X \leq \infty \))
4. Total step cost \( = \Sigma F_n \) (\( 0 \leq X \leq \infty \))
5. Total cost in general \( = V*X + F \) (\( 0 \leq X \leq \infty \))

Cost Drivers

Moreover, cost equations can include multiple cost drivers. A cost driver is any activity that causes additional amounts of money to be spent. An equation for a situation for \( n \) multiple cost drivers for variable costs, in addition to a set of fixed costs would be:

\[
\text{total cost with multiple drivers} = V_1*X_1 + \ldots + V_n*X_n + F
\]

For example, total production cost might be $5 per unit produced and $900 to set up each batch, in addition to $13,000 of fixed cost. An equation to depict this specific pattern is:

\[
\text{total cost} = 5*X_1 + 900*X_2 + 13,000
\]

Where:
- \( X_1 \) = number of units
- \( X_2 \) = number of batches

If it takes 14 batches to produce 16,500 units, then the total cost is $5*16,500 + $900*14 + $13,000 = $82,500 + $12,600 + $13,000 = $108,100.

Changing Costs

Sometimes costs change as volume accumulates. Let’s take the case shown on the right where variable costs are $3 per unit for the first 10,000 units, after which (and only for the units above 10,000) variable costs per unit decrease to $2 per unit. The cost equation of this pattern is:

\[
\begin{align*}
\text{Total variable cost} & = 3*X & (0 \leq X \leq 10,000) \\
\text{Total variable cost} & = 3*10,000 + 2*(X - 10,000) & (10,001 \leq X \leq \infty)
\end{align*}
\]

If \( X = 7,000 \), then total variable cost = \( 3*7,000 + 0 = $21,000 \). If \( X = 13,000 \), then total variable cost = \( 3*10,000 + 2*3,000 = $36,000 \).

There are numerous possibilities for costs where the pattern changes. Observe the pattern at the right. In today’s world, cell phone companies charge a flat monthly fee for which customers receive so many free minutes per month. If the customer exceeds
the allowance, the overage is charged on a per minute basis. For example, if a monthly cell phone account is priced at $39.99 plus $0.30 for all minutes above 700, then the equations are:

\[
\begin{align*}
\text{Total cost} &= \$39.00 \quad (0 \leq X \leq 700) \\
\text{Total cost} &= \$39.99 + 0.30(x - 700) \quad (701 \leq X \leq \infty)
\end{align*}
\]

If \( X = 500 \), then total cost = $39.99. If \( X = 800 \), then total cost = $39.99 + $0.30*100 = $69.99.

**Concluding Example**

The Smith & Jones Company produces widgets in batches. It costs to set up and tear down after each batch, variable production costs per each unit produced, an initial investment of fixed costs, and regular investments of additional fixed costs. The cost data is summarized in the following data:

- Set up and tear down cost per batch .............. $5,200
- Variable cost A per units 1-13,000 ............... $5
- Variable cost A per units 13,001 & above ....... $7
- Initial fixed cost .................................. $15,000
- Additional fixed cost after each 10,000 units ... $4,000

**Case A:** What is the total cost to Smith & Jones if 6,200 units have been produced in 7 batches?

\[
\text{Total cost} = \$5,200*7 + 5*6,200 + \$15,000 = \$36,400 + \$31,000 + \$15,000 = \$82,400
\]

**Case B:** What is the total cost to Smith & Jones if 12,600 units have been produced in 11 batches?

\[
\text{Total cost} = \$5,200*11 + 5*12,600 + \$15,000 + \$4,000 = \$57,200 + \$63,000 + \$15,000 + \$4,000 = \$139,200
\]

**Case C:** What is the total cost to Smith & Jones if 35,100 units have been produced in 27 batches?

\[
\text{Total cost} = \$5,200*27 + 5*13,000 + 7*22,100 + \$15,000 + \$4,000 + \$4,000 + \$4,000 = \$140,400 + \$65,000 + \$154,700 + \$15,000 + \$12,000 = \$387,100
\]
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Two types of Income Statement

In financial accounting, you learned to structure an income statement so that it computes operating income. For lack of a better term, it is called the traditional income statement. The equation for it is:

\[
\text{Sales revenue} - \text{Cost of goods sold expense} \quad \text{Gross margin} - \text{Selling & administrative expense} \quad \text{Operating income}
\]

Operating income is also called income, profit or earnings. I use the terms interchangeably. In the above equation, cost of goods sold expense is called the product cost. If the focus is on a retail company (e.g., Target), then cost of goods sold actually refers to the purchase cost for those items sold during the period. If the focus is on a manufacturing company (e.g., 3M), then cost of goods sold actually refers to the manufacturing cost for those items sold during the period. Common manufacturing costs include material, labor and manufacturing overhead.

A second income statement is called the contribution margin income statement. It is used internally for planning purposes. Its advantage is that costs are classified by the pattern of their behavior.

\[
\text{Sales revenue} - \text{Variable costs} \quad \text{Contribution margin} - \text{Fixed costs} \quad \text{Income}
\]

In this income statement, there can be variable costs (total costs depend upon the amount of activity of some cost driver) as well as fixed costs (total costs do not change). If any cost is determined to be mixed, then its variable portion is subtracted out above the contribution margin, and its fixed portion is subtracted out below the contribution margin. Step costs are treated as fixed.

For example, the XYZ company has sold 10,000 units of a product.

| Sales price per unit | $25 |
| Variable cost of manufacturing per unit | $7 |
| Variable cost of selling & admin per unit | $3 |
| Fixed cost of manufacturing in total | $35,000 |
| Fixed cost of selling & admin in total | $70,000 |