

COST BEHAVIOR ANALYSIS

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Abstract: *Every business is unique, and a business person will be careful to understand their cost structure. For a long time, the trend for many businesses was toward increased fixed costs. Some of this was the result of increased investment in robotics and technology. However, those components have become more affordable. And, we are now seeing more outsourcing, elimination of health insurance, conversion of pension plans, and so forth. These activities suggest attempts to structure businesses with a definitive margin (revenues minus variable costs) that scales up and down with changes in the level of business activity. No matter the specific example, a manager must understand their cost structure.*

Keywords: nature of costs, variable costs, fixed costs, mixed costs, high-low method, method of least squares.

JEL Classification: M₄₁, M₄₉.

1. Introduction

“Profitability is just around the corner.” This is a common expression in the business world; you may have heard or said this yourself. But, the reality is that many businesses don’t make it.

Business is tough, profits are illusive, and competition has a habit of moving into areas where profits are available. And, sometimes, business owners become frustrated because revenue growth only seems to bring on waves of additional expenses, even to the point of going backwards.

How does one realistically assess the viability of a business? This is perhaps the most critical business assessment a manager must make. Most

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of us are taught from an early age to do our best and not give up, even in the face of adversity. And, there are countless stories of businesses that struggled to survive their infancy, but went on to become highly successful firms (Walther, L. & Skousen, C., 2010, p. 23).

A good manager must learn to use information to make informed decisions about which business prospects to pursue. Managerial accounting methods provide techniques for evaluating the viability and ability to grow or “scale” a business. These techniques are called cost-volume-profit analysis (CVP).

2. The nature of costs

Before one can begin to understand how a business is going to perform over time and with shifts in volume, it is imperative to first consider the cost structure of the business. This requires drilling down into the specific types of costs that are to be incurred and trying to understand their unique attributes.

2.1. Variable Costs

Variable costs will vary in direct proportion to changes in the level of an activity. For example, direct material, direct labor, sales commissions, fuel cost for a trucking company, and so on, may be expected to increase with each additional unit of output (Horngren, C., Datar, S., Foster, G., 2006, p. 32).

Assume that HP produces laser printers. Each unit produced requires a printed circuit board (PCB) that costs 11 lei. Below is a spreadsheet that reveals rising PCB costs with increases in unit production. For example, 1.650.000 lei is spent when 150.000 units are produced ($150.000 \times 11 \text{ lei} = 1.650.000 \text{ lei}$). The data are plotted on the graphs. The top graph reveals that total variable cost increases in a linear fashion as total production rises. The slope of the line is constant.

Of course, when plotted on a “per unit” basis (Figure no. 1), the variable cost is constant at 11 lei per unit. Increases in volume do not change the per unit cost. In summary, every additional unit produced brings another incremental unit of variable cost.

The activity base is the item or event that causes the incurrence of a variable cost. It is easy to think of the activity base in terms of units produced, but it can be more than that. Activity can relate to labor hours worked, units

sold, customers processed, or other such “cost drivers”. Each variable cost must be considered independently and with careful attention to what activity drives the cost (Iacob, C., Ionescu, I., Goagară, D., 2007, pp. 45-50).

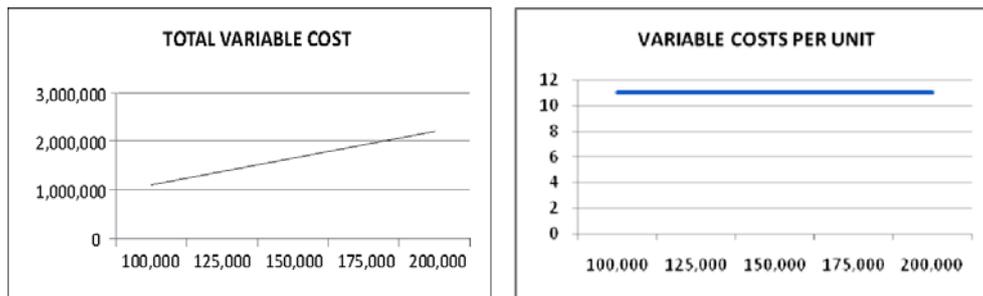


Figure no. 1

2.2. Fixed Costs

The opposite of variable costs are fixed costs. Fixed costs do not fluctuate with changes in the level of activity. Assume that HP leases the manufacturing facility where the laser printers are assembled. Assume that rent is 1.200.000 lei no matter the level of production. The rent is said to be a “fixed” cost, because total rent will not change as output rises and falls. The following spreadsheet reveals the factory rent incurred at different levels of production and the resulting “per unit” rent amount. The fixed cost per unit will decline with increases in production (Figure no. 2).

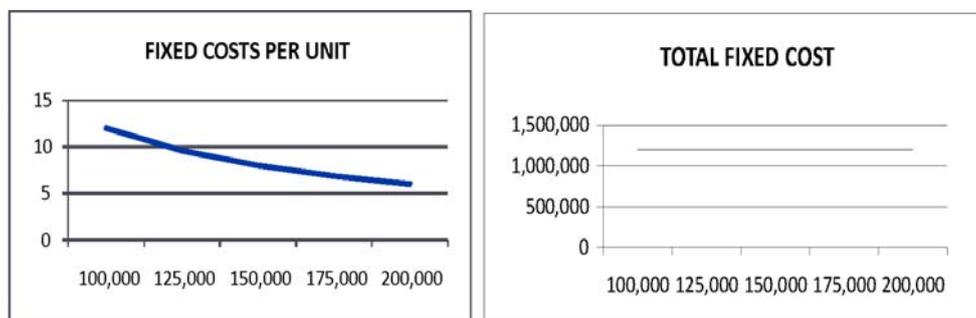


Figure no. 2

This attribute of fixed costs is important to consider in assessing the scalability of a business proposition. There are numerous types of fixed costs. Examples include administrative salaries, rents, property taxes, security, networking infrastructure support, and so forth (Călin, O., Man, M., Nedelcu, M., 2008, pp. 69-85).

The nature of a specific business will have a lot to do with defining its inherent fixed cost structure.

Airlines have historically been burdened with high fixed costs related to gates, maintenance, contractual labor agreements, computer reservation systems, aircraft, and the like. As you are aware, airlines have struggled during lean years because they are unable to cover fixed costs. During boom years, these same companies have been extremely profitable, because costs do not rise (much) with increases in volume. Basically, there is not much cost difference in flying a plane empty or full.

Software companies have a big investment in product development, but very little cost in reproducing multiple electronic copies of the finished product. Their variable costs are low.

Other businesses have attempted to avoid fixed costs so that they can maintain a more stable stream of income relative to sales. For example, a computer company might outsource its tech support (Walther & Skousen, 2009, p. 40).

Rather than having a fixed staff that is either idle or overloaded at any point in time, they pay an independent support company a per-call fee. The effect is to transform the organization's fixed costs to variable, and better insulate the bottom line from fluctuations brought about by the related ability to cover or not cover the fixed costs of operations (Briciu, S., 2006, p. 75).

Every business is unique, and a business person will be careful to understand their cost structure. For a long time, the trend for many businesses was toward increased fixed costs. Some of this was the result of increased investment in robotics and technology. However, those components have become more affordable. And, we are now seeing more outsourcing, elimination of health insurance, conversion of pension plans, and so forth. These activities suggest attempts to structure businesses with a definitive margin (revenues minus variable costs) that scales up and down with changes in the level of business activity. No matter the specific example, a manager must understand their cost structure.

Economists speak of the concept of economies of scale. This means that certain efficiencies are achieved as production levels rise. This can take many forms. For starters, fixed costs can be spread over larger production runs, and this causes a decrease in the per unit fixed cost. In addition, enhanced buying power results (e.g., quantity discounts) as volume goes up, and this can reduce the per unit variable cost (Iacob, C., Ionescu, I., Goagară, D., 2007, pp. 100-123). These are valid considerations. The accountant is not blind to these issues and must take them into consideration in any business evaluation. However, care must also be exercised to limit one's analysis to a "relevant range" of activity.

After grasping the concepts of variable and fixed costs, it is important to understand their full implications in managing a business. Let's first give added thought to fixed cost concepts. In an ideal setting, you would try to produce at the right-most edge of a fixed-cost step. This squeezes maximum productive output from a given level of expenditure. For a machine, it is as simple as running at full capacity. However, for a business with many fixed costs, it is more challenging to orchestrate operations so that each component is fully utilized.

Some fixed costs are committed fixed costs arising from an organization's commitment to engage in operations. These elements include such items as depreciation, rent, insurance, property taxes, and the like (Horngren, C., Datar, S., Foster, G., 2006, p. 59). These costs are not easily adjusted with changes in business activity. On the other hand, discretionary fixed costs originate from top management's yearly spending decisions; proper planning can result in avoidance of these costs if cutbacks become necessary or desirable. Examples of discretionary fixed costs include advertising, employee training, and so forth. Committed fixed costs relate to the desired long-run positioning of the firm; whereas, discretionary fixed costs have a short-term orientation. Committed fixed costs are important because they cannot be avoided in lean times; discretionary fixed costs can be altered with proper planning. Of course, a company should be careful to avoid incurring excessive committed fixed costs.

Variable costs are also subject to adjustment. Even direct labor cost can be subject to adjustment for overtime premiums, based on whether or not overtime is worked. It may or may not make sense to meet customer demand by ramping up production when overtime premiums kick in. Later in this book, you will learn how to perform incremental analysis for such decision tasks.

The interplay between all of the different costs emphasizes the importance of good planning. The trick is to synchronize operations so that the benefits of each fixed cost are maximized, and variable cost patterns are established in the most economic position. All of this must be weighed against revenue opportunities; you must be able to sell what you produce. Some advanced managerial accounting courses present sophisticated linear programming models that take into account constraints and opportunities and project the ideal firm positioning. Those models are beyond the scope of an introductory class, but a number of simpler tools are available, and will be covered next.

3. Cost Behavior Analysis

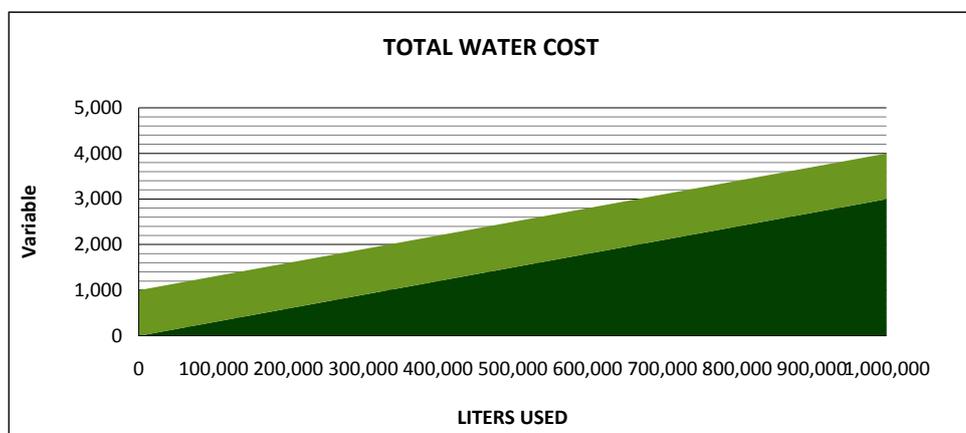
Good managers must not only be able to understand the conceptual underpinnings of cost behavior, but they must also be able to apply those concepts to real world data that do not always behave in the expected manner. Cost data are impacted by complex interactions. Consider for instance the costs of operating a vehicle. Conceptually, fuel usage is a variable cost that is driven by miles. But, the efficiency of fuel usage can fluctuate based on highway miles versus city miles. Beyond that, tires wear faster at higher speeds, brakes suffer more from city driving, and on and on. Vehicle insurance is seen as a fixed cost; but portions are required (liability coverage) and some portions are not (collision coverage). Furthermore, if you have a wreck or get a ticket, your cost of coverage can rise. Now, the point is that assessing the actual character of cost behavior can be more daunting than you might first suspect. Nevertheless, management must understand cost behavior, and this sometimes takes a bit of forensic accounting work. Let's begin by considering the case of "mixed costs."

3.1. Mixed Costs

Many costs contain both variable and fixed components. These costs are called mixed or semi variable. If you have a cell phone, you probably know more than you wish about such items. Cell phone agreements usually provide for a monthly fee plus usage charges for excess minutes, text messages, and so forth. With a mixed cost, there is some fixed amount plus a variable component tied to an activity. Mixed costs are harder to evaluate, because they change in response to fluctuations in volume. But, the fixed

cost element means the overall change is not directly proportional to the change in activity.

To illustrate, assume that Liquid Car Wash has a contract for its water supply that provides for a flat monthly meter charge of 1.000 lei, plus 3 lei per thousand liters of usage. This is a classic example of a mixed cost. Below is a graphic portraying Liquid's potential water bill, keyed to liters used:



	A	B	C	D
1		Variable	Fixed	Total
2	0	0	1.000	1.000
3	100.000	300	1.000	1.300
4	200.000	600	1.000	1.600
5	300.000	900	1.000	1.900
6	400.000	1.200	1.000	2.200
7	500.000	1.500	1.000	2.500
8	600.000	1.800	1.000	2.800
9	700.000	2.100	1.000	3.100
10	800.000	2.400	1.000	3.400
11	900.000	2.700	1.000	3.700
12	1.000.000	3.000	1.000	4.000

Figure no. 3

Look closely at the data in the spreadsheet, and notice that the “variable” portion of the water cost is 3 lei per thousand liters. For example, spreadsheet cell B9 is 2.100 lei (700 thousand liters at 3 lei per thousand). In addition, the “fixed” cost is 1.000 lei, regardless of the liters used. The total in column D is the summation of columns B and C. The cost components are mapped in figure no. 3.

Hopefully, the preceding illustration is clear enough. But, what if you were not given the “formula” by which the water bill is calculated? Instead, all you had was the information from a handful of past water bills. How hard would it be to sort it out? Could you estimate how much the water bill should be for a particular level of usage? This type of problem is frequently encountered in business, as many expenses (individually and by category) contain both fixed and variable components.

3.2. High-Low Method

One approach to sorting out mixed costs is the high-low method. It is perhaps the simplest technique for separating a mixed cost into fixed and variable portions. Information from Butler’s actual water bills is shown at table. Butler is curious to know how much the August water bill will be if 650,000 liters are used. Assume that the only data available are from the aforementioned four water bills.

Table no. 1

April	450.000 liters	2.350 lei
May	340.000 liters	2.020 lei
June	850.000 liters	3.550 lei
July	500.000 liters	2.500 lei

With the high-low technique, the highest and lowest levels of activity are identified for a period of time. The highest water bill is 3.550 lei, and the lowest is 2.020 lei. The difference in cost between the highest and lowest level of activity represents the variable cost (3.550 lei – 2.020 lei = 1.530 lei) associated with the change in activity (850.000 liters on the high end and 340.000 liters on the low end yields a 510.000 liter difference).

The cost difference is divided by the activity difference to determine the variable cost for each additional unit of activity (1.530 lei/510.000 liters = 3 lei per thousand).

Table no. 2

	USAGE (in thousands of liters)	COST
Highest level	850	3.550
Lowest level	340	2.020
Difference	510	1.530
Variable Cost per unit: (1.530 lei/510)	3	
	HIGH	LOW
Total cost	3.550	2.020
Less: Variable cost (3 lei per unit X usage)	2.550	1.020
Fixed cost	1.000	1.000

The fixed cost can be calculated by subtracting variable cost (per-unit variable cost multiplied by the activity level) from total cost. The table at above reveals the application of the high-low method. An electronic spreadsheet can be used to simplify the high-low calculations.

3.3. Method of Least Squares

As cautioned, the high-low method can be quite misleading. The reason is that cost data are rarely as linear as presented in the preceding illustration, and inferences are based on only two observations (either of which could be a statistical anomaly or “outlier”). For most cases, a more precise analysis tool should be used, such as “regression analysis” or the “method of least squares”. This tool is ideally suited to cost behavior analysis. This method appears to be imposingly complex, but it is not nearly so complex as it seems. Let’s start by considering the objective of this calculation.

The goal of least squares is to define a line so that it fits through a set of points on a graph, where the cumulative sum of the squared distances between the points and the line is minimized (hence, the name “least squares”). Simply, if you were laying out a straight train track between a lot of cities, least squares would define a straight-line route between all of the

cities, so that the cumulative distances (squared) from each city to the track is minimized (Walther & Skousen, 2009, p. 46).

Let's dissect this method, beginning with the definition of a line. A line on a graph can be defined by its intercept with the vertical (Y) axis and the slope along the horizontal (X) axis. In the following diagram, observe a red line starting on the Y axis (at the value of "2"), and rising gently upward as it moves out along the X axis. The rate of rise is called the slope of the line; in this case, the slope is 0.8, because the line "rises" 8 units on the Y axis for every 10 units of "run" along the X axis.

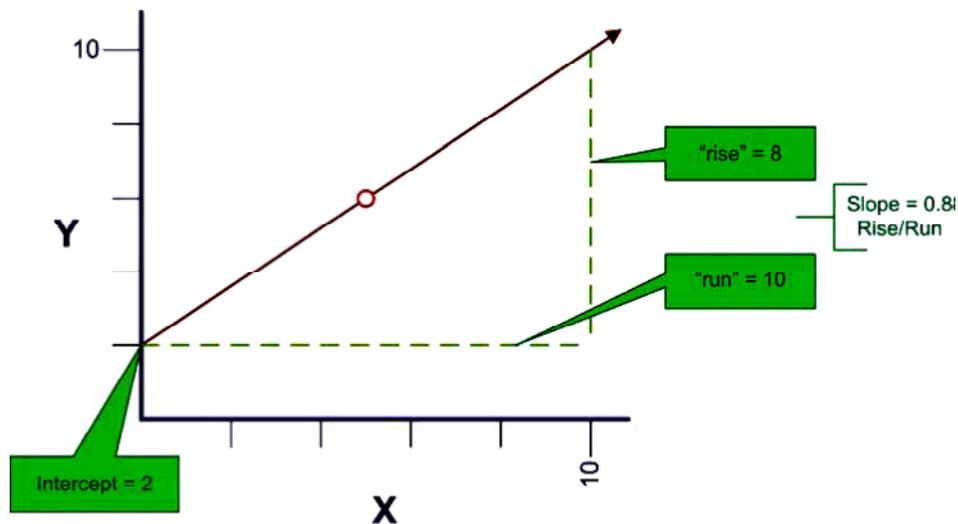


Figure no. 4

Source: Walther, L., Skousen, C., 2009, *Managerial and Cost Accounting*

In general, a straight line can be defined by this formula:

$$Y = a + b X \quad (1)$$

where:

a = the intercept on the Y axis

b = the slope of the line

X = the position on the X axis

For the line drawn on the previous page, the formula would be:

$$Y = 2 + 0,8 X \quad (2)$$

And, if you wished to know the value of Y, when X is 5 (see the red circle on the line), you perform the following calculation:

$$Y = 2 + (0,8 \times 5) = 6 \quad (3)$$

Now, let's move on to fitting a line through a set of points (Walther, Skousen, 2009, p. 76). On the next page is a table of data showing monthly unit production and the associated cost (sorted from low to high). These data are plotted on the graph to the right. Through the middle of the data points is drawn a line, and the line has a formula of:

$$Y = 138.533 \text{ lei} + 10,34 \text{ lei } X \quad (4)$$

This formula suggests that fixed costs are 138.533 lei, and variable costs are 10,34 lei per unit. For example, how much would it cost to produce about 110.000 units? The answer is about 1.275.000 lei (138.533 lei + (10,34 lei x 110.000)).

How was the formula derived? One approach would be to “eyeball the points” and draw a line through them. You would then estimate the slope of the line and the Y intercept. This approach is known as the scatter graph method, but it would not be precise. A more accurate approach, and the one used to derive the above formula, would be the least squares technique. With least squares, the vertical distance between each point and resulting line (as illustrated by an arrow at the 1.500.000 point) is squared, and all of the squared values are summed. Importantly, the defined line is the one that minimizes the summed squared values. This line is deemed to be the best fit line, hopefully giving the clearest indication of the fixed portion (the intercept) and the variable portion (the slope) of the observed data (Popescu, Manea-Bucea-Țoniș, Barbu, 2009, pp. 120-140).

One can always fit a line to data, but how reliable or accurate is that resulting line? The R-Square value is a statistical calculation that characterizes how well a particular line fits a set of data. For the illustration, note (in cell B21) an R2 of 0,798; meaning that almost 80% of the variation in cost can be explained by volume fluctuations. As a general rule, the closer R2 is to 1,00 the better; as this would represent a perfect fit where every point fell exactly on the resulting line.

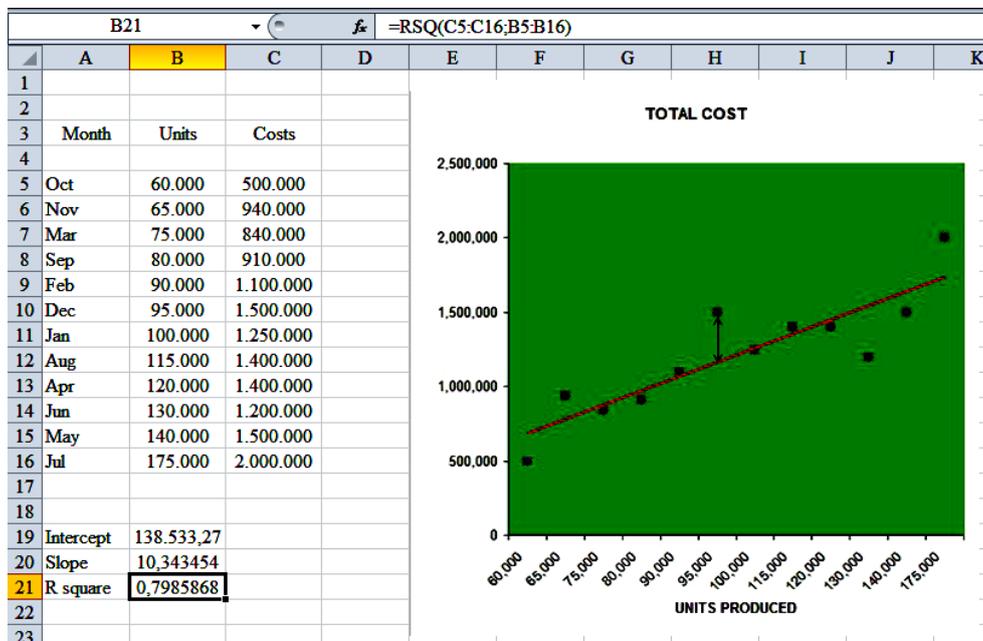


Figure no. 5

Source: adapted to Walther, L., Skousen, C., 2009, *Managerial and Cost Accounting*

The R-Square method is good in theory. But, how does one go about finding the line that results in a minimization of the cumulative squared distances from the points to the line? One way is to utilize built-in tools in spreadsheet programs, as illustrated above. Notice that the formula for cell B21 (as noted at the top of spreadsheet) contains the function RSQ (C5:C16;B5:B16). This tells the spreadsheet to calculate the R2 value for the data in the indicated ranges. Likewise, cell B20 is based on the function SLOPE (C5:C16;B5:B16). Cell B19 is INTERCEPT (C5:C16;B5:B16). Most spreadsheets provide intuitive pop-up windows with prompts for setting up these statistical functions.

4. Conclusion

A good manager must understand an organization's cost structure. This requires careful consideration of variable and fixed cost components. However, it is sometimes difficult to discern the exact cost structure. As a

result, various methods can be employed to analyze cost behavior. Once an organization's cost structure is understood, it then becomes possible to perform important diagnostic calculations.

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ACKNOWLEDGEMENTS: This work was supported by the project “Excellence academic routes in doctoral and postdoctoral research - READ” co-funded from the European Social Fund through the Development of Human Resources Operational Programme 2007-2013, contract no. POSDRU/159/1.5/S/137926.