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Cost-Volume-Profit Analysis

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Cost, volume, and profit decisions—despite the fact that they are vital to any business—are perhaps determined less scientifically than any others. Here's a suggested formula for systematizing—

COST-VOLUME-PROFIT ANALYSIS

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A GENERALIZED formula approach to cost-volume-profit analysis can serve as a foundation on which to build a systematic pattern of data gathering and can be applied to companies of varying sizes in various industries. Such a formula can be derived from the behavior of a few basic variables and can be applied by computer.

Cost-volume-profit analysis is, of course, relevant to many questions that management must answer. What volume and mix of products or services constitute the optimum profit plan? What prices must be charged to provide a sufficent contribution toward coverage of fixed costs and generation of adequate net income? What is the maximum cost that could be paid to an outside manufacturer in lieu of internal production? What ceiling must be placed on discretionary expenditures that are nonvariable in relation to volume? What profit will result from a specified combination of quantities, prices, and costs?

A systematic data gathering approach is needed to provide answers to questions such as these, but is often absent in practice. A research monograph recently published by the National Association of Accountants suggests that executives in small and medium-size manufacturing firms "could attempt to become more orderly in their general decision-making activities" and "could begin to use more of the concept, theory, and techniques (such as contribution margin analysis) of managerial accounting in their decision activities."[1] Replies to a questionnaire indicate the following average order of importance of various operating decisions:[2]

1. Cost-volume-profit analysis
2. Product pricing
3. Financial budgeting
4. Capital equipment analysis
5. Inventory control
6. Make-or-buy products or components

However, "research indicated that in the decision areas of cost-

[1] Gary A. Luoma, *Accounting Information in Managerial Decision-Making for Small and Medium Manufacturers,* Research Monograph No. 2, National Association of Accountants, New York, December, 1967, p. 69.
[2] *Ibid.,* p. 57.

volume-profit analysis, inventory control, and make or buy, no set procedures are followed by decision-makers," whereas in the other decision areas "evidence indicates some pattern *in* the gathering of data and the rendering of a decision."[3] It is noteworthy that the most important area of cost-volume-profit analysis (along with the two areas judged least important) was found to be lacking in a systematic pattern of data gathering. Detecting the relationships among the variables involved would make a considerable contribution toward filling that gap.

The basic formula

Careful consideration reveals that, among all of the seemingly diverse questions requiring cost-volume-profit analysis, there are only five basic variables, and that a generalized formula involving these variables can provide a framework for the systematic gathering of relevant data, regardless of the nature or size of the business involved. The basic equation is:

$$Q\,(P-V) = F + I$$

where:

- Q is quantity or volume in units
- P is selling price per unit
- V is variable cost per unit
- F is fixed cost in total
- I is income or profit

Multiple sources of income can be represented by:

$$Q_1(P_1-V_1) + Q_2(P_2-V_2) + \ldots Q_n(P_n-V_n) = F+I.$$

"F" is placed on the right side of the basic equation because it is a nonvariable sum unaffected by the mix of revenue sources. Any attempt to reduce it to per unit terms is artificial and may be misleading.

The general formula can be applied to various types of businesses. The multiple sources of revenue on the left side of the equation could represent various products, services, rental units, admission prices, or whatever is involved in the business under consideration.

The use of a formula must not be allowed to convey the impression that specific solutions can be determined with absolute precision. Most costs are mixed costs which include both fixed and variable elements. Even purely fixed or variable costs may be subject to random variations. The relation between selling price and volume is seldom known more than roughly, and demand is generally unpredictable. Cost-volume-profit analysis must be preceded by and supplemented by other techniques such as market surveys to help forecast sales and regression analysis to identify when and how costs vary. However, despite its admitted limitations, cost-volume-profit analysis is still deemed to be very useful, as evidenced by its number one ranking in the survey mentioned earlier. Furthermore, there does not appear to be any limitation involved in a formula approach which is not inherent in the very nature of cost-volume-profit analysis itself.

Care must be taken to identify properly the pattern of cost or revenue behavior. For example, it would *not* be appropriate to include in "V" sales commissions based on a percentage of dollar sales, because such commissions would vary with selling prices as well as with units sold—with "P" as well as "Q"—whereas "V" is defined as cost which varies only with units —only with "Q." Commissions should be treated as a reduction of "P."

Occasionally certain data may not seem to fit anywhere in the suggested equation. For example, lease revenue may consist of a fixed minimum amount plus an additional amount varying with sales of the lessee. Where does the basic formula provide for "fixed revenue"? The answer is to treat such revenue as an offset to fixed costs. Thus, "F" is to be thought of as a net fixed dollar outlay.

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[3] Luoma, *op. cit.*, p. iv.

Once problem data are identified in terms of the generalized formula, it is a relatively simple matter to rearrange the terms to solve for any unknown. Thus the equation for required quantity in units can be expressed as

$$Q = (F + I) / (P - V)$$

and the formula for the breakeven point ($I = \$0$) is simply

$$Q = F / (P - V).$$

The breakeven point in dollars of revenue would be

$$QP = F / \frac{(P - V)}{P}.$$

Note that the breakeven formula is just one of several possible variations of the basic equation and that the formula can be varied in other ways to assist in solving problems in which a target volume has been established and some other variable must be computed.

For example, the income that will result from a specified combination of volume, price, and cost factors can be determined as

$$I = [Q (P - V)] - F.$$

Given cost data plus a target volume and profit, the formula for required selling price is

$$P = V + [(F + I) / Q].$$

The formula for maximum allowable variable cost per unit is

$$V = P - [F + I) / Q].$$

Note the similarity of the two preceding equations, each of which requires computing a required contribution margin per unit. If a limit on fixed costs is to be determined, the following equation is appropriate:

$$F = [Q (P - V)] - I.$$

If a company previously offering a single product wishes to determine a selling price for a second product consistent with cost data, expected volume, and target profit, the problem can be expressed as follows:

$$P_2 = \frac{(F+I)-[Q_1(P_1-V_1)]}{Q_2} + V_2$$

where P_2 is the required selling price of the second product.

Other examples could be given, of course, but the foregoing should be sufficient to illustrate the flexibility and applicability of the generalized formula. Although the last example was stated in terms of multiple products, it could just as well have been applied to multiple services or other sources of income as noted previously. In other words, the generalized formula is applicable to a variety of situations involving one or more categories of revenue and related cost.

The use of a basic equation also facilitates the preparation of a computer program for solving cost-volume-profit problems. A more realistic situation involving many products or services would not increase the number of basic variables or the relationships among them and a computer simulation should be quite feasible.

Cost-volume-profit analysis is useful in helping management deal with a wide range of questions, but a systematic data gathering approach is needed to facilitate such analysis. Since there are a limited number of basic variables involved, explicit recognition of these in the form of a generalized equation may help management establish a system that will provide relevant data in a form suitable for use in cost-volume-profit analysis for any size of organization. The larger the organization, the more effective the use that may be made of a computer.

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