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THE COST-VOLUME-PROFIT MODEL: A DISCUSS

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Abstract

A good understanding of cost and revenue behavior is critical to providing decision makers with an understanding of the relationship between a project's revenues, costs, and profits. Cost Volume Profit analysis emphasizes the interrelationships of costs, quantity sold, and price as well as brings together all of the financial information of the firm. We set out to survey extant literature on cost-volume- profit analysis and attempted to shed light on the concept using the hermeneutics approach which focuses on the interpretation and explanation of a text with the intent to express its meaning to others. We concluded that since the model only serve as a useful guide in short-term decision making and its application is subject to a number of restrictive assumptions, decision makers should consider performing sensitivity analysis to determine whether and/or how the assumptions affect decision, take cognizance of the existence of multiple or several cost drivers and incorporate this into equation formulation of the model, as we believe that with this process more realistic results can be obtained.

Keywords: Decision making, marginal costing, contribution margin, contribution graph, break-even chart, profit volume graph.

1.0 Introduction

One of the duties of the accountant is to supply managers with relevant data that will assist them in planning and controlling activities. This information is usually structured and acts as an input to decision making which will rely also on other information forms. In the views of Garrison

and Noreen (2003) some of these decisions may include: which products to manufacture or sell (acceptance or rejection of a decision); what pricing policy to follow (pricing); what marketing strategy to employ; what type of productive facility to acquire (capital budgeting decisions) and so on. Cost-volume-profit analysis is a powerful tool which helps managers deal with these types of decisions (Atkinson, Kaplan, Matsumura & Young, 2012; Kaplan & Atkinson, 1998; Zimmerman, 1996; Weetman, 1999). The origin of the concept Cost Volume Profit (CVP) model can be traced to Hess, 1903; Mann, 1903; 1907 whose works were founded on the assumptions of a single product, absence of uncertainty and the segregation of costs into fixed and variable elements, and Williams, 1922 who proposed a new distinction between the various cost elements organizations are confronted with by introducing a new category of cost (semi - variable costs) which include costs that are not directly related to variable or fixed costs, while Jaedicke and Robichek, 1964 proposed the idea of incorporating the problems of uncertainty into the model (Stefan, Stefan, Savu, Sumandea &Comes, 2008). Planners and decision makers like to know the risk associated with the decisions that they make. For example, a movie producer might wonder how many showings of a new movie will be required so that the producer can recover his/her total investment in the movie and earn a required target profit (Atkinson, Kaplan, Matsumura & Young, 2012). Many decision makers use the probability of at least breaking even or earning a target profit as a measure of a project's risk. Uncertainty is the possibility that an actual amount will deviate from an expected amount. A good understanding of cost and revenue behavior is critical in providing decision makers with an understanding of the relationship between a project's revenues, costs, and profits. CVP analysis emphasizes the interrelationships of costs, quantity sold, and price and therefore brings together all of the financial information of the firm. CVP analysis can be a valuable tool for identifying the extent and magnitude of the economic trouble a company is facing and helping pinpoint the necessary solution (Hansen & Mowen, 2006). The main objective of this paper is to identify measures that can assist decision makers in dealing with the limitations of the CVP model.

2.0 The Concept and Uses of the CVP analyses

2.1 The CVP model

Cost–volume–profit (CVP) analysis examines the relation between changes in volume (output) and changes in profit. Cost volume profit analysis is a systematic method of examining the

relationship between changes in volume (output) and changes in total sales revenue, expenses and profit and their relationship is based on the income statement formulae which look at profit as the difference between total revenue and total cost (Dopuch & Maher, 2005; Okoye, 2011). In addition, CVP plays a key role in strategic planning by assisting management decides the goal of the organization and the main strategies of achieving these goals (Anthony & Govindarajan, 1995). The following are some of the strategic questions answered by CVP analysis: (a) What is the expected level of profit at a given sales volume? (b) What additional amount of sales is needed to achieve a desired level of profit (c) What will be the effect on profit of a given increase in sales? (d) What is the required funding level for a firm, given desired service/production levels? (e) What sales level is needed to cover all costs in a sales region or product line? (Blocher et al., 2002). The objective of CVP analysis is to identify the most cost effective manufacturing methods, including automation, outsourcing, and total quality management. Also CVP analysis is needed by a firm following the differentiation strategy, and it is required at the early phases of the cost life cycle to assess the profitability of new products and the desirability of new features for existing products (Chenhall & Langfield-Smith, 1998). Nevertheless, CVP provides a useful basis for exploring certain business decision situations because it forces managers to understand how costs and revenues vary with changes in output (Zimmerman, 2003). According to Hilton et al (2003), CVP analysis is the most basic financial model which examines a product's profitability at different sales volume. CVP estimates the change in profit with a change in units sold. It makes certain assumptions about revenues and product costs to simplify the analysis. Furthermore, CVP analysis helps managers to understand the interrelationship between cost, volume and profit in an organization by focusing on interactions among prices of products, volume or level of activity, variable cost per unit, total fixed costs and mix of products sold (McWatters et al. 2001). CVP analyses commonly assume that the firm (department, division, or the relevant decision unit) commits itself to holding various forms of capacity for at least another operating period. Analysts define capacity as plants, buildings, equipment and managerial and other skilled labour (both manufacturing and nonmanufacturing). Practitioners may also classify inventories that will be carried over from one period to another as capacity. (Dopuch & Maher, 2005). The commitment to hold capacities results in the incurrence of fixed capacity costs— that is, the firm will incur costs whether it utilizes the capacities or allows them to remain idle. The costs incurred may be current cash outlays or allocations of prior period outlays. The cash

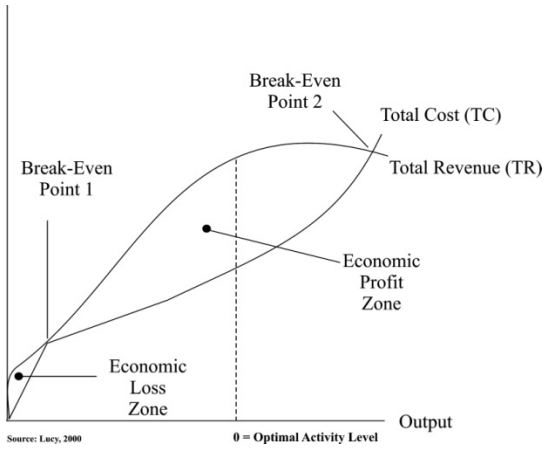
outlays include salaries for managerial and other skilled personnel, taxes, and insurance on properties owned (plant, buildings, equipment, and inventories), rentals or lease payments on fixed contracts, and interest and principal payments on existing debt, assuming that the latter will be kept outstanding to finance asset acquisitions of the decision unit. Fixed costs that are allocations of prior period outlays include depreciation on fixed tangible assets, allocations of patent costs, and of other intangible assets (advertising, research, etc.). Very often, fixed costs represented by cash outlays are quite significant in comparison with the noncash fixed costs, an important factor in CVP analyses under uncertainty (Hilton, Maher & Selto, 2006; Hongren, Datar & Foster, 2003; Maher, Stickney & Weil, 2006).

2.2 Accountants and Economists models of the CVP analyses

(a) The Economist's Model

According to Okoye et al (2006), the accounting view contradicts the economist's view, which holds that: based on the phenomenon of diminishing marginal productivity, total cost line will now be a straight line it will be of curvilinear shape indicating that the firm is only able to sell increasing quantities of output by reducing the selling price per unit. As a result the total revenue line does not increase proportionately with output. Any anticipated increase in the quantity sold will necessitate a reduction in the unit selling price which causes the total revenue line to rise steeply and eventually begin to fall. This is because the adverse effect of price reductions outweighs the benefits of increased sales volume (Drury, 2008). Moreover, the behavioural pattern of cost-line is influenced by such factor as:

1. Fixed cost is not fixed throughout, and
2. Variable cost is not the same throughout. It will decline initially as long as there are increasing physical products ...per unit of input if constant. It will eventually increase after the point of decreasing average return has been reached.



(b) The Accountant's Model

In the accountant's model below the faint line above and below the accountant's total cost line at the profit and loss region respectively represents the economist's total cost function which permits comparison with the accountant's total cost function. The diagram of the accountant's model assumes a constant variable cost and a selling price per unit; thus resulting in a linear relationship for total revenue and total cost as volume changes. The consequence is a single breakeven point (unlike what obtains in the economist's model) and the profit area which widens as volume increases implying that the most profitable output is at the maximum practical capacity. However, it is instructive to mention that the economist's model appears more realistic as it assumes that the total cost is non linear (Drury, 2008, p.167).

Contribution Margin Approach

Cost–volume–profit (CVP) analysis uses the concepts of variable and fixed costs to identify the profit associated with various levels of activity (Atkinson et al., 2006). Suppose Eternit Ltd sells its asbestos roofing sheet for N500 apiece. The revenue equation for the Company will be:

Revenue = N500 x Number of asbestos roofing sheet sold

The difference between total revenue (Sales) and total variable cost (Marginal cost) is called the ***'contribution'*** or ***contribution margin.*** The **contribution margin per unit** is the contribution that each unit makes to covering fixed costs and providing a profit. The contribution margin ratio is the fraction of each naira sales that is available to cover fixed expenses and produce a profit. Two frequently used approaches to finding the break-even point in units are the operating income approach and the contribution margin approach.

Operating Income Approach

The operating income approach focuses on the income statement as a useful tool in organizing the firm's costs into fixed and variable categories. The income statement can be expressed as a narrative equation:

Operating income = Sales revenues - Variable expenses - Fixed expenses

Note that we are using the term **operating income** to denote income or profit *before* income taxes. Operating income includes only revenues and expenses from the firm's normal operations. We will use the term **net income** to mean operating income minus income taxes

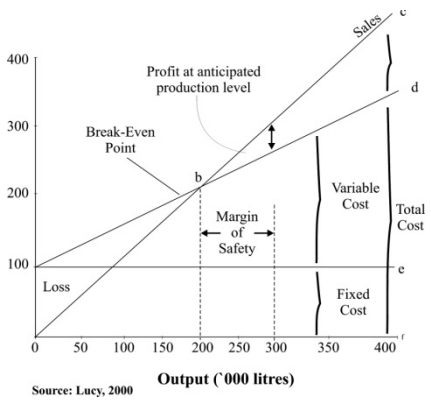
A refinement of the operating income approach is the contribution margin approach. In effect, we are simply recognizing that at break-even, the total contribution margin equals the fixed expenses. The **contribution margin** is sales revenue minus total variable costs. If we substitute the unit contribution margin for price minus unit variable cost in the operating income equation and solve for the number of units, we obtain the following break-even expression:

Number of units = Fixed costs/Unit contribution margin

2.3 The break-even chart, contribution graph and profit volume graph

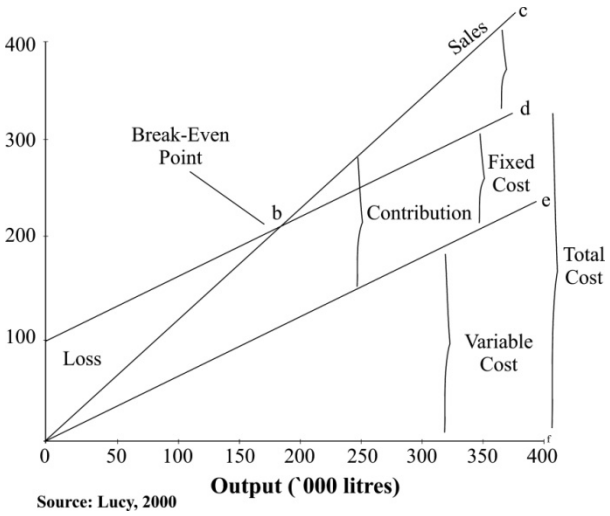
A graphical format of presenting information on the CVP analysis gives a clearer understanding of the CVP behaviour. The various forms are the break-even chart, the contribution graph and the profit-volume graph. The break-even and contribution charts do not highlight the profit or loss at different volume levels. To determine the profit or loss figure from a break-even chart requires ascertaining the difference between total-cost and total-revenue lines. The profit-volume graph is a more convenient method of showing the impact of changes in volume on profit (Drury, 2008, p.175).

(a) Break-even chart



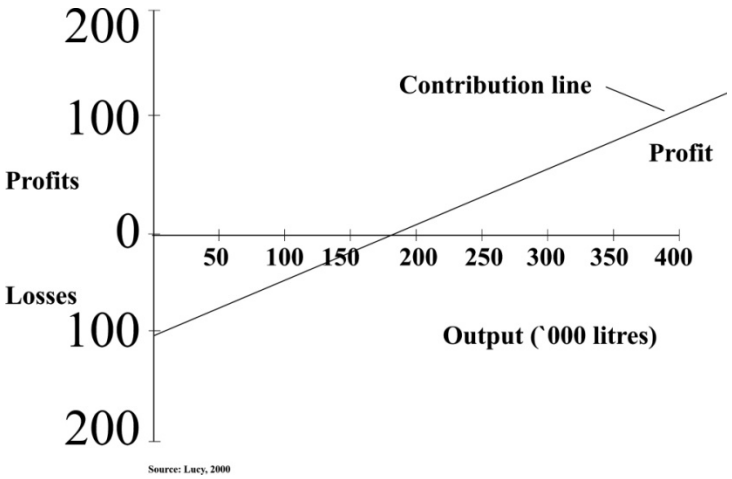
Source: Lucy, 2000

(b) Contribution graph



Source: Lucy, 2000

(c) Profit-volume graph



Source: Lucy, 2000

2.4 Decision Situations Requiring the Use of CVP

The three situations described in this section rely on the basic assumption of cost-volume-profit analyses—that is, a decision unit intends to hold a set of capacities during the subsequent

operating period that will result in the incurrence of fixed costs, whether or not the unit uses the capacities in some productive effort. Generally, if the firm uses the capacities, revenues increase at a faster rate than costs. As a result, the firm will decide for utilization, for example, by adding a product. Discussion on the three situations assumed that only a single other alternative existed for the capacities.

(a) Add or Drop a Product. A decision unit will add (drop) a product if the incremental revenues from the product are greater (less) than the incremental costs of producing and distributing the product. In general, the incremental costs consist of the incremental cash outlay costs plus the opportunity costs of using the capacities to produce the product. The firm will have positive opportunity costs if it has the option of diverting the capacities from the current product and use them to produce another product. The question of whether to add a product generally arises in job-shop operations, where a decision to bid on a new order constitutes a decision to add a new product (the order). The capacity needed to work on the new order is available to the decision unit, and the firm must decide whether to devote the capacity to the new order, to other products (other orders), or let it remain idle (Hilton, Maher & Selto, 2006).

Abandonment policy is adopted when a product is unprofitable either because revenues no longer exceed costs or because another organization offers to buy the rights to the product at a favorable price. The decision of whether to add a new product in a continuous processing type of operation is less common, because the firm may need to acquire the capacity needed to produce the new product through additional investments.

(b) Make or Buy a Unit. A firm may have capacities available that it can use to manufacture a subunit rather than to purchase the subunit from an outside supplier. Firms can make this decision each operating period, opting to make the unit in some periods and purchase it in others. The firm will manufacture the unit if the incremental costs of purchasing exceed the incremental costs of manufacturing. The incremental costs of manufacturing are the incremental outlay costs plus the opportunity costs of devoting the capacities to the subunit. The latter will be zero if the capacities would otherwise stand idle. These costs will be positive if the firm could use the capacities devoted to the subunit to manufacture another profitable product, such as a main product or another type of subunit.

(c) Sell now or process further. Generally, a decision unit will process a product further rather than sell it immediately if the incremental revenues from processing exceed the incremental costs

of processing. The incremental revenues are measured by the difference between the selling price of the unit after processing and the selling price if sold immediately times the number of units to be processed. The incremental costs are the incremental outlay costs of processing and the opportunity costs of using the capacities to process the product. Deciding to use a resource in a particular way causes a manager to give up the opportunity to use the resource in alternative ways. The lost opportunity is a cost that the manager must take into account when making a decision. **Opportunity cost** is the contribution to income that is forgone (rejected) by not using a limited resource in its next-best alternative use (Dopuch & Maher, 2005).

2.5 C-V-P analysis by formula method

According to Lucy (2000, p. 284), C-V-P analysis can be undertaken by graphical means or by simple formulae as illustrated below:

(A) For a single product firm or one with varying mix of sales, break-even point is computed with the following formulae:

$$\text{(a) Break-even point (in units)} = \frac{\text{Fixed costs}}{\text{Unit contribution margin (contribution/unit)}} = \frac{FC}{UCM}$$

$$\text{(b) Break-even point (naira sales)} = \frac{\text{Fixed costs}}{\text{Contribution/ unit}} \times \text{Sales Price/unit}$$

$$= \text{Fixed costs} \times \frac{1}{\text{C/S Ratio}}$$

$$\text{(c) C/S Ratio} = \frac{\text{Contribution/unit}}{\text{Sales Price/unit}} \times 100$$

$$\text{(d) Level of sale to result in target profit (in units)} = \frac{\text{Fixed costs + Target operating profit}}{\text{Unit contribution margin (contribution/unit)}} = \frac{FC + TOP}{UCM}$$

$$\text{(e) Level of sale to result in target profit after tax (in units)} = \frac{\text{Fixed costs + Target profit/ (1-Tax Rate)}}{\text{Unit contribution margin (contribution/unit)}}$$

$$\text{(Fixed costs + Target profit) x Sales Price/unit}$$

(f)Level of sale to result in target profit (naira sales) = $\frac{\text{Fixed Costs + Target Profit}}{\text{Unit contribution margin (contribution/unit)}}$

(B) With a multi product firm the break-even point is calculated as follows:

(a) Break-even point (naira sales) = $\frac{\text{Fixed Costs x Sales Value}}{\text{Contribution}}$

3.0 The Assumptions underlying Cost-Volume-Profit Analysis

The profit-volume and cost-volume-profit graphs rely on some important assumptions which includes: total costs can be divided into a fixed component and a component that is variable with respect to the level of output; the behaviour of total revenues and total costs is linear (straight-line) in relation to output units within the relevant range; the unit selling price, unit variable costs and unit or total fixed costs can be accurately identified and are constant; the analysis either covers a single product or assumes that the proportion of different products (sales mix) when multiple products are sold is known and will remain constant as the level of total units sold changes; all revenues and costs can be added and compared without taking into account the time value of money (this assumption is relaxed when considering capital investment decision; changes in the level of revenues and costs arise only because of changes in the number of products (or service) units produced and sold. The number of output units is the only revenue and cost driver; the price per unit and the variable cost per unit (and therefore the contribution margin per unit) remain the same over all levels of production; fixed costs remain the same over all contemplated levels of production and sales equal production (that is, what is produced is sold (Atkinson et al., 2012; Hansen et al., 2006; Bhimani et al., 2008; Horngren, Foster & Datar, 1999).

4.0 Limitations of CVP analysis

After the considerations of the following researchers (McWatters et al. 2001, Mchlaney and Atrill. 2002, Blocher et al. 2002, Garrison and Noreen. 2003), the following four basic limitations were identified as regards CVP analysis: Multiple products; Assumption of a constant sales price; Non-linear relationships and One-product model

5.0 Conclusion

The accountant's model of the cost-volume-profit analysis which examines the relationship between changes in activity (output) and changes in total sales revenue, expenses and net profit provides managers with a pragmatic basis for decision making as it avails them with information which assists in providing answers to questions relating to the consequences of following particular courses of action. The CVP is a veritable tool for revenue planning, cost planning and profit planning such as determining the impact of selling prices, costs and volume on profits and a conceptual tool or way of thinking about managing a company. It helps management focus on the objectives of obtaining the best possible combination of prices, volume, variable costs and fixed costs. An advantage of the CVP model is its simplicity. However, the price of such simplicity is a set of limiting assumptions that result in some loss of realism with one of the most troubling being the use of a single cost driver. When CVP analysis is applied to a multiple-product company, it is assumed that there is a constant sales mix of products as the total quantity of units sold changes. Moreover, it should be noted that the model only serve as a useful guide in short-term decision making and its application is subject to a number of restrictive assumptions. For instance the model is intended to predict CVP behaviour only within the relevant range, where a firm is likely to be operating on constant returns to scale.

Consequently, we recommend that whenever assumptions are made, it is advisable to perform sensitivity analysis to determine whether and/or how the assumptions affect decision. Also, activity-based costing can be used to cure the simplicity in the assumptions of the traditional CVP analysis. Finally, recognizing the existence of multiple or several cost drivers and then incorporating this into the equation formulation of the model, more realistic results can be obtained.

References

Anthony, R.N. and Gorinderajan, V. (1995). *Management Control Systems*. USA : Richard D. Irwin.

Atkinson, A. A., Kaplan, R. S., Matsumura, E. M. & Young, S. M. (2012). *Management accounting: Information for decision making and strategy execution* (6th ed.). Upper Saddle River, New Jersey: Pearson Education

Bhimani, A., Horngren, C.T., Datar, S.M. & Foster, G. (2008). *Management and Cost Accounting* (4th ed.). England: Pearson Education

Blocher, E.J., Chen, K.H, and Lin, TH.W (2002). *Cost Management*; *A Strategic Emphasis*., New York: McGraw-Hill Companies, Inc

Chenhall, R.H, and Langfield-Smith, K. (1998). The relationship between strategic priorities, management techniques and management accounting: An empirical investigation using a systems approach. *Accounting Organizations and Society*, Vol. 23(3), 243-264.

Choo, F. & Tan, K.B. (2011). An income statement approach for cost volume profit (CVP) analysis by using a company's CVP model. *Journal of Accounting & Finance* 11(4), 23-26

Dopuch , N. & Maher, M. W. (2005). Cost-volume-profit analyses. In R.W. Weil and M.W. Maher (Eds.), *Handbook of cost management* (2nd ed.) (645-656). Hoboken, New Jersey: John Wiley.

Drury, C. (2008). *Management and cost accounting* (7th ed.). Andover, Hampshire: Bookpower/South-Western Cengage Learning.

Garrison, R.H. and Noreen, E.W. (2003), "*Managerial Accounting*", McGraw-Hill companies, Inc, New York.

Hansen, D. N. & Mowen, M. M. (2006). *Cost management: Accounting and control*, (5th ed.). Ohio: Thomson South-western

Hillier, F.S. & Lieberman, G. J.(2006). *Introduction to Operations Research* (7th ed.) Burr Ridge, Ill.: McGraw-Hill/Irwin.

Hilton, R. W., Maher, M.W & Selto, F.H. (2006). *Cost Management: Strategies for Business Decisions* (3rd ed.) Burr Ridge, Ill.: McGraw-Hill/Irwin.

Hilton, W. R., Mahar, W. M., & Selto, H. F. (2000). *Cost Management Strategies for Business Decisions*. USA: Irwin McGraw-Hill Inc.

Hongren, C.T., Datar, S.M., & Rajan, M. (2012). *Cost Accounting*; *A Managerial Emphasis*, 14th ed. New Jersey: Pearson Education Inc.

Horngren, C. T., Datar, S. M. & Foster. G. (2003). *Cost Accounting: A Managerial Emphasis* (11th ed). Upper Saddle River, N.J.: Prentice-Hall.

Horngren, T. C, Foster, G. & Datar, M. S. (1999). *Cost Accounting*: *A Managerial Emphasis*. (9th Ed.). New Delhi: Prentice Hall of India Inc.

Horngren, T. C., Foster, G., & Datar, M. S. (2002).*Cost Accounting*: *A Managerial Emphasis*.(10th ed.). New Delhi: Prentice Hall of India Inc.

Kaplan, R.S, and Atkinson, A.A. (1998). *Advanced Management Accounting*. New Jersey: Prentice Hall International.

Kattas, & Lau, (1982). *Cost Management*. London: Macdonald and Evans.

Lucey, T. (1989). *Costing*. (3rd Ed.). Great Britain: DP Publications Ltd.

Lucy, T. (2000). *Management accounting*. London: ELST/ Continuum.

Maher, M.W., Stickney, C. & Weil, R.L. (2006). *Managerial Accounting: Concepts, Methods and Uses*, (9th ed.). Mason, Ohio: Thomson International/South-Western Publishing.

Mclaney, E. and Atrill, P. (2002), "*Accounting: An Introduction*", Pearson Education limited, England.

McWatters, CH., Morse, D. and Zimmerman, J.L. (2001). *Management Accounting: Analysis and Interpretation.* McGraw-Hill Companies, Inc, New York

Okoye, A.E. (2011). *Cost Accounting: Management Operational Applications*, Benin City: United City Press

Weetman, P. (1999), "*Financial and Management Accounting: An Introduction*", Pearson Education limited, England.