A CRITICAL EVALUATION AND TEST OF BREAK-EVEN ANALYSIS AS A TECHNIQUE FOR PROFIT PLANNING

by

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ABSTRACT

This study provides a critical evaluation of break-even analysis in terms of its assumptions and uses and also in terms of the economic theory of the firm in the short and long run and under perfect and imperfect competitive conditions. It also includes a test of the hypothesis that break-even analysis can be better than the percentage of sales method as a technique for forecasting the future operating profits of firms and the null hypothesis that there is no difference between break-even analysis and the percentage of sales method as a technique for forecasting the future operating profits of firms. The test is based on data (without adjustments) from Moody's Industrial Manuals.

Although the break-even approach is more sophisticated and requires more time, effort and expense, the test shows that at the 0.01 level of significance, there is no difference between the accuracy of its forecasts of operating profits and that of the percentage of sales method. The hypothesis is therefore rejected and the null hypothesis accepted. The conclusion drawn from the test is that the management of a firm should not make use of break-even analysis to forecast its operating profits if it is not prepared to make any adjustments to its data to recognise the effects of changes in the determinants (excluding volume) of profits. The percentage of sales method should be used instead.

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CHAPTER I

INTRODUCTION

There has been a great deal of controversy in recent years regarding the objectives of privately operated business organisations. Some people argue that a business organisation ought to have long-run profit maximisation as its sole objective while others argue that the management of a business should not only think of profits but also try to provide satisfaction for the participants in the organisation, take the lead in technological developments and secure social approval.[1] Whatever the arguments, it cannot be denied that, in a free enterprise system, no privately operated business can afford to make less than a 'healthy' profit for any appreciable period of time.

The survival of a business, therefore, depends on the ability of the management to earn, at least, a 'healthy' profit for the business. In order to achieve this, under existing competitive conditions, the management of a business has to provide for proper financial planning and control. In other words, management must be able to plan its profit performance and realise its profit plans to justify its existence.

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1. Assuming no distinction between the management and the owners of a business, it should also be recognised that maximisation of the value of owners' common stocks could be the objective of business.

To do this efficiently, management has developed and adopted various tools.

One of the more basic of these tools is break-even analysis. As will be seen in chapter II, this tool has been used by a fair number of firms as an aid for their financial planning and control. Graphically or mathematically, it permits management to study the probably effects on profits of changes in single financial factors or combinations of them.

Statement of the Problem

Break-even analysis does not provide a completely reliable forecast of future profits. The forecasts are made under a given set of assumptions regarding such factors as production and sales, prices, costs, and sales mix. A change in any of these assumptions will affect the forecast. But, given the assumptions, break-even analysis may show the expected profits at various volumes. Profit, then, becomes a single valued function of volume. If break-even analysis is to be used to give more accurate results, then changes or expected changes not only in volume but also in the other variables which affect profits, must be carefully watched for and adjustments must be made for such changes.

This, however, does not seem to go along well with the advantages of break-even analysis. One of the strongest points of break-even analysis, as a tool for forecasting future profits, is that it is simple, quick and cheap to prepare. But, if a prerequisite to the use of break-even analysis is a forecast of all the variables that affect profits and if adjustments have to be made in break-even analysis on the basis of the results of the forecasts of these variables, then the very advantages of break-even analysis will be defeated.

If, on the other hand, management does not go to the trouble to make the preliminary forecasts and adjustments but merely makes use of break-even analysis to show profit expectations under a specific set of assumptions regarding external market conditions and internal management strategy, then profits will be shown to vary only with volume. But, in break-even analysis, sales revenue is often used as a measure of volume, on the assumption that volume (output) and sales are synchronised. Under the circumstances, the question arises, "Isn't it simpler, quicker and cheaper to determine the average of profits as a percentage of sales for several past years and apply this percentage to arrive at the expected profits for different volume levels?" This method of forecasting profits is known as the percentage of sales method. With this method, the problem of cost separation and a host of other problems do not arise at all.

This study attempts to compare the accuracy of the results of the break-even method with that of the percentage of sales method. On the basis of this comparison, a conclusion will be drawn on the merit of using break-even analysis for forecasting the operating profits of firms and its managerial implications.

Hypothesis and Null Hypothesis

The hypothesis is that break-even analysis can be better than the percentage of sales method as a technique for forecasting the future operating profits of firms. Since break-even analysis is more sophisticated, it is expected that, at worst, it will be as good as the percentage of sales method. Therefore, the possibility that the latter may be better than the former will not even be considered here.

In order to test the hypothesis, firstly, a sample of firms has to be picked since it is not possible to study the performance of the two methods in all firms.[2] Secondly, the average difference between forecast profits and actual profits by each of the two approaches has to be determined and finally a comparison has to be made of the two averages. In establishing the averages, the mean, the median or the mode can be used. In this study, the mean is preferred to the other two measures since it is least subject to sampling variation.[3]

The alternative to the hypothesis is that there is

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2. In chapter IV, an explanation is given of the manner in which random sampling has been used to pick the fifty-seven firms, which form the sample.

3. Frederick E. Croxton and Dudley J. Cowden, Applied General Statistics, 2nd Ed.; Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1955, p. 197.

no difference between break-even analysis and the percentage of sales method as a technique for forecasting the future operating profits of firms. This alternative hypothesis is called the null hypothesis. With the symbol p_1 used to represent the mean difference between actual and forecast profits obtained by the percentage of sales method, and the symbol p_2 used to represent that obtained through break-even analysis, the null hypothesis may then be formulated as $p_1 = p_2$. Since the possibility that the less sophisticated percentage of sales method may prove to be more accurate, has been ruled out on the grounds that it is unlikely to happen, the alternative to $p_1 = p_2$ is $p_1 > p_2$. This alternative implies that the average difference between actual and forecast profits by break-even analysis is smaller and, therefore, the hypothesis as stated earlier, is correct.

From the above discussion, it is obvious that the acceptance of the hypothesis depends on the rejection of the null hypothesis. But, before a decision can be made on the null hypothesis, a test of significance has first to be carried out. The purpose of such a test of significance is to determine whether there is any statistical significance between p_1 and p_2. In order to do this, it is necessary to set a criterion of significance and to determine the probability of z, where z is the ratio of $p_1 - p_2$ to an estimate of the standard error of the difference between the two sample means. The criterion of significance established depends on the type of error that is to be avoided.[4]

In tests of statistical significance, there are two types of errors. A type I error arises when a null hypothesis is actually correct but the difference involved is declared to be significant. A type II error arises when a null hypothesis is actually wrong but the difference involved is declared to be not significant. If the intention is to reduce type I errors to the minimum, then the criterion of significance established should be such that the level of significance is very small. On the other hand, if type II errors are to be reduced to the minimum, then the level of significance ought to be larger. Whether type I or type II errors ought to be minimised depends very much on individual situations and circumstances.

In this study, a type I error would be committed if the difference between the sample means is so small that it can almost be said that there is no difference between them but it is declared that the difference between them is significant. The consequence of this may be that people who would otherwise not use the break-even method to forecast operating profits, may now use the break-even method. The reverse would be true if a type II error is committed. In such a case, the difference between the sample means is actually very large but a declaration is made that the difference is not significant. The result of such an error may be

4. Ibid., p. 640.

that people, who would otherwise make use of break-even analysis to forecast operating profits, may now consider that, after all, it is not worthwhile to go to all the extra effort, time and expense to use the break-even method.

The above discussion suggests that, in this study, it is more serious to commit a type I error since when such an error is committed, extra costs are incurred for which no appreciable benefits are received. A type II error appears to be less serious since it merely results in a loss of benefits, in the form of greater accuracy in the forecast, which can otherwise be obtained. But, at the same time, no extra costs are incurred.[5] In short, this means that in committing a type I error, extra costs are incurred for no appreciable benefits whereas, in committing a type II error, no new benefits are received but no extra costs are incurred.

It was stated earlier that if type I error is to be minimised, then the level of significance ought to be very small. The level of significance that is customarily used is 0.05 or 0.01.[6] In this study, 0.01 will be used. From the t-table in Appendix II, it may be noted that by inter-

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5. It is, however, possible that the loss in accuracy, if measurable in dollar terms, may be large enough to more than offset the extra costs and the ultimate costs of committing a type II error may in fact be higher.

6. John E. Freund and Frank J. Williams, Modern Business Statistics, Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1958, p. 224.

polation, for fifty-seven degrees of freedom, the value of z at the 0.01 level of significance, is 2.667. In this study, a one-tail test is used since the alternative to the null hypothesis that $p_1 = p_2$ is one-sided, i.e. $p_1 > p_2$. With this information, it may be stated that the null hypothesis should be accepted if $z \leqslant 2.667$ and should be rejected if $z > 2.667$. This is the same as saying that the hypothesis, that break-even analysis can be better than the percentage of sales method as a technique for forecasting the future operating profits of firms, is acceptable if $z > 2.667$ and should be rejected if $z \leqslant 2.667$.

Organisation

Chapter I is the introductory chapter to this thesis. Here, the statement of the problem, the hypothesis and the null hypothesis, the limitations of the study, the organisation and the definitions of terms are given. To provide a basis for the critical evaluation of break-even analysis, chapter II is devoted to a factual description of the nature of break-even analysis. Briefly, an idea is given of the extent to which break-even analysis is used, the development of break-even analysis, the break-even chart and the break-even point. An idea is also given of how costs of firms are separated for the purposes of break-even analysis.

Against this background, a critical evaluation of break-even analysis is made in chapter III, in terms of the assumptions used and the uses to which break-even analysis is put. The evaluation is also in terms of the economic theory of the firm in the short and long run and under perfect and imperfect competitive conditions. This chapter and chapter II are based primarily on a close examination of the various publications relating to the analysis of cost-volume profit relationships.

Chapter IV deals with the test of the hypothesis and the null hypothesis, using data taken from Moody's Industrial Manuals. A test of this nature, to be very accurate, requires a very intimate knowledge of the operations of the firms under study. Unfortunately, firms willing to provide such detailed, confidential information are difficult to find. The problem is particularly serious since there are as many as fifty-seven firms in the sample.[7] Under the circumstances, resort has to be made to published data. For the purposes of this study, Moody's Industrial Manuals provide the most detailed, published information and have therefore been chosen as the source of data .

Chapter V provides the summary and conclusion of the study.

Limitations of the Study

In this study, in forecasting profits by the break-

7. A detailed explanation of the estimation of the sample size is given in chapter IV.

even method, no adjustments were made to take into account the effects of possible changes in the determinants of profits. This is due to the fact that the necessary data for such adjustments are not available. It is admitted here that failure to make the adjustments will most certainly reduce the accuracy of the forecasts.

Again, in the break-even method of forecasting operating profits, total costs have to be separated into fixed costs and variable costs. To achieve this, as described in chapter IV, the statistical approach using the method of least squares is used. But, it has been found in preliminary studies that this approach is possible only if the data for the firms show that the firms have experienced losses over some of the periods in the analysis. This drawback can be avoided if the accounting or engineering approach[8] is used, but since the statistical approach is likely to give the most reliable results in terms of the data available, it is preferred to the other two techniques.[9] Hence, the universe of firms, from which the sample is chosen, is restricted to only those firms in Moody's Industrial Manuals, which have had losses at some time in the periods under study. The data of some firms do not appear in Moody's Industrial Manuals for the period prior to 1951. These firms have also

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8. This is explained in chapter II.

9. The data in Moody's Industrial Manuals are not in sufficient detail to enable the use of either the accounting or engineering methods, with reasonably accurate results.

been excluded from the universe.

Definitions

Break-even analysis: Break-even analysis refers to the segregation of all costs, in the short-run, between those that are fixed and those that are variable and to the cost-volume-revenue relationships, which determine the amount of profits at different volume levels.

Break-even point: Break-even point refers to the volume level at which total revenue exactly equals total cost and neither profits nor losses are made. It may also refer to the point of time in the budgetary period when losses turn into profits.

Short-run: The short-run is a time period so short that a firm cannot vary the quantities of some of the resources that it uses. In actual fact, it can legitimately be said that the short-run is any time period between that in which no resources can be varied in quantity and that in which all resources but one are variable. This would be a very broad definition. Throughout this thesis, a more restrictive definition will be used and the short-run concept will be taken to refer to a time period within which a firm cannot alter or add to such items as its capital equipment, buildings, land and top management. These are the firm's short-run 'fixed resources'. The time period, however, will be long enough for the firm to vary quantities of such resources as labour, raw materials and the like. These are the firm's variable resources.

Long-run: The long-run is a period of time that is long enough for a firm to vary quantities of all the resources that it uses. Hence, in the long-run, no problem exists as to whether resources ought to be classified as fixed or variable. All resources are variable.

Fixed costs: Fixed costs may be defined as those costs whose amount is not at all influenced by the level of activity in the short-run and within the expected range of activity. Examples of fixed costs are such payments as rent, the salaries of top management and debenture interest. In terms of the definition of the short-run, given above, fixed costs are the costs of fixed resources.

Variable costs: Variable costs may be defined as those costs, whose amount is a function of activity, increasing or decreasing in the same direction as increases or decreases in the level of activity. Examples of variable costs are payments for 'piece rate' wages, raw materials, fuel and power and transportation. In terms of the definition of the short-run, given above, variable costs are the costs of variable resources.

Explicit costs: The explicit costs of a firm are the explicit payments for resources bought outright or hired by the firm. Examples of explicit costs are the firm's payroll, payments for raw and semi-finished materials and payments for overhead costs of all kinds.

Implicit costs: The implicit costs of a firm are the costs of self-owned, self-employed resources. Examples of implicit costs are the returns to labour provided by the owner himself (implicit wages) and the returns to the land and capital, which are provided by the owner himself rather than hired from outside owners (implicit rent and interest).

Margin of safety: Margin of safety refers to the excess of actual (or budgeted) sales over the break-even sales volume.

Operating costs: The operating costs of a firm are the costs incurred by the firm in conducting its regular major activities. They include the costs of goods sold, commercial costs, interest and depreciation and amortization. But, they exclude all other costs which are not subject to the controls exercised through everyday operating procedures. Hence, income taxes, losses from sales of plants and other property disposals, losses on foreign exchange and flood, fire and other extraordinary losses are excluded.

Operating revenue: The operating revenue of a firm refers to the gross revenue or gross sales from the firm's regular major activities less returns, allowances and cash discounts.

Operating profits: The operating profits of a firm are the excess of the operating revenue over the operating costs. If operating costs exceed operating revenue, the excess is called operating losses.

Summary

In this chapter, an attempt has been made to bring out the purpose of this study, its limitations and its organisation. The hypothesis and null hypothesis have also been discussed in detail and the definitions of some of the more important terms in this thesis have been given. The nature of break-even analysis is presented in the next chapter.

CHAPTER II

THE NATURE OF BREAK-EVEN ANALYSIS

Introduction

The term, 'break-even' has become a part of the standard vocabulary of economists, accountants and managers in general. Each of these three classes of people have contributed in no small way to the increasing popularity of this subject in recent years. In fact, it may be said that, today, the best discussions on break-even analysis are to be found in economics, accounting and management books and journals. But, although a great deal of attention has been given to this subject, there is still some vagueness as to what the area involves. To many people, when break-even analysis is mentioned, the first thing that comes to mind is a simple cross-over chart, indicating total sales revenue and total costs, with the cross-over point representing the break-even point. In reality, break-even analysis is more than the mere determination of the volume level at which revenue equals cost. Rather, it exposes the effect on profits resulting from the interplay of such factors as prices, costs, volume and product mix.

Use of Break-Even Analysis

To date, very little has been done to determine the extent to which firms are using break-even analysis. The study carried out for the Controllership Foundation, Inc. in 1958 by two professors, Burnard Sord and Glenn Welsch of the University of Texas, is probably the only published study relating to the extent to which break-even analysis is used.[1] In this study, personal interviews were held with 35 leading companies in Canada, the District of Columbia and 13 other states in the United States. It was found that forty per cent of the companies did not prepare break-even analyses, while thirty-seven per cent of the companies prepared break-even analyses at regular intervals (Table I). The remaining twenty-three per cent of the companies prepared break-even analyses only periodically and as a part of special studies.

In the same study, questionnaires were also mailed out to 389 other companies, out of which 344 responded. As Table II shows, fifty per cent of the 344 respondents were making use of break-even analyses. The study also tried to determine the frequency of preparation of break-even analyses and the types of break-even analyses used. The details are given in Tables I and II.

<u>The Development of Break-Even Analysis</u>

The concept of break-even analysis was probably

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1. Burnard H. Sord and Glenn A. Welsch, <u>Business Budgeting</u>, New York: Controllership Foundation, Inc., 1958, pp. 281-284.

TABLE I

Number and Percentages of Companies Interviewed Indicating Various Types and Frequencies of Break-Even Analysis

Preparation of Break-Even Analysis	No. of Companies	Per Cent of 35 Companies
Prepare break-even analysis at regular intervals	13	37
Prepare break-even analysis periodically as a part of special studies	8	23
Do not prepare break-even analysis	14	40
	35	100

Frequency of Preparation of Break-Even Analysis	No. of Companies	Per Cent of 21 Companies using B-E Analysis
Prepare monthly	3	14
Prepare semi-annually	1	5
Prepare annually	9	43
Prepare periodically	8	38
	21	100

Types of Break-Even Analysis*	No. of Companies	Per Cent of 21 Companies using B-E Analysis
Prepare for company as a whole	13	62
Prepare for various divisions	11	52
Prepare for plants	5	24
Prepare for product lines	9	43
Prepare for branches or territories	3	14

*The number of companies does not total 21 and the percentages do not total 100 because some companies use more than one type of break-even analysis.

Source: Burnard H. Sord and Glenn A. Welsch, Business Budgeting, New York: Controllership Foundation, Inc., 1958, p. 282, Table 83.

TABLE II

Number and Percentage of Companies Answering Questionnaires Indicating Types and Frequency of Preparation of Break-Even Analysis as Reported by 344 Companies

Use of Break-Even Analysis	No. of Companies	Per Cent of 344 Companies
Companies using break-even analysis	175	51
Companies not indicating the use of break-even analysis	169	49
	344	100

Frequency of Preparation	No. of Companies	Per Cent of 175 Companies using B-E Analysis
Prepare monthly	45	13
Prepare quarterly	7	2
Prepare semi-annually	1	*
Prepare annually	106	31
Prepare as needed	51	15
No indication as to frequency of preparation	134	39
	344	100

Types of Break-Even Analysis**	No. of Companies	Per Cent of 175 Companies using B-E Analysis
Prepare for company as a whole	182	53
Prepare for various divisions	147	43
Prepare for plants	106	31
Prepare for product lines	134	39
Prepare for sales branches	24	7

*Less than one per cent.

**The number of companies does not total 344 and the percentages do not total 100 because some companies use more than one type of break-even analysis.

Source: Burnard H. Sord and Glenn A. Welsch, Business Budgeting, New York: Controllership Foundation, Inc., 1958, p. 282, Table 83.

conceived as a result of attempts by university teachers and businessmen to develop tools to provide a scientific approach to business.[2] Very little is known about the early stages of the development of this tool. Some writers[3] have tried to throw some light on this area but views tend to conflict.

The first attempt to separate costs into their fixed and variable components was made in 1832 and the man who, supposedly, holds the distinction of having made that attempt is a certain Charles Babbage.[4] To the extent that the separation of costs is the basis of break-even analysis, it may be said that Charles Babbage made the first contribution to the development of break-even analysis. But anything close to the formulas or charts that are used in break-even analysis today, was not known till 1897 when Henry Hess wrote on "Time Saving and Its Relation to Profits" in Volume XX (Dec. 16, 1897) of the Engineering Magazine. In December, 1903, Henry Hess contributed another article, "Manufacturing: Capital, Costs, Profits, and Dividends", to the Engineering Magazine (Volume XXVI) and, in this article, he included charts which are quite similar to those used in break-even

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2. Sord and Welsch, op. cit., p. 281.

3. Ned Chapin, "The Development of the Break-Even Chart: A Bibliographical Note", Journal of Business, Vol. XXVIII, No. 2, April 1955, pp. 148-149.
Raymond Villers, "Communications - The Origin of the Break-Even Chart", Journal of Business, Vol. XXVIII, No. 4, Oct. 1955, pp. 296-297.

4. Villers, ibid., p. 296.

analysis today, although he did not designate his presentation as break-even charts.[5]

During the period just prior to World War I, two other industrial engineers, Walter Rautenstrauch and C. E. Knoeppel, were prominent in the development of the break-even chart. Rautenstrauch was the first to use the name, 'Break-even charts'.[6] This terminology is, today, universally accepted. It might also be mentioned that in Rautenstrauch's charts, the functional relationship between costs and volume was brought out, for the first time. Such a relationship was never depicted in the charts Henry Hess used.[7]

The Break-Even Chart

The break-even chart is a portrayal in graphic form of the relationship of production, costs and sales to profit. It shows the amount of fixed and variable costs and the sales revenue at different levels of operation. Various names have been given to this chart. It is sometimes known as a crossover chart, a profit realisation chart or a profitgraph.

The break-even chart may be plotted in several different forms, depending on the kind of information desired.

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5. Chapin, op. cit., p. 149.

6. Villers, loc. cit.

7. Ibid., p. 296-297.

The details of these charts may vary but the underlying principles are all the same. Some are quite simple, consisting of a line or two, while others are quite complex, with many lines and legends. In essence, they all interrelate sales, variable costs, fixed costs and volume level in a form considered most helpful to the user.

Since they are all basically the same, they will not be described here individually. Only the conventional break-even chart and the profit/volume chart will be examined, since reference will be made specifically to them in later chapters. In the conventional break-even chart (Exhibit I), the total cost line, at the lower extremity, cuts the Y axis at the point where costs are fixed and volume (production or sales) is equal to zero. From this point, it slopes upwards to the right. Revenue is also represented by a linear line which originates at the zero interception of the Y and X axes and slopes upwards to the right; it is often presented as a 45 degree line, with the horizontal and vertical axes having the same scales and on the assumption that production is equal to sales and selling price is fixed for all levels of sales. The point at which the total revenue line crosses the total cost line is the break-even point and, at this level of production and sales, the firm allegedly will have neither net profit nor net loss.

A somewhat simpler graphic presentation of the

EXHIBIT I

CONVENTIONAL BREAK-EVEN CHART

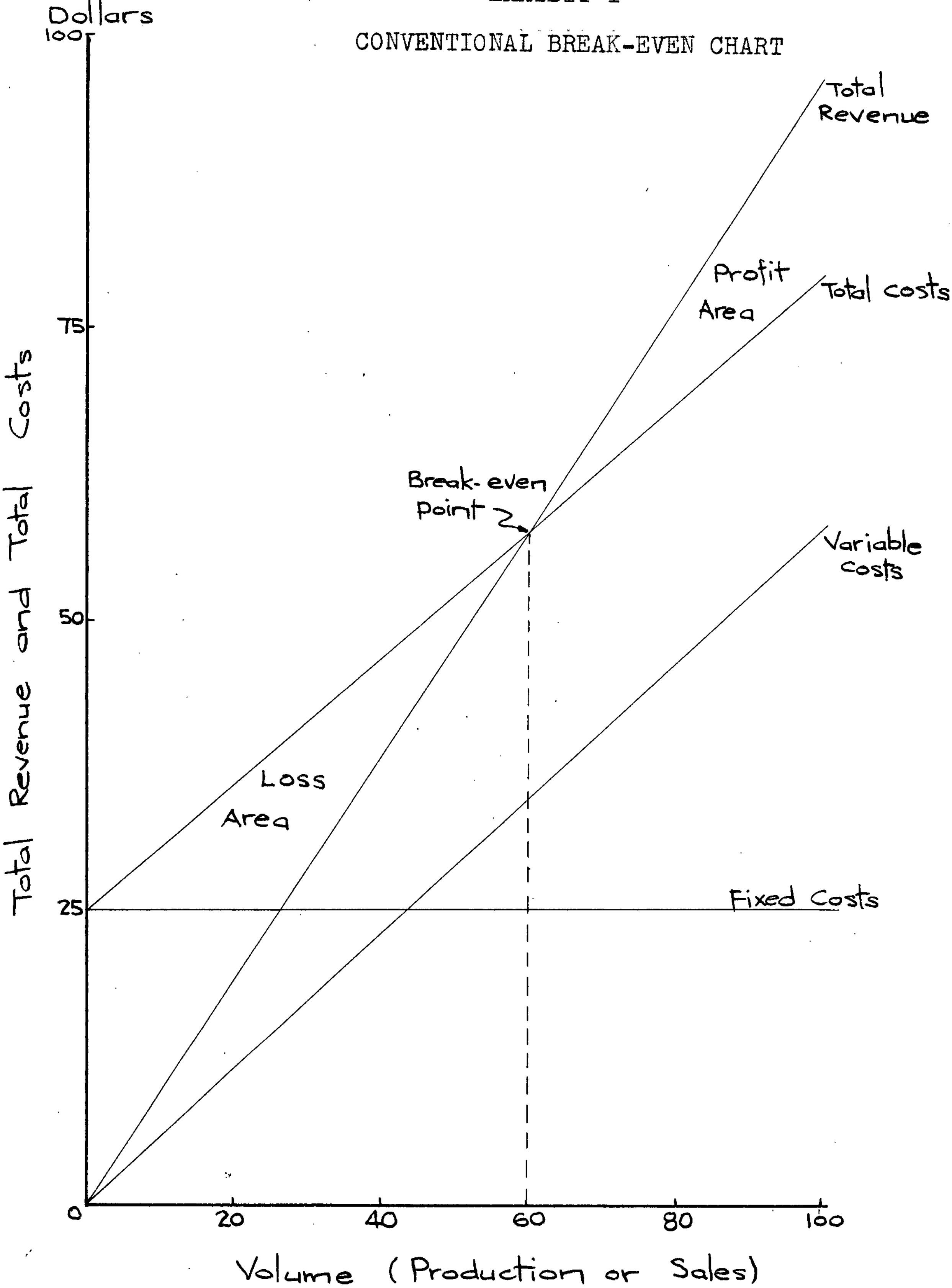
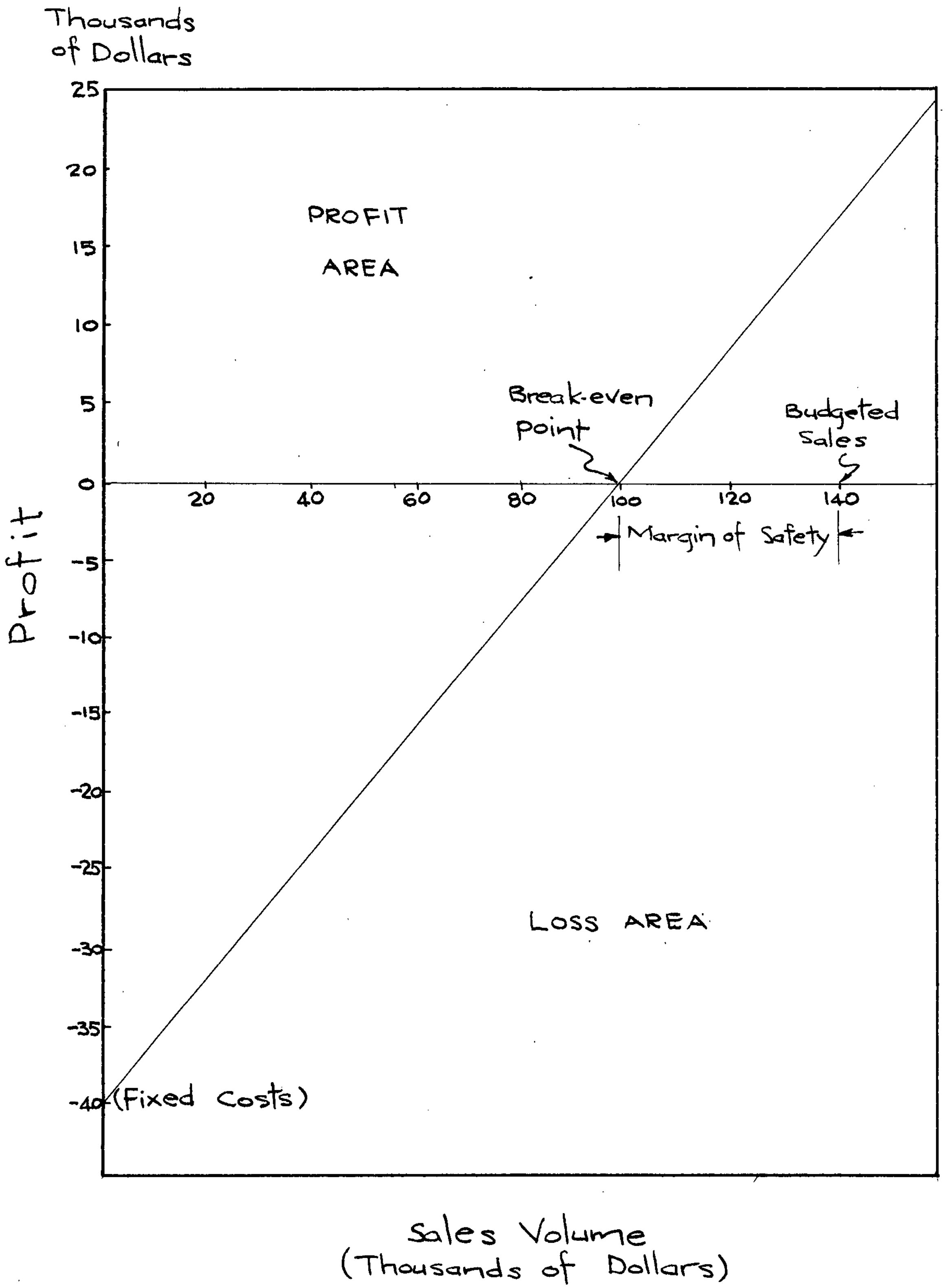


EXHIBIT II

A PROFIT/VOLUME CHART



relationship between profits and volume is the profit/volume chart. It is sometimes referred to as a profitgraph, a marginal income chart, or a profit-volume analysis graph. It is said to have been developed by C. E. Knoeppel.[8] Although profit/volume charts are generally simpler than break-even charts, they are not always preferred to break-even charts because they do not show the relationships between costs, revenue and volume. Nickerson, however, argues that since profit is the residue of cost and revenue, profit/volume charts, therefore, really reflect cost-volume-revenue relationships.[9]

The profit/volume chart indicates the path of profit and consists of two areas, the profit area and the loss area, both of which are created by the horizontal axis which represents the total sales volume. The loss area is composed of the fixed costs which is marked off on the vertical axis. The profit area indicates the amount of profit earned as the profit line passes over the horizontal axis. The points of the profit line are computed by

8. Knoeppel explained the reason for its development as follows: "So far the financial statement has been a financial tool rather than a management tool. It is a historical document and not in the least prophetic. It is static rather than dynamic. It performs only a part of the function of which it is capable. Few accountants have crossed the line between accounting and engineering, while many engineers have jumped the fence between the two" - C. E. Knoeppel and Edgard C. Seybold, Managing for Profit, New York: McGraw-Hill Book Company, Inc., 1957, pp. 53-54.

9. Clarence B. Nickerson, Cost Accounting, Toronto: McGraw-Hill Book Company, Inc., 1954, p. 272.

subtracting from sales income the total costs indicated for each sales volume.[10] The break-even point is the point at which the profit line intersects the horizontal axis.

The Break-Even Point

Various definitions have been advanced for the break-even point. Generally, it may be said that the break-even point is the volume level at which total revenue exactly equals total cost and neither profits nor losses are made. Other definitions are merely variations. Mathematically, the break-even point can be determined by using the following equation:

$$\text{Break-even point} = \frac{\text{Fixed Costs}}{1 - \dfrac{\text{Variable Costs}}{\text{Sales}}}$$

To illustrate, the following budget data of a fictitious company, the ABC Company, may be used.

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10. The slope of the profit line is also equal to the profit-volume (P/V) ratio, which is the rate at which profit increases with increases in volume and is given by the formula:

$$\frac{P}{V} = 1 - \frac{\text{Variable Costs}}{\text{Sales}}$$

$$\text{or} \quad \frac{P}{V} = \frac{\text{Sales - Variable Costs}}{\text{Sales}}$$

$$\text{or} \quad \frac{P}{V} = \frac{\text{Fixed Costs + Profits}}{\text{Sales}}$$

The profit-volume ratio is sometimes called the marginal income ratio or variable profit ratio.

Annual Profit Plan - ABC Company

	Fixed Costs	Variable Costs	
Budgeted Sales (200,000 units @ $15.)			$3,000,000.
Budgeted Costs:			
Direct Material		$500,000.	
Direct Labour		550,000.	
Factory Overhead	$450,000.	200,000.	
Administration Expenses	425,000.	100,000.	
Distribution Expenses	325,000.	150,000.	
	$1,200,000.	$1,500,000.	
Total			2,700,000.
Budgeted Profit			$ 300,000.

If the above data is applied to the break-even point equation given earlier, the result will be as follows:

$$\text{Break-even point} = \frac{\$1,200,000.}{1 - \frac{\$1,500,000.}{\$3,000,000.}} = \frac{\$1,200,000.}{1 - \frac{1}{2}}$$

$$= \$2,4000,000.$$

Since the cost of each unit is equal to $15, therefore,

$$\text{Break-even point} = \frac{\$2,400,000.}{\$15.}$$

$$= 160,000 \text{ units}$$

It is claimed that the break-even point is useful partly because it is a prerequisite to the determination of the margin of safety, which is the excess of actual or budgeted sales over the break-even sales volume. Expressed as a percentage, it is equal to sales above the break-even point divided by sales (actual or budgeted) multiplied by 100. The amount or the percentage indicates to what extent sales revenue may drop before losses begin. It is obvious that the higher the margin of safety, the better is the position of the firm. It often pays management to determine the margin of safety at the average volume over a business cycle. A low margin often spells danger. The low margin may be due to the fact that the break-even point is too high and since high fixed costs is an important cause of high break-even points, the remedy may be a reduction of the fixed costs over the long run. But, Bruce Willis warns that the blame should not be put on fixed costs without a careful study.[11] He suggests that inefficient production, inadequate pricing and ineffective selling techniques may be the cause of the poor performance.

Another usefulness of the break-even point follows from its very definition. As was stated in Chapter I, the break-even point may also be defined as the point of time in the budgetary period when losses turn into profits. Hence, the break-even point may be used to indicate the point of time in the budgetary period when contributions to profits begin. It may also be used to indicate the portion of the budgetary period that remains for the accumulation of the contributions to profits.

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11. Bruce C. Willis, "The Use of Break-Even Analysis in Management," Canadian Chartered Accountant, Vol. 73, Dec. 1958, p. 526.

Although the break-even point may have some usefulness, its determination should not be over-emphasised. It should always be remembered that it does not remain fixed at all times, for any particular enterprise, but varies from time to time as the factors affecting it undergo change. Howard Stettler, a professor of Business Administration in the University of Kansas states that:

> Although statistical confirmation is not available, there appears to be considerable justification for concluding that most people who are familiar with break-even charts and the analysis of break-even information assume that the reason for seeking such information is to determine the break-even point for all or some segment of a profit-making enterprise. True, break-even analysis is capable of living up to its name and showing the volume level at which expenses and revenues are equal, but if, as contended, this is the only use generally made of such information, the use is not only deficient, but may involve an actual disservice as well.[12]

It must also be stressed that the break-even point is, at best, only an approximation because of the many restrictive assumptions that have to be made in its computation.[13] Under the circumstances, even the appropriateness of the term, 'break-even point' is questionable. The word, 'point', carries the connotation of great exactness. A better term might be 'break-even area' to indicate that the

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12. Howard F. Stettler, "Break-Even Analysis: Its Uses and Misuses", Accounting Review, Vol. 37, July 1962, p. 460.

13. This is discussed in Chapter 3.

precise location of the break-even volume is not known and can be estimated only roughly.

Cost Breakdown

From the discussion so far, it may already be evident that cost behaviour constitutes the central problem in break-even analysis. If costs cannot be classified as fixed or variable, no break-even chart can be constructed. This can easily be explained. If all costs are variable, there cannot be any break-even point so long as the total revenue and the total costs are represented by straight lines, starting from the intersection of the X and Y axes. The two lines will never intersect to provide a situation whereby losses turn into profits or whereby profits turn into losses. At the same time, all costs cannot be fixed because this would be an unrealistic situation. Therefore, total costs have to be separated into their fixed and variable components.

Fixed costs may be defined as those costs whose amount is not at all influenced by the level of activity in the short-run and within the expected range of activity. On the other hand, variable costs may be defined as those costs, whose amount is a function of activity, increasing or decreasing in the same direction as activity. The change in the total variable costs may or may not be proportional to the change in the level of activity. However, it is usually assumed in conventional break-even analysis that straight line relationships exist and, consequently, it is not uncommon to find variable costs being defined as those costs which increase or decrease proportionately with increases or decreases in volume.[14]

The assumption of linearity is justified if the change in output is not too great - assuming that there is no change in technology and advertising and sales promotion are absent. If output changes are too large, the variable costs may not be linear (constant per unit). This could be caused by changing prices or increasing or diminishing returns. This follows from the fact that, with a large change in the demand for factors of production, the prices of the factors of production may also change and this may result in a change in the variable costs per unit. Further, the level of efficiency at which variable resources work, may differ when different amounts of them are used with given quantities of the fixed resources. The increasing or diminishing returns that result may also change the average variable costs. This will be explained in greater detail in chapter III.

In our definition of fixed costs, reference was made to the 'short run' which may be defined as a period of time within which a firm cannot alter or add on to items such as its capital equipment and buildings. It now becomes clear that the classification of costs into fixed and variable

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14. Paul Yacobian, "A Practical Evaluation of Break-Even Analysis", N.A.A. Bulletin, Vol. 40, Sec. 1, Jan. 1959, p. 24.

categories is possible only when the time period is specified. If a sufficiently long time period is provided, almost all costs become variable through changes in the scale of the firm's operations. The fixed-variable distinction is generally also based on the assumption that volume will move within a certain expected range of activity,[15] because movements outside this range would be accompanied by changes in the so-called fixed costs.

Some writers, however, are not too happy about the classification of costs as fixed or variable. In most cases, the various writers are prepared to accept the idea that variable costs vary in direct proportion to the rate of activity. It is the non-variable costs that have caused disagreement among the writers. In at least one case, the disagreement is nothing more than a question of semantics. Gardner is against the use of the word, 'fixed'. He argues that this word is psychologically unfit to describe costs which do not vary with volume but, which vary with time.[16] He suggests that a better word for such costs would be 'stand-by' costs.[17]

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15. This is the range of activity which management expects to handle with the equipment and organisation provided for in the budget.

16. Fred V. Gardner, Profit Management and Control, New York: McGraw-Hill Book Company, Inc., 1955, p. 28.

17. The same costs are also known as period costs or time costs since they are a function of time or capacity costs since they represent the costs of providing the capacity to do business.

Writing in the Harvard Business Review in 1954, he states:

> To me, the term fixed cost is very unsatisfactory, because no cost is really fixed; I prefer to label expenditures that continue regardless of production level as stand-by costs.[18]

This view seems to be in line with the advice given by Wally George about thirteen years earlier. In 1941, George had given the following advice:

> Regard no costs as fixed or sacred. From thirty to fifty percent of 'fixed cost' is generally subject to management control.[19]

Apparently, Gardner is only quarrelling with the choice of words. What he prefers to call stand-by costs are essentially the same costs as those commonly referred to as fixed costs. There are, however, more serious disagreements over the problem of non-variable costs. In one approach,[20] it has been suggested that the term, 'fixed costs' be replaced by the term, 'constant costs' to be made up of fixed costs and regulated costs. In this case, fixed costs would refer to costs which are fixed and beyond the control of management at a moment in time (for example, the salary of sales-

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18. Fred V. Gardner, "Break-Even Point Control for Higher Profits", Harvard Business Review, Vol. XXXII, Sept.-Oct. 1954, p. 124.

19. Wally E. George, "How to Control Your Break-Even Point", Factory Management and Maintenance, Oct. 1941, p. 87.

20. "How to Tell Where You Break-Even", Fortune, February 1949, p. 83.

men), while regulated costs would refer to costs which, though fixed, are nevertheless subject to the discretion of management (for example, the bonus given to salesmen). This kind of approach seems to agree with the advice given by Wally George in 1941.

As of today, a great deal has already been written in textbooks and journals about the inappropriateness of the term, 'fixed costs'. In the years to come, there is no doubt that even more will be written about it. Admittedly, it is not the ideal term to describe the kind of costs to which it refers. But, its critics should realise that it, nonetheless, is perhaps a better term than any that they can suggest, to the extent that it has the advantage of widely established usage.

In the past, many people were dissatisfied with the classification of costs into fixed and variable. Today, many people are still dissatisfied with this classification. In the years to come, more people may join the ranks of this dissatisfied group. It is true that the classification of cost behaviour in this way is far from being perfect; but, it is also true that for years, costs have been classified in a similar way for budgeting purposes and although the techniques used in the separation were simple ones, the ultimate results have been quite satisfactory.[21] There is no doubt that the alarm raised

21. William J. Vatter, "Accounting Measurements of Incremental Cost", Journal of Business, Vol. XVIII, No. 1, Jan. 1945, pp. 147-148.

is not a false one. But, the intensity of the excitement is perhaps greater than is warranted by the nature of the problem.

In break-even analysis, it is assumed that it is reasonable to classify costs as fixed or variable. This brings us to the problem of semi-variable costs. Such costs vary with volume though not in direct proportion to it. They possess the characteristics of both fixed and variable costs and are sometimes called fixed-variable costs or semi-fixed costs. Examples include items such as supervision, power and maintenance costs. In break-even analysis, one is faced with the problem of separating these costs into their fixed and variable components. One way out of this problem is to measure the variability of these costs.

Generally, there are three approaches to the measurement of cost variability. They are:

(a) The Accounting Approach - Inspection of accounts.

(b) The Statistical Approach- Statistical analysis of historical costs.

(c) The Engineering Approach- Industrial engineering studies.[22]

The accounting approach is, by far, the simplest of the three. It also requires the least time. By this

22. Joel Dean, "Methods and Potentialities of Break-Even Analysis" in David Solomons (ed.), Studies in Costing, London: Sweet & Maxwell, Ltd., 1952, pp. 232-233.

method, a careful study has first to be made of the chart of accounts. On the basis of this study, costs which are either fixed or wholly variable, are then picked out, leaving behind the so-called semi-variable costs. The statistical technique and/or the engineering technique may then be applied to the semi-variable costs to separate their fixed and variable components. It is obvious that the accounting approach requires a thorough knowledge of the behaviour of the costs in each of the accounts. Unless a fairly complete knowledge of the operations and activities of the enterprise is obtained beforehand, the results arrived at, by using this method, may be misleading. In any case, the very fact, that this approach requires the exercise of judgement, means that it is far from being an infallible one.

The statistical approach, involving the statistical analysis of historical costs is probably more thorough and scientific than the accounting method. But, unless computers are used, it can also be more time consuming and expensive. It can be carried out by using statistical correlation techniques which relate each cost component to some measure of activity. The best example of this approach is the scatter chart technique under which the historical cost and volume (production or sales dollars as a measure of activity) during each of several past months or years are plotted on a chart with volume as the horizontal axis and costs as the vertical axis. Depending on the pattern formed by the grouping of the points plotted, a line may then be fitted through the points, either by the simple and practical method of inspection or by the more scientific method of least squares, to illustrate the usual behaviour of the costs at various volumes (Exhibit III).[23] The point (above the intersection of the horizontal and vertical axes), at which this line cuts the vertical axis, represents the fixed costs i.e. those costs not affected by any changes in volume. A horizontal line may then be drawn through this point to reflect the fixed costs.

Another statistical technique is the high-low points method. In this method, the periods with the highest and lowest volumes are first selected. Then, the differences in the volumes of the two periods are related to the differences in the costs of the two periods, to give the cost variability pattern. This method is almost as simple as the method of inspection, but it is very seldom used because it is extremely vulnerable to random variations in costs. Unusually high or low cost figures may distort the whole picture since only the extremes are considered in this method.

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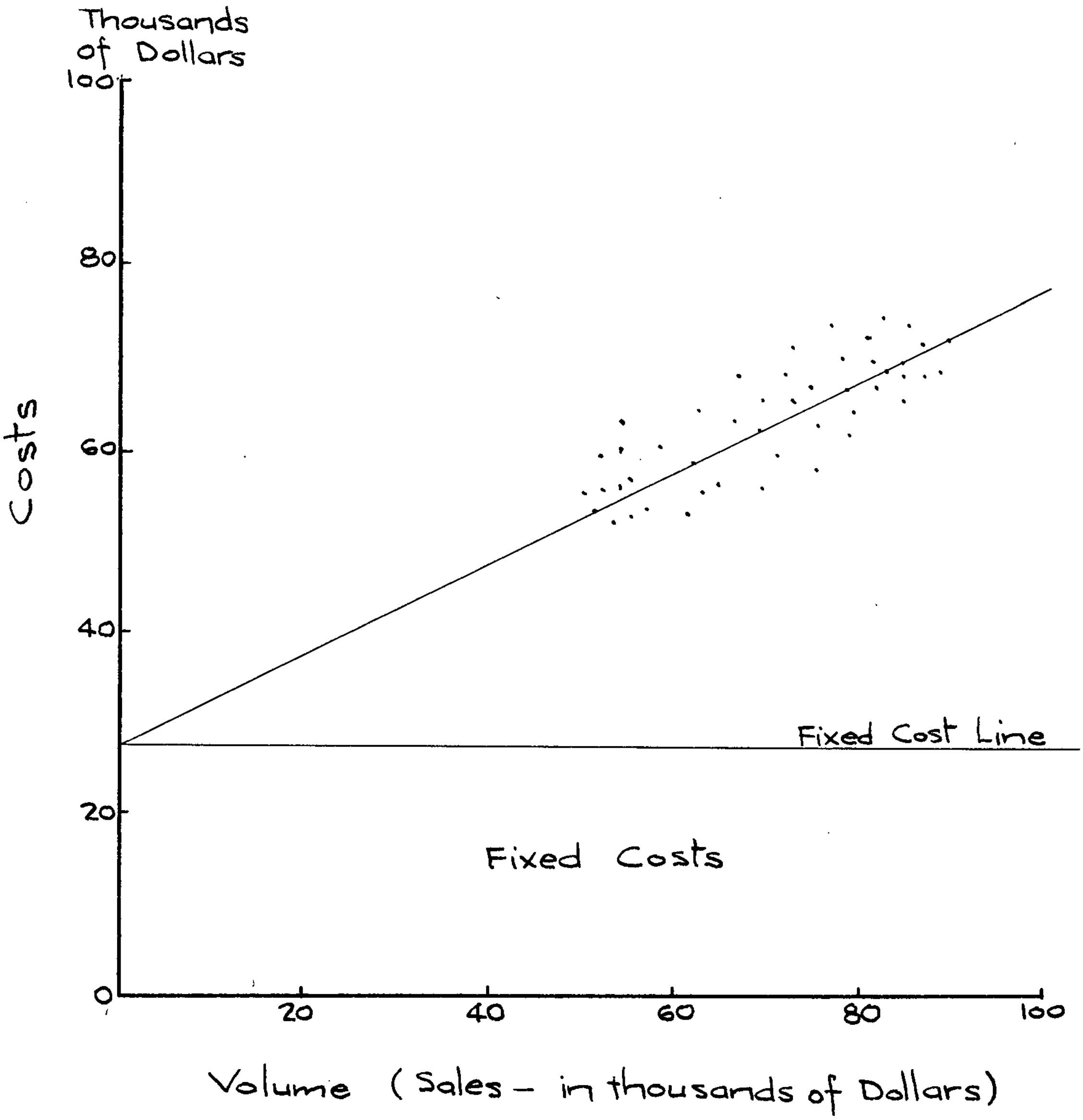
23. This is explained in greater detail in chapter IV, which describes a study of 57 firms in North America to determine the extent to which break-even analysis is useful as a tool for forecasting operating profits. In this study, the statistical approach is used to separate the costs and the least squares method is used to fit the line through the points in the scatter charts.

EXHIBIT III

A SCATTER CHART



The main difficulty with the statistical approach is that historical cost data often show poor correlation with volume. This is so mainly because costs often vary not solely because of volume but also because of many other factors. These factors include changes in plant, equipment, materials used, methods of manufacturing, personnel, working hours, factor prices and managerial policy. In studying cost behaviour for purposes of break-even analysis, it is necessary to assume that these non-volume factors, which affect costs, will remain constant.

The engineering approach is the only feasible method, when historical data are unavailable or too unreliable but it can also be used for supplementing statistical or accounting analysis when it is desired to project cost behaviour beyond the range of past output experience or when it is necessary to estimate the effect of major changes in technology or plant size upon cost behaviour over a familiar or unfamiliar output range. In essence, this method attempts to determine the physical inputs necessary to achieve certain levels of output and then convert these to dollars at current or anticipated prices. The superiority of this method lies in the fact that it attempts to work with relationships between various physical inputs and the volume of activity rather than with observed historical patterns, which may be distorted by certain non-volume factors. However, like the statistical approach, it also can involve very high expenses. In addition, it suffers from the drawback that the practical feasibility of its estimates cannot be pretested.

These three approaches to the measurement of cost variability are not necessarily mutually exclusive. In fact, it is often a good practice to use them to supplement each other.[24]

Summary

Break-even analysis does not merely involve the determination of the break-even point. It also shows the effect on profits resulting from the interplay of such factors as prices, costs and volume. Although there is very little agreement among writers regarding the development of break-even analysis, it may generally be said that Charles Babbage, Henry Hess, Walter Rautenstrauch and C. E. Knoeppel were the pioneers. Henry Hess was responsible for the basic idea of the break-even chart but its universally accepted terminology has been credited to Professor Rautenstrauch.

The break-even chart is basically a portrayal in graphic form of the relationship of production, cost and sales to profit, though it may be plotted in several different ways. In this chapter, only the conventional break-even chart and the profit/volume chart have been presented.

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24. Dean, op. cit., p. 231.

In the discussions on break-even charts, in later chapters, reference will be made mainly to these two charts.

In any break-even chart, there must be a break-even point, which may be defined as the volume level or point of time in the budgetary period when losses turn into profits. The break-even point is useful because it is a prerequisite to the determination of the margin of safety, which is a useful reference device for action. It is also useful because it indicates the point of time in the budgetary period when contributions to profits begin. However, it must be realised that the break-even point is not as exact as its name implies and that it does not remain fixed at all times. Therefore, its usefulness should not be overemphasised.

One of the most important steps in break-even analysis is the classification of costs as fixed or variable. Three approaches may generally be used. They are the accounting, statistical and engineering approaches. Of these three, the statistical method is likely to give the most reliable results in terms of the data available and will be used in the test, which will be described in chapter IV.

From the facts that are presented on break-even analysis in this chapter, a critical evaluation of break-even analysis is made in the next chapter.

CHAPTER III

A CRITICAL EVALUATION OF BREAK-EVEN ANALYSIS

Introduction

In chapter II, the nature of break-even analysis was given and some of the methods of separating the total costs of firms were presented. In this chapter, a critical evaluation of break-even analysis is attempted in terms of the economic theory of the firm in the short and long run and under perfect and imperfect competitive conditions. The assumptions which are used in break-even analysis and the uses to which break-even analysis may be put are also discussed.

Static Analysis

The reliability of break-even analysis is dependent upon reasonably accurate portrayals of cost behaviour, which are affected by the interplay of a number of factors. These factors, as was discussed in chapter II, are constantly changing as management seeks to improve profits. Break-even analysis attempts to arrest the motion of these dynamic forces by assuming that all of them, except volume, will remain constant during the period in which the analysis will be used. Hence, break-even analysis assumes a static analysis, being a picture of relationships which prevail only under one set of assumptions.

Since static assumptions underlie the construction of break-even charts, certain cautions have to be observed in the use of these charts. To begin with, the positions of the lines on the charts are reliable only within the range of normal volume fluctuations i.e., the relevant range which was the basis for drawing the charts.[1] Thus, it would be more realistic if the lines on break-even charts were not extended back to the origin but instead were drawn as illustrated in Exhibit IV.

The revenue-cost relationships may be valid within the relevant range of volume but the same relationships are unlikely to persist if volume falls outside the limits of the relevant range. An extreme reduction of volume may cause management to reduce many fixed costs. For example, executive salaries may be reduced or excess plant and equipment may be sold to reduce depreciation, insurance and property taxes. By such actions, the break-even point is lowered. A large increase in volume has the opposite effect because costs which are fixed within the normal range of volume will be increased. As examples, additional supervisors and clerks are often added and more machinery and equipment might be bought.

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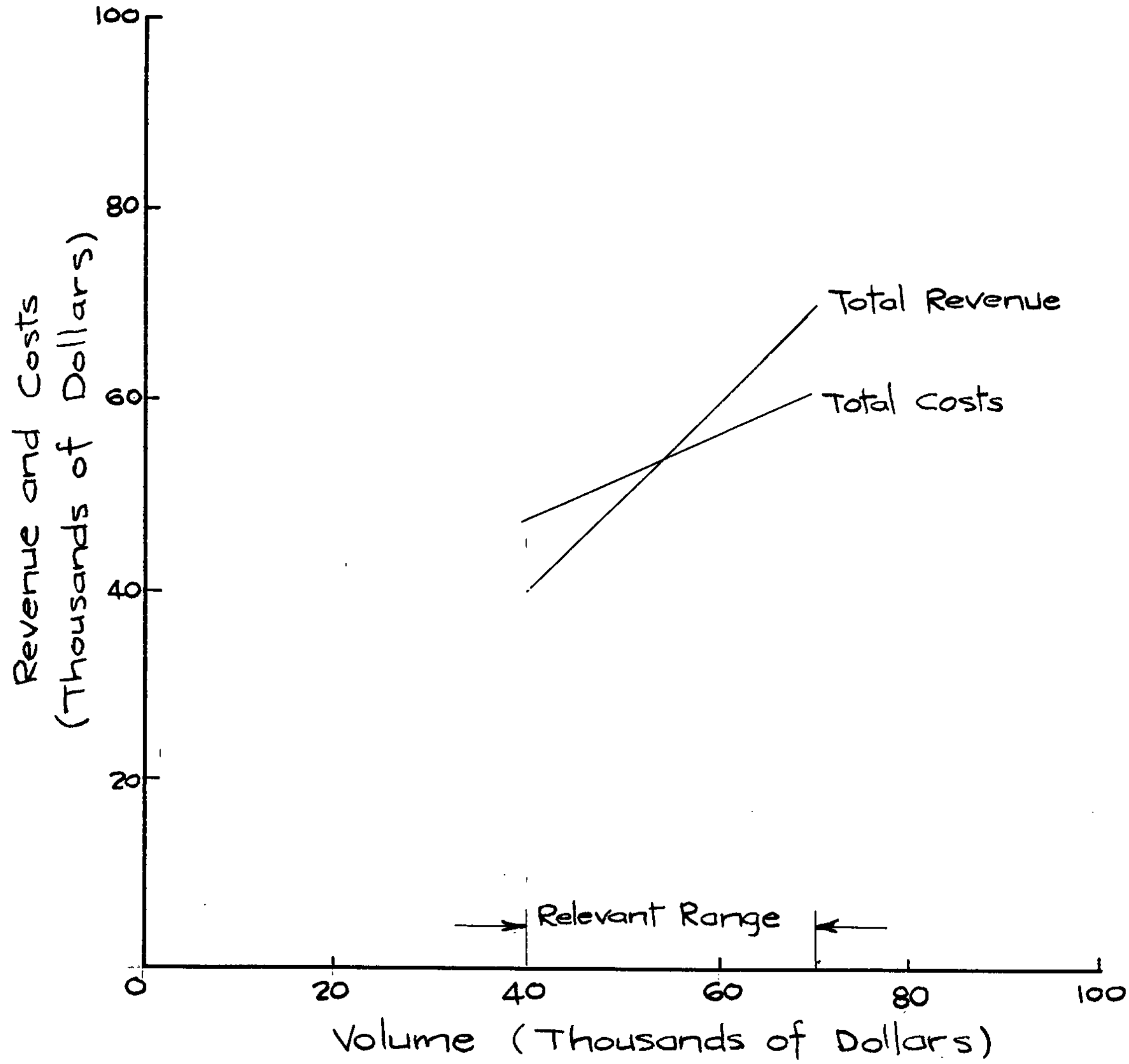
1. It is true that even within this range, the effects of the dynamic forces may be felt, but as will be pointed out later in the chapter, research studies have shown that, within this range, total variable costs increase at a constant rate and prices are unlikely to change since firms tend to feel that their customers prefer stable prices.

EXHIBIT IV

MODIFIED CONVENTIONAL BREAK-EVEN CHART



A Short-Run Concept

The static situation that break-even analysis assumes cannot exist for long periods of time because the longer the period covered in the projection, the less reliable is the forecast of revenue and costs. In the short-run, it may be true that there exists a unique functional relationship between the profits of a firm and its volume and that, given the volume, the corresponding level of profit could be determined. But, this is progressively less true as the time period increases because, realistically, profit is dependent on a great many other factors, apart from volume and, in the long-run, dynamic forces continually work to shift and modify these other factors as well as volume. It, therefore, becomes clear that break-even analysis is essentially a short-run concept and is more useful in short-run, as opposed to long-run, financial planning. In fact, if a long-run concept is attached to break-even analysis, its usefulness immediately becomes dubious. Professor Neuner states that:

> Break-even analysis and charts must be kept current and not attempt to reflect probable operating circumstances over a period longer than a year because not only the mixture of variable cost and income elements may change but also fixed costs gradually shift over extended periods of time.[2]

Linear and Curvi-Linear Charts

There is an interesting and perhaps deceptive resem-

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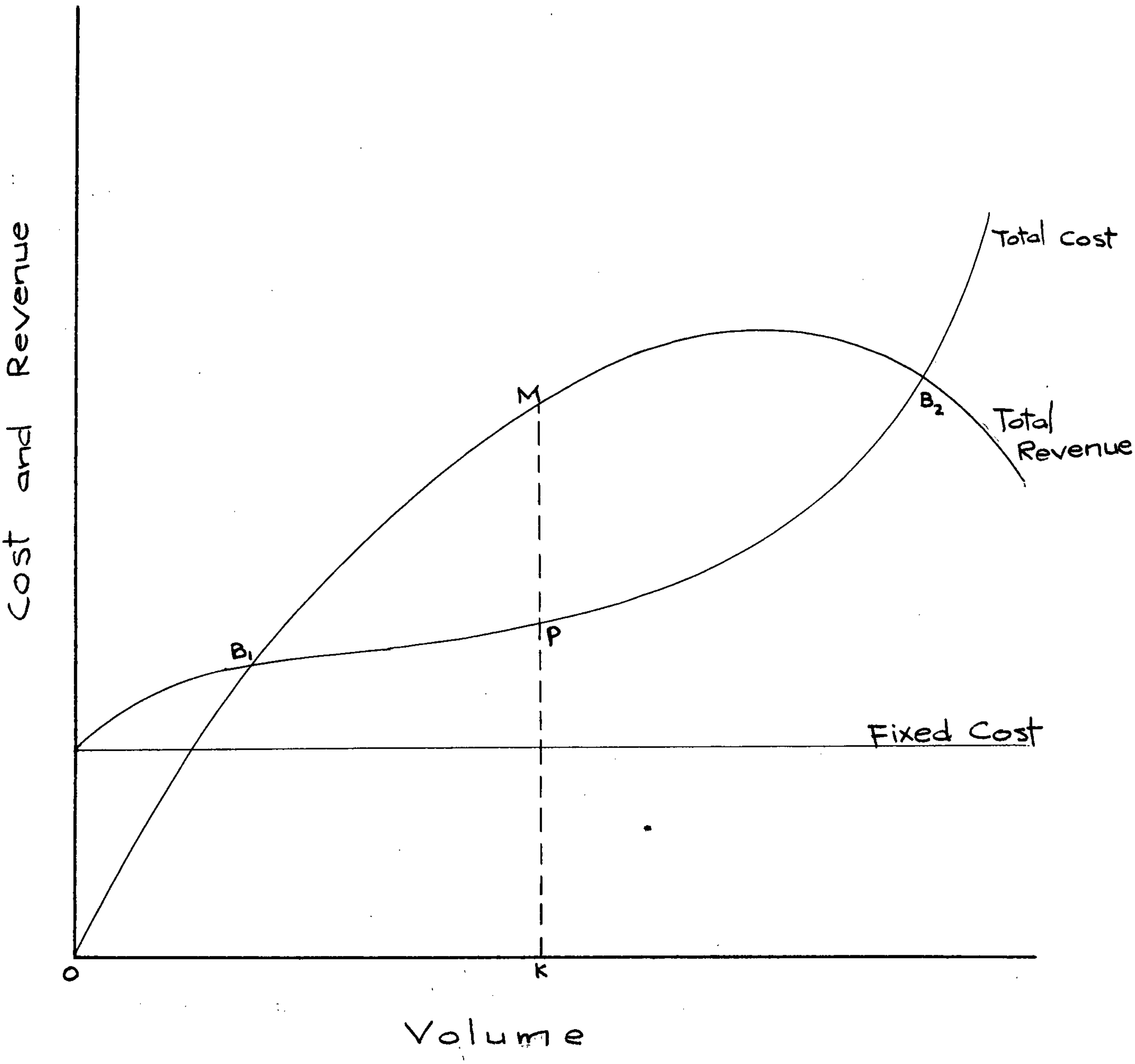
2. John J. W. Neuner, Cost Accounting, Homewood, Illinois: Richard D. Irwin Company, 1957, p. 790.

blance between the linear and curvi-linear break-even charts. The basis for the construction of the latter stems from the cost-volume and revenue-volume functions of the economic theory of the firm, as illustrated in Exhibit V. Presented in this form, the curvi-linear chart closely resembles the linear chart, as described in chapter II, except for the nature of its total cost and total revenue functions. This will be discussed in detail later. Meanwhile, it must be pointed out that whereas the linear chart has only one break-even point, the curvilinear chart reveals two break-even points, i.e., two levels of output at which the firm's revenue just covers its costs so that net profit is zero. These are the points B_1 and B_2 (Exhibit V). Point B_1 is analogous to the break-even point in the linear chart and point B_2 is the logical result of the curvi-linear nature of the total cost and total revenue functions.

Another basic difference between the two analyses is in the point of maximum profits. Profits may be defined as the excess of total revenue over total costs. It is clear, therefore, that the largest profits, which a firm could make, will be earned when the vertical distance between the total cost and the total revenue curves is at its greatest. This is indicated by MP at volume K, in Exhibit V. The linear break-even chart, on the other hand, shows profit maximised at full capacity. This tends to give the impression that the curvi-linear analysis has a slight advantage over the

EXHIBIT V

CURVI-LINEAR BREAK-EVEN CHART



linear analysis, since it specifies the profit maximisation conditions. In other words, the curvi-linear approach appears to specify the position within the profit area at which the firm should endeavour to operate. Linear break-even analysis, merely suggests that the business should operate above the break-even point and it implies, what is logically untenable, that the profit area within the range of normal volume fluctuations will keep on widening as production volume expands.

Different concepts of profits underlie the construction of the linear and curvi-linear charts. In the latter a distinction is made between implicit costs and explicit costs and profits are defined as the surplus or excess of total revenue over both types of costs. Explicit costs take the form of explicit payments for resources bought outright or hired by the firm. The firm's payroll, payments for raw and semi-finished materials, payments of overhead costs of various kinds and payments into sinking funds and depreciation charges are examples of explicit costs. They are the costs which accountants list as expenses. Implicit costs, on the other hand, are those costs of self-owned, self-employed resources. The salary of a single proprietor, who sets aside no salary for himself but who takes the firm's profits as payment for his services is an excellent example. In accordance with the opportunity cost doctrine, the cost of the single proprietor's services in producing his product is the foregone alternative product, which would have been produced, had he worked for someone else in a similar capacity. To the economist, a salary for the proprietor equal to the value of his services in his next best alternative employment may be considered as a part of the firm's costs. It is an implicit cost.

In linear charts, however, implicit cost is ignored and a firm's total costs are considered to include only the explicit obligations to resource owners. Under the circumstances, a firm's net income becomes the remainder of gross revenue after operating and financial expenses have been deducted. No consideration is given to implicit costs such as interest and dividend payments equal to what investors could earn had they invested elsewhere in the economy.

Separation of Costs

In chapter II, it was stated that in break-even analysis, it is necessary to separate total costs into fixed costs and variable costs. Unless such a classification is made, it is impossible to construct a break-even chart. But, if as defined earlier, fixed costs equal those costs which remain fixed, irrespective of volume and variable costs equal those costs which vary in direct proportion to volume, and if costs can only be classified as fixed or variable, then there are bound to be some costs which are beyond classification. Sidney Robbins states that, "many costs and the components of these costs do not fall into neat black or white, fixed or variable categories, but are rather greyhued, partaking of the characteristics of both types...."[3] Some of these costs, popularly known as semi-variable costs, include costs for such items as supervision labour, power, maintenance, and accounting services.

In break-even analysis, as indicated in chapter II, these costs are usually broken down into their fixed and variable components by either the accounting, statistical or engineering methods. None of these methods can produce completely accurate results but there is also no reason to suspect their ability to produce satisfactory results.[4] Under the circumstances, the assumption made in break-even analysis that all costs can be reasonably separated into their fixed and variable components should not provide any cause for alarm. What is important is recognition of the fact that irrespective of the method used in the division of the costs, the result will not be completely accurate and the more inaccurate the division of the costs, the more inaccurate will the results of the break-even analysis be.

Constant Selling Prices

The presentation of total cost and total revenue

3. Sidney M. Robbins, "Emphasizing the Marginal Factor in Break-Even Analysis", N.A.A. Bulletin, Vol. 43, Oct. 1961, p. 59.

4. William J. Vatter, "Accounting Measurements of Incremental Cost", Journal of Business, Vol. XVIII, No. 1, Jan. 1945, pp. 147-148.

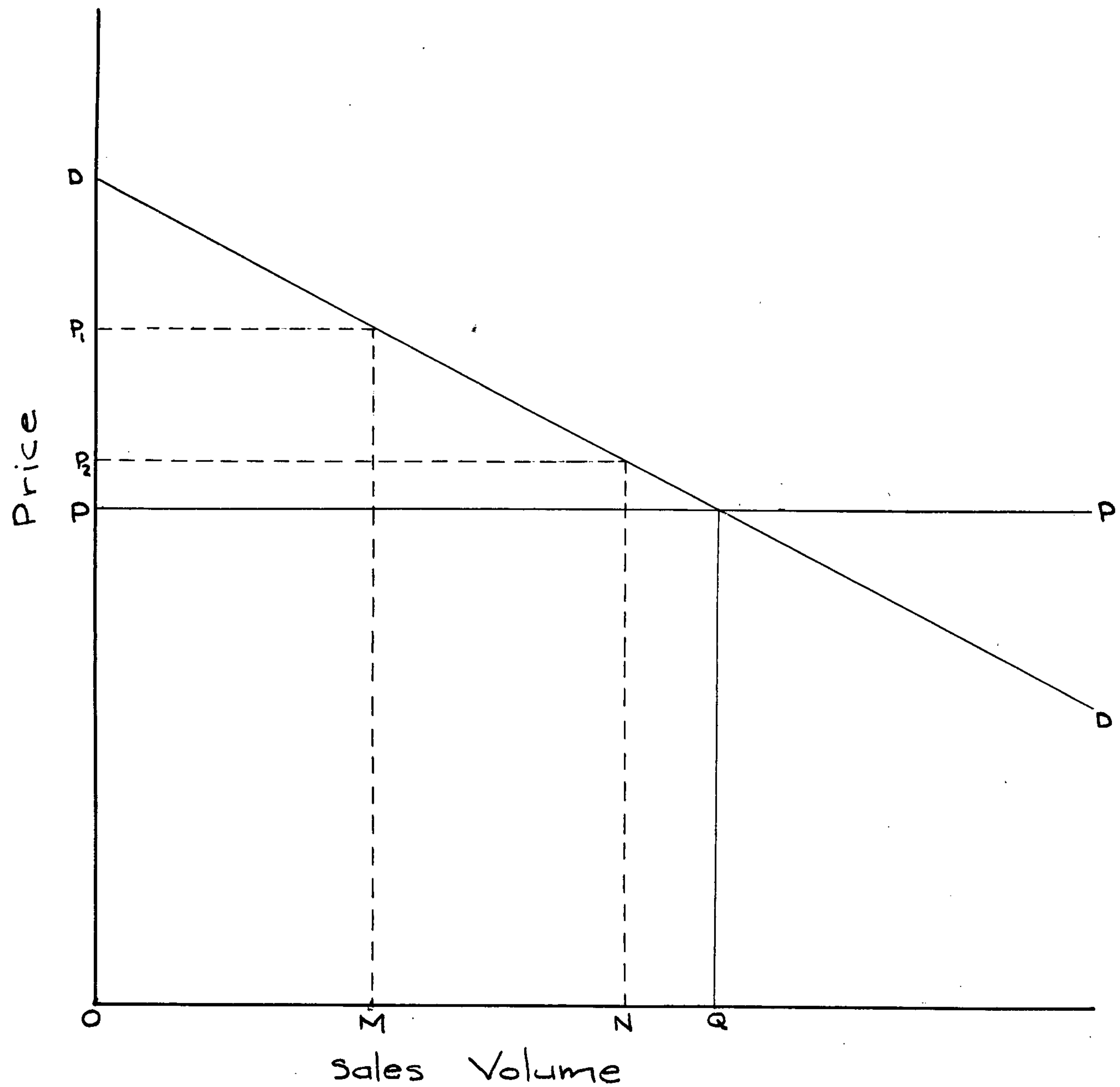
functions as straight lines has often been questioned. The linearity of the total revenue curve implies a constant selling price over the entire range of output. This is not unusual if conditions of pure competition are assumed. In a pure market, all competitors sell an insignificant proportion of the total output of a homogenous product and no single seller can, by his own efforts, influence price. Every seller must accept the same market price, determined as it is by the overall interaction of supply and demand in the market. In addition, every seller can sell all his output at the market price. Unfortunately, such conditions of pure competition are rare or impossible to achieve in the real world. This, therefore, tends to suggest that the presentation of the total revenue function as a straight line is not valid.

Under any other market condition, other than pure competition, a firm can increase its sales volume only by lowering its selling price, when all other determinants of demand - consumer incomes, consumer tastes and preferences, number of consumers and range of goods available to consumers - remain unchanged and if advertising and sales promotion are assumed to be absent. In other words, the demand curve slopes downward to the right when the seller has any degree of monopolistic control over price, implying that for each possible selling price, there is a corresponding sales volume. Under such circumstances, the total revenue function takes a curvi-linear form, as shown in Exhibit V. Since in almost all cases, producers face conditions of imperfect or monopolistic competition, one therefore tends to find more acceptable the presentation of the total revenue function as curvi-linear rather than linear.

However, it must not be forgotten that over the range of sales volume with which most producers are familiar, an unchanged price can be charged and hence it is possible to have a straight line total revenue function. By 'unchanged price', it is not implied here that this is the price which the market will bear or that this is the price which can be held indefinitely in association with sales volume increases. Assuming that non-price inducements are absent, once sales volume has increased beyond the level at which the selling price is just right to enable the producer to clear all his output with the given market demand, any further increase in output must necessarily be sold at a lower price. It is only when the price charged, within the normal sales volume range, is below the demand curve faced by the producer that it is possible to have an unchanged price. But, sooner or later, the demand curve is bound to make its influence felt. This can be illustrated. In Exhibit VI, price is measured along the vertical axis and sales volume along the horizontal axis. If OP is the price and DD the demand curve and if the firm is only concerned with the range of sales volume MN, then the price OP can be charged throughout that range. So

EXHIBIT VI

THE LIMITS OF CONSTANT PRICES



long as the demand does not change, the firm can charge a constant price, OP and sell any output up to the level OQ. Obviously, for quantities less than OQ, the firm could have charged a higher price and still sell the whole of its output. For example, for quantity OM, the firm could have charged OP_1. But, it is not unusual to find a firm fixing its price at OP even though it is willing to sell only OM quantities, with the given demand curve DD. This is so because firms tend to feel that their customers prefer stable prices and hence once price is set and shown to be profitable, it is likely to be retained until some major change in conditions causes an inroad into the desired profit goal.[5] Since PP and DD, in Exhibit VI, have to intersect somewhere, it therefore follows that the total revenue curve cannot continue indefinitely as a straight line but, sooner or later, must fall quite steeply. Beyond the sales volume OQ, the price line PP is above the demand line DD and any desired increase in sales must therefore necessarily be preceded by a reduction in prices. From the above it may logically be concluded that, in the vast majority of non-agricultural, industrial enterprise situations, which are characterised by conditions of imperfect or monopolistic competition, the linear break-even chart is incorrect on the revenue side, except for small range of sales volume over which it is

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5. Robert F. Lanzillotti, "Pricing Objectives in Large Companies", <u>American Economic Review</u>, VOL. XLVIII, No. 5, Dec. 1958, p. 937.

possible to have an unchanged price.

Total Cost and Constant Unit Variable Costs

The linear break-even chart also carries the assumption that cost-volume relationships are usually characterised by straight lines and since the fixed cost component is always taken as given, it therefore follows that it is the shape of the variable cost function that determines the shape of the total cost function. If this is the case, then to draw a linear total cost function from zero to 100 percent of productive capacity is to suggest that variable cost per unit is constant for all volumes of activity up to full capacity and that marginal cost is also constant and equal to variable cost per unit, as illustrated in Exhibit VII. A linear total cost function also suggests, as the same Exhibit shows, that total cost per unit declines continuously over the entire volume range up to full capacity and is always higher than variable costs per unit or marginal costs. Diseconomies of scale are supposedly non-existent.

This disturbs economists because it conflicts with the economic theory of the firm. Economists have generally drawn the total cost function as a curve which rises first at a declining rate and then at an accelerating rate, as illustrated in Exhibit VIII. They believe that, as the volume of output of a firm increases from zero level to 'optimum'

EXHIBIT VII

CONSTANT AVERAGE VARIABLE COST

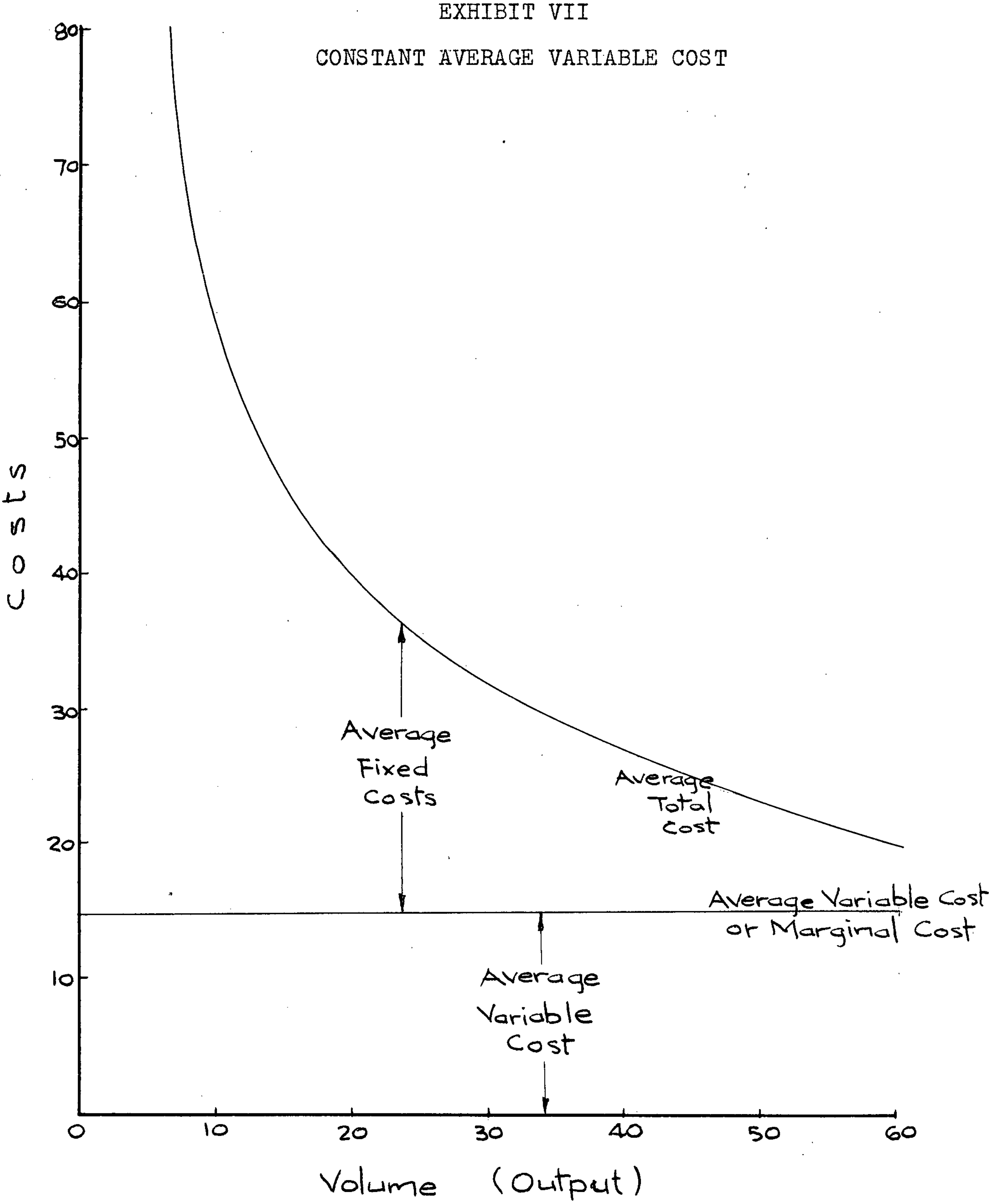
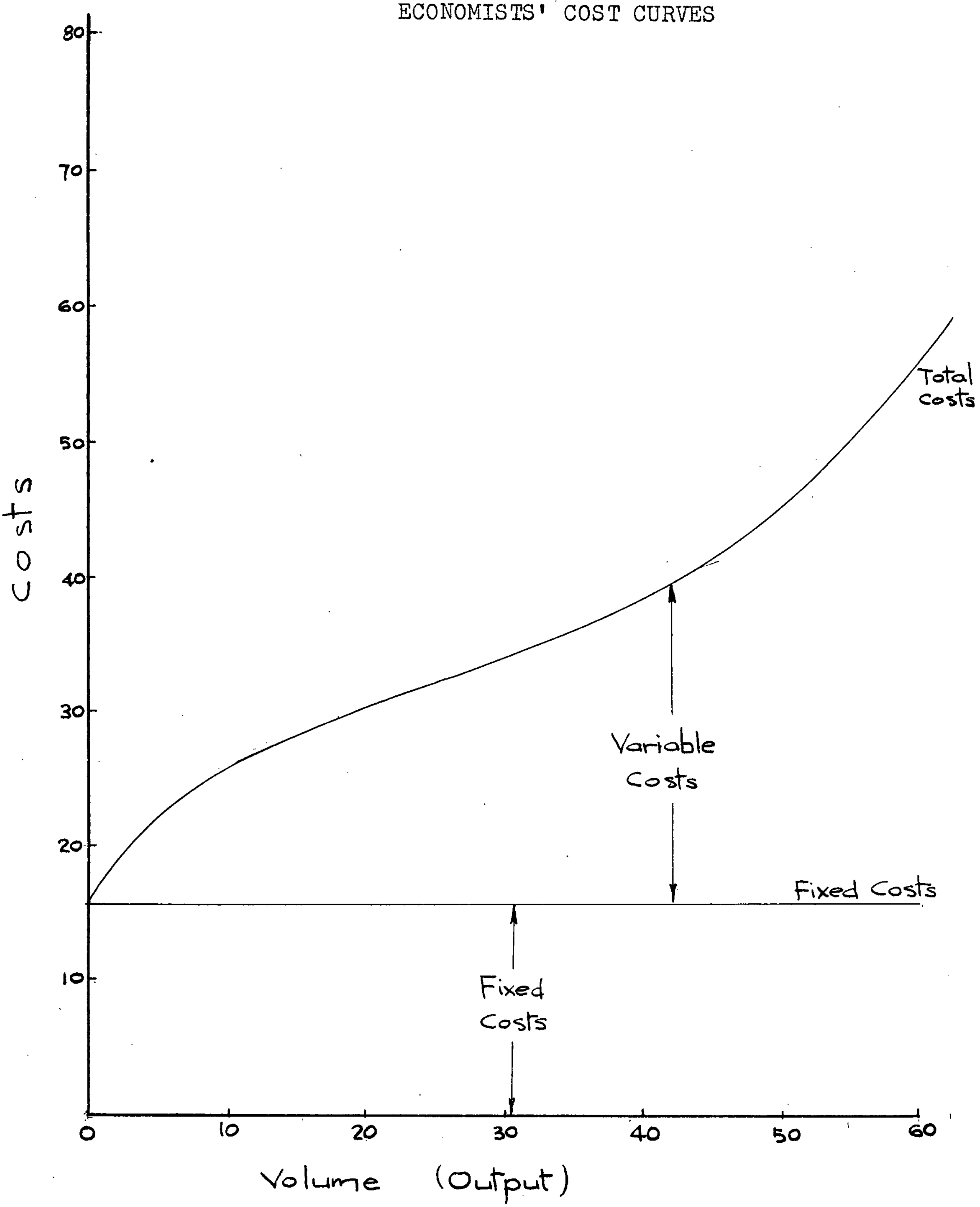


EXHIBIT VIII

ECONOMISTS' COST CURVES



volume level,[6] unit variable costs will most likely fall slightly (assuming that factor prices remain constant), since the variable factors will produce somewhat more efficiently near the firm's 'optimum' volume level than at very low volume levels. The increased efficiency may be due to increased specialisation. But, as the firm approaches its 'optimum' volume level, economists argue that a further increase in the volume of output will most certainly increase unit variable costs quite sharply. Economists point out that an increased volume of output can only come from the use of more of the variable factors of production or from obtaining harder work or greater output from the existing ones. The fact that more of the variable factors have to be used to a fixed amount of the fixed factors, will lead to overcrowding and bad organisation. Moreover, the fact that existing factors have to be used more intensively will mean that workers tend to suffer from overstrain and that machines tend to break down more frequently. Hence, economists envisage unit variable cost curves as falling slightly from zero volume to a volume level just short of the 'optimum' volume level and rising sharply from there onwards, as illustrated in Exhibit IX. Unit variable cost curves, according to economists, are unlikely to remain constant.[7]

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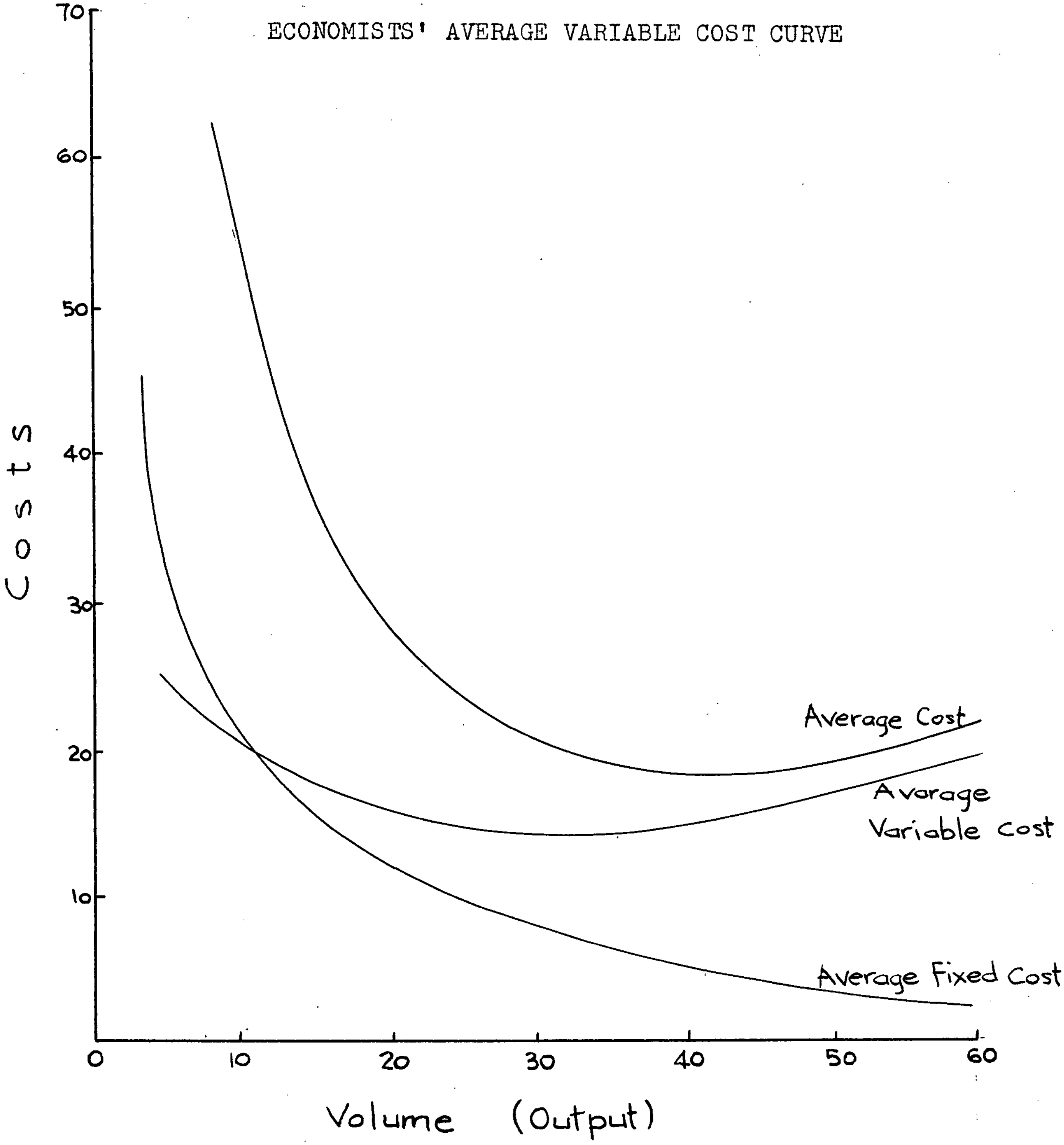
6. The 'optimum' volume level is the volume level at which all the factors of production used by the firm are being employed in the 'right' or 'optimum' proportions with each other. At this volume level, the average cost of the firm is therefore at a minimum.

7. It may be added that sales promotion efforts may also work to destroy the linearity of cost curves.

EXHIBIT IX

ECONOMISTS' AVERAGE VARIABLE COST CURVE



Meticulous statistical investigation by Joel Dean, R. A. Lester, R. H. Whitman and others, however, do not seem to support the arguments of the economists.[8] In an article in an N.A.C.A. bulletin, John Kempster mentioned that:

> In the economic research which has been done on cost, one of the important points which has been at stake is the question of whether unit variable costs fall and then rise with expanding output or are constant in their variability. Putting it another way, this is the same question as whether total variable costs would be expressed as a curve or a straight line in diagrammatic presentations. Somewhat contrary to theory, the research investigations of economists have concluded, in general, that unit variables are constant throughout the relevant ranges of volume, that is, total variable costs increase at a constant rate.[9]

Summarising from the above discussion, it may be said that since fixed costs remain fixed at all volumes, it is the variable cost function that determines the shape of the total cost function. In the linear break-even analysis, the total cost function is drawn as a straight line, giving the impression that unit variable costs remain constant at all volumes. This is contradictory to the economic theory of the firm. In economic analysis, unit variable costs are described as having a 'U' shape. The research investigations of some economists, however, support the impression of constant

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8. J. Johnston, Statistical Cost Analysis, New York: McGraw-Hill Book Company, Inc., 1960, pp. 136-168.

9. John H. Kempster, "Break-Even Analysis - Common Ground for the Economist and the Cost Accountant", N.A.C.A. Bulletin, Feb. 15, 1949, p. 712.

unit variable costs given in linear break-even analysis, for relevant ranges of volume.

Production Equals Sales

So far, various assumptions in break-even analysis, relating to the total cost and revenue functions, have been made. To this list, may be added the further assumption that sales and production are synchronised and there is no significant amount of production for inventory or no substantial amount of sales from inventory. All fixed costs incurred by the firm are, therefore, considered as period costs and charged against the revenue realised in the same period.

This assumption is obviously not entirely true. At times, firms produce more than what they can sell, as a result of which inventories are built up and, at other times, they may produce less than what they can sell and consequently, inventories are depleted. In fact, in practice, firms seldom find that their sales exactly equal their production. In many periods, however, firms may find that the difference between sales and production is not very significant and this is the position that is generally taken in discussions on break-even analysis. One writer stated that:

> Inventories, though, are usually very small in comparison to total production and, for practical purposes, are ignored in comparing sales at various levels of production....The least probable error, then, is obtained by disregarding the inventory problem in determining sales

> at any volume and to consider all production immediately saleable.[10]

Glenn A. Welsch is of the opinion that "productivity and inventory change are frequently of little consequence within any one period" but added that "in case of lack of synchronization between production and sales, it is important that adjustment be made for the increase or decrease in inventory".[11] However, this tends to weaken the usefulness of break-even analysis. As G. R. Crowningshield puts it:

> The adjustments that are required in the break-even analysis, when sales and production volumes do not coincide, take away one of the principal merits of the break-even analysis, its simplicity. If synchronization within reasonable limits cannot be presumed, the usefulness of the analysis may be destroyed and some other device will have to be substituted for it.[12]

Since conventional break-even analysis assumes that production equals sales, therefore, no provision is made for the deferral of fixed costs in inventories. This is consistent with the procedure known in accounting as direct costing, variable costing or marginal costing, where-

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10. W. L. Fill, "The Break-Even Chart", The Accounting Review, Vol. 27, April 1952, p. 203.

11. Glenn A. Welsch, "The Construction and Uses of Break-Even Analysis", Controller, Vol. 21, Oct. 1953, p. 465.

12. Gerald R. Crowningshield, Cost Accounting: Principles and Marginal Applications", Boston: Houghton Mifflin Company, 1962, p. 403.

by only variable costs are included in inventories. But, this is not consistent with normal cost accounting procedures.[13] In accounting theory, if an inventory arises from current production, that portion of fixed costs, which is utilised to produce the goods going into inventories, is deferred in the inventories. To use direct costing in inventory valuation is to assume that the wage of a worker who operates a machine in producing goods is a product cost while a proportionate part of the cost of the machine is not a product cost.

From the conventional break-even analysis, it may be implied that even if production is not equal to sales, all fixed costs will still be charged against the revenue of the same period. Under such circumstances, expenses are not properly matched against revenue because the concept of break-even analysis implies that revenue equals expenses incurred in realising revenue, at the break-even level of activity. If production is greater than sales and all fixed costs are funnelled through the profit and loss statement

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13. The Committee on Accounting Concepts and Standards of the American Accounting Association explicitly states that: "...the cost of a manufactured product is the sum of the acquisition costs reasonably traceable to that product and should include both direct and indirect factors." "Accounting and Reporting Standards for Corporate Financial Statements: 1957 Revision", The Accounting Review, Vol. XXXII, Oct. 1957, p. 539. Two members of the Committee dissented from this portion of the statement.

Gordon Shillinglaw states that"...there are two divergent points of view as to which cost elements should be assigned to products. The most widely held view is that product cost should include a share of all manufacturing costs". However he adds that direct costing has been winning increasing support in recent years. Shillinglaw, Gordon, Cost Accounting: Analysis and Control, Homewood, Illinois: Richard D. Irwin, Inc., 1961, p. 291.

for the period, then it means that, at the break-even level of activity, revenue for the period equals the expenses incurred in realising this revenue plus the expenses incurred in realising the revenue of later periods, when the inventories from current production are sold. This tends to distort the picture of the profitability of the business for the current period as well as for those periods in the future, whose sales include inventories from prior production.

Although conventional break-even analysis eliminates this problem by assuming that production equals sales, it is wise to be aware of the existence of this problem. The greater the difference between production and sales, the more serious is the problem. In fact, in firms in which there exists a significant difference between production and sales, it may be advisable not to consider the use of break-even analysis.

Sales Mix

The synchronization of production and sales is, however, not the last of the basic assumptions of break-even analysis. An executive, who intends to make use of break-even analysis, is also faced with the problem of product mix or sales mix. This problem arises so long as the firm is a multi-product firm and if, in addition, the various products have different margins of return over variable costs. This becomes clear when we consider the fact that, in a firm, if the total sales revenue is made up of the revenue of products with high margins over variable costs, the break-even point will be lower than if total sales revenue is composed of the revenue of low margin items. This being the case, each time the sales mix changes, the break-even point and the profit pattern will also change. Hence, other things being equal, management is generally considered to be making a good move, profitwise, if it tries to increase the sales of a high-profit margin product at the expense of a less profitable item.

The sales mix is, therefore, an important factor in break-even analysis. With a given total cost function and a given total revenue function, an increase in total sales, from a sales volume above the break-even volume, may not produce the expected increase in profits, if there is a change in the sales mix. The increase in profits may be greater or less than what is expected, depending on whether the change in sales mix is from the higher margin products to the lower margin products or the reverse. To overcome this problem, the users of break-even analysis assume a given mix or that the sales mix will remain constant as sales volume changes. This assumption, however, presents a serious limitation when the composition of demand for the products of the firm changes.

To avoid this assumption and to make break-even analysis more useful, various writers have advanced many possible solutions to this problem.[14] Perhaps, the approach which has received the greatest attention, is the one which requires a separate calculation or graph for each product. Fixed costs, therefore, have to be appropriately allocated to the various products and this is where the difficulty lies with this method. It has already been mentioned earlier that the separation of costs as fixed costs or variable costs is fraught with difficulties. The job of allocating fixed costs among the various products is even more trying. Some costs may be common costs, the allocation of which is just not practicable. This means that the sum of the individual break-even points will not equal the break-even point for the firm as a whole.

The assumption of a constant sales mix, made in conventional break-even analysis, is thus necessary only in a multi-product firm; but then the single-product firm is, today, a distinct rarity in the real world of business. None

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14. Paul May recommends the use of a profit polygraph - P. A. May "Profit Polygraph for Product Mix Evaluation", N.A.C.A. Bulletin, Vol. 37, Sec. 1, Nov. 1955, pp. 307-318.

Richard Conway suggests the method of sequential consideration on a single chart or the use of multi-dimensional analysis - R. W. Conway, "Breaking out of the Limitations of Break-Even Analysis", N.A.C.A. Bulletin, Vol. 38, Sec. 1, June 1957, pp. 1265-1272.

Joel Dean suggests the use of a family of product-mix lines - Joel Dean, Managerial Economics, Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1951, p. 335.

These methods may produce more accurate results but, usually this is achieved at the expense of the advantages of break-even analysis, such as, ease of understanding, inexpensiveness and quickness in preparation.

of the methods, which have been advanced to overcome the limitations of this assumption, seems to be completely satisfactory. Each has its weaknesses and consequently, the problem of adjusting break-even analysis to the dynamic situation of changing product mix is as serious now as it was when break-even analysis was first used more than fifty years ago. Today, as far as the problem of sales mix goes, users of break-even analysis can do little more than recognise the fact that generally, the usefulness of break-even analysis, for the firm as a whole, decreases as the number of products sold by the firm increases, ceteris paribus. This, however, may not necessarily be true if the sales mix of the multi-product firm changes so slowly over time that when break-even analysis is used for short-term forecasting, the distortion in the results caused by the assumption of a constant sales mix, may be only negligible. Further, some multi-product firms price their products in such a way as to provide on all products sold, a constant return over variable costs, in which case, the problem of changes in sales mix does not even arise, because in such a situation, assuming that the sales volume and fixed costs remain the same, a change in the sales mix will not cause a shift in the break-even point. This, however, presupposes the use of cost-plus pricing as opposed to the marginal cost pricing of the economists. Such a presupposition may be valid. Some writers claim that cost-plus pricing is the common method of pricing.[15]

15. Ibid., p. 447-457.

This has been confirmed in some studies. Hall and Hitch, in a study undertaken before the outbreak of World War II, indicated that about sixty-five per cent of firms in monopolistic competition and seventy-five per cent of monopolistic and oligopolistic firms adopt cost-plus pricing.[16]

Planning and Control

It has been mentioned before that break-even analysis is useful for financial planning and control. This arises mainly from the fact that break-even analysis is capable of depicting graphically the relationships between cost, volume, revenue and profit. Hence, if management is faced with several alternative courses of action, break-even analysis is capable of bringing out for the benefit of management, the probable effects on cost, volume and revenue and ultimately on profit of each of the different courses of action. This will help management in its decision-making and planning.

In planning, for instance, break-even analysis may also show whether efforts would be better directed toward

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16. R. L. Hall and C. J. Hitch, "Price Theory and Business Behaviour", Oxford Economic Papers, No. 2, May 1939, Table 6, p. 26.

In another study of 20 companies in the United States, over a period of years in the 1950's, Professor Lanzillotti found that target return on investment pricing was the most frequently used method of pricing. He also found that the most frequent use of this method was in the pricing of new products, and that some companies, which used this method for their new products, employed cost-plus pricing for their other products. Lanzilotti, *op. cit.*, p. 923-932.

the reduction of fixed costs or of variable costs or whether the efforts should be exerted to increase volume. If the fixed costs of a firm constitute a very high proportion of total costs, then it must operate at a substantial percentage of capacity to cover such costs but, once the break-even volume is reached, profits increase at a very rapid rate, with increases in volume. On the other hand, if the total costs of a firm are made up mainly of variable costs, then a relatively low volume is sufficient to cover fixed costs but, even after the break-even volume has been reached, profits will not increase at a fast rate. On the financial side, if a firm has a high percentage of fixed costs, an increase in volume may not cause a serious demand for cash but, if the firm has a high percentage of variable costs, an increase in volume is likely to cause an increase in variable costs and eventually a drain on cash.

In control, break-even analysis is useful for detecting any insidious upward creep of costs, which might otherwise go unnoticed. It can also be used to compare actual and planned performances and to show the logical points of attack to effect improvement. A common error made by management is to overemphasize the importance of volume as a determinant of profits. Some management people may assume that an increase in volume will automatically increase profits. Actually, this happens above the break-even point only if prices remain unchanged and only if variable costs are kept under control. Unfortunately, an increase in volume very often is accompanied by an increase in costs, which is frequently large anough to more than offset the beneficial volume effect. Break-even analysis comes in handy here since it is capable of bringing to the attention of management the profit determinant that has been responsible for offsetting the volume effect.

With this brief introduction to the uses of break-even analysis, we can now go on to examine more specific areas of management planning and control, in which break-even analysis is capable of playing a significant role.

Pricing Policies

Pricing a product is one of the most delicate problems of management. A poor pricing policy may lead a business into bankruptcy. Many factors influence the pricing decisions of management but the most important factor is probably cost. Some firms adopt the policy of selling some of their minor products below cost, in order to attract customers. There is, however, hardly any profit-making firm which can afford to sell consistently below cost. In order to be successful, firms have to recover not only their costs but also a profit that is adequate to maintain the incentive for their continued operation.

Break-even analysis can provide some help to management in the establishment of prices. Break-even charts can be drawn to show the effect on profits of different price levels. These charts may then be compared with one drawn under existing conditions to show the volume of sales that would be necessary to achieve the same level of profits. A higher price, ceteris paribus, has the effect of raising the profit/volume ratio and accelerating the recovery of fixed costs. Hence, a lower volume of sales would be sufficient to attain the profit objective. Conversely, a lower price would lower the profit/volume ratio and reduce the rate of recovery of fixed costs. Attainment of the profit objective, in this case, would require a higher volume of sales.

The usefulness of break-even analysis, in pricing decisions, arises mainly from the fact that it can ably show the cost-volume-revenue structure of a business. But, one should never overestimate the usefulness of break-even analysis in pricing decisions because the effect on profits of a change in price depends not only on the cost-volume-revenue structure of the business but also on the effect on volume of the change in price, that is, on the price elasticity of demand. In actual fact, in any pricing decision, the latter would appear to be, as important as, if not more important than the former. Unfortunately, break-even analysis does not, in any way, tell us what the price elasticity of demand for a product is like.

Capital Expenditures

Capital expenditures usually involve large sums of money. Firms, very often, have to resort to outside sources of funds to finance their capital expenditures. An unwise investment decision by management may put an end to the operation of a business. Therefore, management has to be extremely careful in every investment decision that it makes. This requires management to have a good idea of, among other things, the changing relationships of cost, volume, revenue and profits. Break-even analysis is useful in decisions involving capital expenditures since it is extremely capable of bringing out these relationships.

If a firm is thinking of making an investment, it can make use of break-even analysis to compare its position under the two alternative situations; (a) if the investment is undertaken and (b) if the investment is not undertaken. The difference in the profits under the two situations, after adjustments for present values, may then be compared with the cost of capital. On the basis of this and other relevant evidence, a decision may be made as to whether the investment ought to be undertaken. In looking at its position under the two situations, the firm should recognise the changing cost-volume-revenue relationships and the resultant effect upon profit, caused by variations in the volume of business. Occasionally, firms have made the error of computing cost and revenue estimates on the basis of maximum utilisation of proposed productive facilities or on the basis of a certain 'representative', 'normal' or 'average' volume of business.[17]

17. John Y. D. Tse, Profit Planning through Volume-Cost Analysis, New York: The Macmillan Company, 1960, p. 21.

An implicit assumption is then made that the unit cost and profit will remain the same at all other levels of operation, as they would at the maximum or representative volume of business. This tends to distort the picture and lead to unsound decisions because the changing cost-volume-revenue relationships are ignored.

Break-even analysis, by making management aware of the changing cost-volume-revenue relationships, tends to guide management to more realistic thinking. With this method, management can obtain a clear perception of costs, revenue and profits or losses to be expected under actual operating conditions and not under some imaginary or deceptive situation. The use of break-even analysis does not mean that management's judgement can now be completely eliminated and decisions can be made solely on an objective basis. But, break-even analysis can help management to make better and more intelligent decisions about capital expenditures.

<u>Make or Buy Problems</u>

Many firms have faced the problem of having to decide whether it is more profitable to make or to buy component parts that are used in the firm's assembled products. A decision of this nature requires consideration of a number of factors. For instance, the firm may have to consider the need for an assured supply, continuity of delivery and maintenance of product quality. If it is assumed that the firm need not have to worry about these policy factors, then the answer to the make or buy problems would probably revolve around the question of costs. This means that proper cost information would be required so that the cost of making can be compared with the cost of buying.

If a firm has unused productive capacities in the short-run, the cost of making may be based on the additional costs that it will have to incur if the orders were kept in the company. In the long-run, however, the firm's cost of making should include direct materials, direct labour, the variable costs involved, a share of fixed costs and a profit figure.

Break-even analysis is useful in the comparison of the cost of making and the cost of buying since it can show the effects on profits, at different volume levels, of the two alternatives and thereby help management to make its decision.

Cost Control

Cost control is one of the most important aspects of the management of a business. Operating profits, as defined in chapter I, are equal to operating revenue minus operating costs. But, management does not have too much control over operating revenue since there is a limit to the amount that a business can sell and selling prices are, to a large extent, established by competition. Hence, the profit-making capacity of a business depends largely on the efficiency with which costs are controlled.

One of the ways in which cost control can be achieved is through the use of flexible budgets, which "reflect the amount of cost that is reasonably necessary to achieve each of several specified volumes of activity."[18] For purposes of cost control, the predetermined costs are based on standards set for materials, labour and expenses. These predetermined costs may then be compared with actual costs and the differences, called variances, may be analysed. From the analysis of the variances, management may introduce measures to check the unfavourable trends and departures from the predetermined costs. In this way, flexible budgets aid in the control of costs.

There is a greal deal of similarity between flexible budgets and break-even charts. In fact, it may be said that whereas flexible budgets are tabular variable income statements, break-even charts are graphic variable income statements.[19] The construction of break-even charts is very often based on the data of flexible budgets; and just as flexible budgets are useful for cost control, so are break-even charts. For purposes of cost control, the predetermined costs and the actual cost may be plotted on a break-even chart to

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18. Shillinglaw, <u>op. cit.</u>, p. 217.

19. Adolf Matz, Othel J. Curry and George W. Frank, <u>Cost Accounting</u>, Cincinnati: South-Western Publishing Company, 1952, p. 678.

bring out the variances and on the basis of the analysis of these variances, corrective actions may be taken by management.

Summary

In this chapter, it has been shown that break-even analysis can be used in decision-making involving make or buy problems and in problems related to capital expenditures, cost control and pricing decisions. These are, by no means, the only uses to which break-even analysis can be put. In fact, break-even analysis has been used in the solving of many other problems concerning alternatives, which involve cost, volume and profit relationships.

It was also pointed out, in this chapter, that in using break-even analysis, many restrictive assumptions have to be made. The assumptions include the following:

(a) All costs can be reasonably separated into their fixed and variable components and whereas fixed costs remain fixed at all volumes, variable costs vary in direct proportion to volume.

(b) Selling prices remain constant at all volumes.

(c) Production equals or closely follows sales and all fixed costs incurred in a period are, therefore, deducted from that period's revenue.

(d) There is only one product or if several products are being produced and sold, the sales mix will remain constant.

These assumptions are more valid for some firms than for others. In those firms in which these assumptions are very unrealistic, break-even analysis is virtually useless, unless the firms are willing to make adjustments to overcome the limitations that are inherent in these assumptions.

CHAPTER IV

TEST OF BREAK-EVEN ANALYSIS

Introduction

There are many ways of forecasting the operating profits of firms. Some of these techniques are rather naive. An example is the environmental analysis method. The essential idea here is to discover a functional relationship between a firm's profits and one or more indicators of national activity - such as, disposable income or any reliable index of industrial production - on the assumption that the well-being of a firm, as measured by its profits, is directly determined by business conditions in the total economy. A modification of this technique is the correlation analysis method, whereby a functional relationship is first determined between a firm's profits and some internal variable factor, for example, the sales of the firm. On the basis of this relationship, forecasts of the firm's profits may then be made. In this study, this technique will be called the percentage of sales method. It is obvious that the accuracy of the profit forecast, by this method, depends directly on: (a) the extent to which the firm's profits are truly related to the independent variable, sales and (b) the accuracy of the forecast made for the independent variable.

A more sophisticated way of forecasting profits involves the use of the break-even technique. Break-even analysis - its nature and its pros and cons - needs no further comment here. The purpose in this chapter is to test the hypothesis and the null hypothesis, as detailed in chapter I.

Source of Data

The data for the test are taken from Moody's Industrial Manuals.[1] As indicated in chapter I, the statistical approach (least squares method) is used to separate the total costs of the firm into fixed costs and variable costs, since in terms of the data available, it is likely to give more reliable results than the accounting or engineering methods. Included in the universe of firms are only those firms in Moody's Industrial Manuals, which have had losses at some time or other over the period covered in the study. This is so because preliminary studies to this test showed that, in the case of those firms, which had never suffered any losses, it was not possible to separate their total costs into their fixed and variable components, by the statistical approach.

In this test, the year chosen for the forecast is 1956. Any other year could have been chosen so long as it is a past year; otherwise, it would not be possible to

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1. Detailed in chapter I.

compare the forecast profits with the actual profits, to determine the accuracy of the forecasts. For the test, in order to measure cost variability, the behaviour of costs of each firm in the sample is studied for a maximum period of ten years, from 1946 to 1955. As indicated in chapter I, Moody's Industrial Manuals from 1946 to 1958 are used to obtain the data.[2] A close examination of the Manuals for this period showed that 589 firms could be included in the universe.

Forecasting Operating Profits

A. Break-Even Method

In forecasting the operating profits of the sample firms by the break-even method, the following assumptions are made:[3]

(a) All costs can reasonably be classified as fixed or variable.

(b) Selling prices remain constant at all volumes.

(c) Production and sales are synchronised and

(d) The sales mix remains constant.

The operating profits of firms at any given volume level is equal to the operating revenue minus the operating

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2. There is a time lag in Moody's Industrial Manuals. The data of some companies appear in the manuals one or two years after the end of their fiscal year.

3. The need for these assumptions have been discussed in chapter III. Their validity varies among the sample firms. For most of the sample firms, the first three assumptions are quite valid. The fourth assumption, however, is not valid for almost all the firms but has to be made in order to carry out the test.

costs at that volume level. In this study, the forecast volume level is given and is equal to that at which the actual operating profits are realised. The operating revenue is also given and is equal to the volume level, on the assumption that production and sales are synchronised. Therefore, in order to forecast the operating profits, it is only necessary to determine the operating costs.

The determination of the operating costs, at a given volume level, can be attempted in many ways. The accounting, engineering and statistical approaches have already been explained in chapter II. The statistical approach, with the scatter chart technique and the method of least squares, is used here. The reason for this has been discussed in chapter I. By this method, the operating cost figures of all the sample firms are collected for as many as possible of the years between 1946 and 1955 (inclusive). These figures are then plotted on scatter charts with sales volume as the horizontal axis and operating costs as the vertical axis. The idea here is to achieve an estimate of the correlation between costs and sales volume. Shillinglaw advises that the statistical approach "must be regarded as first approximations. If there are strong common-sense reasons for doubting that the resulting cost-volume pattern is reasonable, then the conclusion of the statistical analysis should be supplemented by the application of judgement."[4]

4. Gordon Shillinglaw, Cost Accounting: Analysis and Control, Homewood, Illinois: Richard D. Irwin, Inc., 1961, p. 235.

In this study, those cost figures which show an 'abnormal' relationship to sales volume are eliminated.[5]

Once this stage has been reached, a line of best fit may be established through the remaining plotted points by the method of least squares.[6] The formula for a straight line trend is $y = a + bx$. The least squares method provides two simultaneous equations which when solved determine the values of the constants, a and b in the equation of the straight line trend.[7] These two simultaneous equations are as follows:

$$\Sigma y = Na + b\Sigma x$$
$$\Sigma xy = a\Sigma x + b\Sigma x^2$$

where:

Σ = sigma, sum of, summation.

N = No. of items, years or plotted points of the data under consideration.

x = Value of the independent variable, for example, the sales volume in this study.

y = Value of the dependent variable, for example, the operating costs in this study.

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5. A cost figure is considered to have an abnormal relationship to sales volume if it lies some distance away from the trend that other cost figures seem to be establishing. Judgement is, of course, involved here.

6. For a technical explanation of this statistical process, reference may be made to Frederick E. Croxton and Dudley J. Cowden, Applied General Statistics, 2nd Ed.; Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1955, pp. 263-275.

7. Fortran Programming is used to assist in arriving at the values of the constants, a and b. See Appendix VI.

Since, in this study, x represents the sales volume and y, the operating costs, once the values of a and b have been derived, the operating costs of any firm, for any sales volume, may be estimated merely by substituting x, in the formula $y = a + bx$, with the value of the given sales volume.

When the operating costs, at the given sales volume, have been determined, a forecast of the operating profits, at that sales volume, can be made by subtracting the operating costs from the given operating revenue.

B. Percentage of Sales Method

The percentage of sales method of forecasting operating profits is very much simpler than the break-even method. By the percentage of sales method, for each sample firm, the operating profits as a percentage of the sales volume is determined for as many as possible of the years between 1946 and 1955 (inclusive). The mean average of these percentages is then determined.[8] The ultimate purpose here,

8. The mode is not used here because, for most of the sample firms, the same percentage did not appear more than once. There is no special reason to prefer the median. Simpson and Kafka state that "the arithmetic mean is the most commonly used and best known of the averages, and is preferred unless precluding circumstances are present, such as extreme values at either end of the series, or open-end classes or varying class intervals or unless we definitely wish to establish the most frequent value or some other positional average." George Simpson and Fritz Kafka, Basic Statistics, New York: W. W. Norton and Company, Inc., 1957, p. 171. In this study, the precluding circumstances are either absent or are very insignificant.

as in the case of break-even analysis, is to compare the forecast operating profits with the actual operating profits, therefore, it is assumed that the sales volume in the forecast year, 1956, is given and is equal to the sales volume at which the actual operating profits are realised in 1956. Once the sales volume is known, a forecast of the operating profits can be made by applying to the given sales volume, the average percentage of profits as a percentage of sales for the years 1946 to 1955.

The Sample

Before making a decision on the firms to be included in the sample, a decision has to be made on the number of firms to be included in the sample. For this purpose, it is necessary to state the desired degree of accuracy. In this study, it is asserted with a probability of 0.95 that the estimated mean will be within $0.10 of the true mean. The confidence interval is arbitrarily fixed, depending on what is felt to be reasonable, under the circumstances. In this case, consideration was given to the fact that the sample mean of the exploratory study,[9] $\bar{X}_d$, is only $0.26m. (Table III). The t-table (Appendix II) shows that for a 95 percent degree of confidence, with 9 degrees of freedom (n-1), the standard error of the mean

9. This is explained in the next page.

is equal to 2.262. From this, the following formula[10] may be used to determine the size of the sample:

$$2.262 \left(\frac{\sigma}{\sqrt{n}}\right) = \$0.10m$$

where σ = standard deviation of the universe (population)

and n = size of the sample.

In order to determine the standard deviation of the universe, a start has to be made with an exploratory study of some firms, picked at random from the universe. In this case, 10 firms are used for the exploratory study. The basic principle behind random sampling is that every firm in the universe must have an equal chance of being chosen. To achieve this, use can be made of prepared tables of random numbers. Firstly, all the 589 firms in the universe are listed in alphabetical order and numbered from 1 to 589. A decision is then made to use Kendall and Smith's "Tables of Random Sampling Numbers, Tracts for Computers No. XXIV"[11] (Appendix I). To avoid any possibility that the choice of a starting point might be nonrandom, it is arbitrarily decided, before examining the Random Number Tables, to start picking 10 firms from Row 12, and columns 6, 7 and 8 of the random numbers shown on page 15 of the tables. This would give the numbers:

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10. John E. Freund and Frank J. Williams, Modern Business Statistics, Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1958, p. 193.

11. M. G. Kendall and B. B. Smith, Tables of Random Sampling Numbers, Tracts for Computers No. XXIV, Cambridge: Cambridge University Press, 1951.

377	339	218	043	157
144	451	498	070	525

Since the universe is made up of 589 firms, any number exceeding 589 is ignored. In the same way, any number which appeared more than once is also ignored after it had appeared for the first time. This happened in the case of the number, 043.

Once the firms for the exploratory study have been picked, the standard deviation of the universe X (σ) can be determined by using the formula:

$$\sigma = \sqrt{\frac{\Sigma (X_d - \bar{X}_d)^2}{n-1}}$$

where: σ = standard deviation of the universe

Σ = sigma, sum of, summation

X_d = difference between actual and forecast profits

$\bar{X}_d$ = mean of the difference in profits

n = size of the sample in the exploratory study

Table III shows that $\Sigma(X_d - \bar{X}_d)^2$ = \$0.9127m. Therefore, the standard deviation of the universe, σ is equal to:

$$\sqrt{\frac{\Sigma(X_d - \bar{X}_d)^2}{n - 1}} = \sqrt{\frac{\$0.9127m}{9}}$$

$$= \sqrt{\$0.1014m.} = \$0.3184m.$$

Earlier, the formula for the size of the sample had been given as:

$$2.262 \left(\frac{\sigma}{\sqrt{n}}\right) = \$0.10m.$$

where: σ = standard deviation of the universe

and n = size of the sample

This is the same as:

$$n = \left(\frac{\sigma}{\frac{\$0.10m}{2.262}}\right)^2$$

Since, it has already been found that σ = \$0.3184m.

$$\text{Therefore,} \quad n = \left(\$0.3184m \div \frac{\$0.10m}{2.262}\right)^2$$

$$= \left(\frac{\$0.3184}{\$0.0442}\right)^2 \qquad = 7.2036^2$$

$$= 51.88$$

This means that a random sample of size, 52 will suffice to give the desired degree of accuracy. But Simpson and Kafka advises that "the use of a formula to obtain an estimate of sample size does not give us more than a rough approximation. In practice, it is advisable to take the sample estimate as a bare minimum to be increased for safety."[12] Therefore, following the advice of Simpson and Kafka, five more firms are added to the 52 firms to give a sample size of 57 firms.

Once the number of firms to be included in the

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12. Simpson, <u>op. cit</u>., p. 44.

TABLE III

Computation of the Standard Deviation of the Universe
($ Amounts in Millions)

Name of Company	Volume or Sales Revenue (x)	Fixed Costs (a)	Slope of Trend Line (b)	Variable Costs (bx)	Total Costs (a+bx)	Forecast Profits $p_f = x-(a+bx)$	Actual Profits p_a	Difference Between Actual and Forecast Profits $p_a-p_f = X_d$	$X_d-\overline{X}_d$	$(X_d-\overline{X}_d)^2$
Auto Soler Company (ga.)	$2.02	$0.09	0.81	$1.64	$1.73	$0.29	$0.37	$0.08	-$0.18	$0.0324
Bolsa Chica Oil Corp. (Del.)	1.20	0.06	0.93	1.12	1.18	0.02	0.20	0.18	- 0.08	0.0064
Diamond T.Motor Car Co. (Ill.)	45.43	0.02	0.97	44.07	44.09	1.34	2.40	1.06	0.80	0.6400
Dauega Stores Corp.(N.J.)	24.64	2.24	0.90	22.19	24.42	0.22	0.14	0.06	-0.20	0.0400
Globe American Corp. (Ind.)	4.39	1.42	0.76	3.34	4.76	(0.37)	(0.28)	0.09	-0.17	0.0289
Mohawk Liquer Corp. (Mich.)	5.07	0.79	0.70	3.55	4.34	0.73	0.28	0.55	0.29	0.0841
New England Box Co. (Mass.)	4.04	0.60	0.84	3.39	3.99	0.05	(0.01)	0.06	-0.20	0.0400
Ronson Corp.(N.J.)	31.95	7.91	0.65	20.77	28.68	3.27	3.07	0.20	-0.06	0.0036
Standard Commercial Tobacco Co.Inc.(Del.)	4.87	0.06	0.94	4.58	4.64	0.23	0.04	0.19	-0.07	0.0049
12th Street Store (Ill.)	3.85	0.91	0.80	3.08	3.99	(0.14)	(0.06)	0.08	-0.18	0.0324
								2.55		0.9127

The sum of the differences between actual and forecast profits (ΣX_d) = $2.55 m. Therefore, the mean of the differences ($\overline{X}_d$) = $2.55 ÷ 10 = $0.26 m.

In determining the differences between actual and forecast profits ($p_a - p_f$), signs are ignored because we are only interested in the magnitude of the difference and not in the direction of the differences.

sample is known, the firms can be drawn at random from the universe of 589 alphabetically listed firms. Here, again, use can be made of Kendall and Smith's "Tables of Random Sampling Numbers, Tracts for Computers No. XXIV"[13] (Appendix I), following the same procedure as that used to obtain the firms for the exploratory study.

Method of Analysis

In order to determine whether break-even analysis or the percentage of sales method can provide a better forecast of operating profits, a comparison must first be made of the forecasts of the two methods with the actual operating profits. A comparison of the forecast of the percentage of sales method with the actual operating profits is given in Table IV and a comparison of the forecast of break-even analysis with the actual operating profits is given in Table V.

The method which gives a smaller difference between forecast operating profits and actual operating profits should be the more accurate method. Table V shows that, for the 57 firms shown in the sample, the difference between the forecast operating profits and actual operating profits, by the percentage of sales method, totals \$24.27m. This gives a mean difference of \$0.4257m, that is \$24.27m divided by 57.[14] Table V shows that the difference between the forecast

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13. Kendall, loc. cit.

14. The mean is used instead of the mode or the median because it is least subjected to sampling variation. This was discussed in chapter I.

TABLE IV

DIFFERENCE BETWEEN ACTUAL AND FORECAST PROFITS - PERCENTAGE OF SALES METHOD
($ Amounts in Millions)

Name of Company	Av. Percentage of Profits as a Percentage of Sales (a)	Sales Volume in 1956 (b)	Forecast Profits $p_f = a \times \frac{b}{100}$	Actual Profits p_a	Difference Between Actual and Forecast Profits $(p_a - p_f)$
1 Baush Machine Tool Co.	9.84	$4.03	$0.39	$0.44	$0.05
2 Bell Company	- 0.55	6.64	(0.04)	(0.28)	0.24
3 Bishop and Babcock Manufacturing Co.	3.69	5.72	0.21	(0.15)	0.36
4 Brown-McLaren Manufacturing Co.	3.44	1.62	0.05	(0.10)	0.15
5 Carpenter (L.E.) & Co.	- 2.52	3.45	(0.09)	(0.43)	0.34
6 Chief Consolidated Mining Co.	0.74	0.56	0.00	(0.07)	0.07
7 Cleveland-Sandusky Brewing Corp.	5.76	1.38	0.08	0.02	0.06
8 Consolidated Retail Stores, Inc.	2.59	21.04	0.55	(1.77)	2.32
9 Cooper Tire and Rubber Co.	3.13	23.74	0.74	1.07	0.33
10 Curtis Lighting, Inc.	2.01	3.73	0.08	0.15	0.07
11 Dixon (Joseph) Crucible Co.	3.20	12.65	0.41	0.98	0.57
12 E. & B. Brewing Co. Inc.	1.35	0.92	0.01	0.05	0.04
13 Flagg-Utica Corp.	- 1.17	17.18	(0.20)	0.64)	0.84
14 Flotill Products, Inc.	1.73	21.41	0.37	1.92	1.55
15 Flour Mills of America, Inc.	0.44	48.55	0.21	0.97	0.76
16 Gerotor May Corp.	- 5.55	1.34	(0.07)	(0.25)	0.18
17 Gum Product, Inc.	- 4.13	2.10	(0.09)	0.13	0.22
18 Hathaway Bakeries, Inc.	2.81	18.89	0.53	(1.00)	1.53
19 Hiller Helicopters	4.39	9.83	0.43	0.32	0.11
20 Jacob Ruppert	0.03	47.57	0.01	(0.19)	0.20
21 Jeannette Glass Co.	5.69	5.18	0.30	0.44	0.14
22 Jessop Steel Co.	3.06	24.85	0.76	3.47	2.71
23 Lanston Industries, Inc.	10.21	2.91	0.30	(0.02)	0.32
24 Longchamps, Inc.	2.16	7.73	0.17	(0.02)	0.19
25 Macmillan Petroleum Corp.	2.63	14.16	0.37	0.53	0.16

Name of Company	Av.Percentage of Profits as a Percentage of Sales (a)	Sales Volume in 1956 (b)	Forecast Profits $p_f = a \times \frac{6}{100}$	Actual Profits p_a	Difference Between Actual and Forecast Profits ($p_a - p_f$)
26 Maguire Industries, Inc.	- 3.82	$2.50	$(0.10)	$0.08	$0.18
27 Mandel Brothers, Inc.	0.05	31.55	0.02	(0.36)	0.38
28 Merrimac Hat Corp.	2.26	3.04	0.07	0.15	0.08
29 Michigan Bakeries, Inc.	1.72	8.38	0.14	0.27	0.13
30 Morgan's, Inc.	- 2.24	4.76	(0.11)	0.05	0.16
31 National Research Corporation	- 1.49	7.14	(0.11)	0.49	0.60
32 Nelson (N.O.) Co.	1.54	15.62	0.24	(0.09)	0.33
33 Oceanic Oil Co.	17.35	1.85	0.32	0.58	0.26
34 O'Sullivan Rubber Corp.	4.35	6.35	0.28	0.08	0.20
35 Peck, Stow & Wilcox Co.	6.03	2.51	0.15	0.29	0.14
36 Plastic Wire & Cable Corp.	5.29	11.43	0.61	1.48	0.87
37 Plume and Atwood Manufacturing Co.	0.67	10.16	0.07	0.00	0.07
38 Powdrell & Alexander, Inc.	3.67	4.75	0.17	0.73	0.56
39 Queen Anne Candy Co.	4.17	2.73	0.11	0.08	0.03
40 Reis (Robert) & Co.	0.86	4.83	0.04	0.06	0.02
41 Reymer & Brothers, Inc.	1.82	1.73	0.03	(0.01)	0.04
42 Richmond Cedar Works	2.16	1.51	0.03	(0.19)	0.22
43 Rochester & Pittsburgh Coal Co.	2.35	45.76	1.08	1.87	0.79
44 Rock-Ola Manufacturing Co.	0.41	5.97	0.02	0.73	0.71
45 Rudy Manufacturing Co.	0.75	9.03	0.07	1.05	0.98
46 Sandura Co.	- 0.75	8.67	(0.07)	1.00	1.07
47 Scranton Lace Co.	5.34	6.05	0.32	(0.09)	0.41
48 Seneca Falls Machine Co.	- 5.11	2.44	(0.37)	(0.06)	0.31
49 Shasta Water Co.	2.26	2.32	0.05	0.04	0.01
50 Sherman Products, Inc.	3.71	5.84	0.22	0.58	0.36
51 Sidney Blumenthal & Co.	2.14	20.23	0.43	0.27	0.16
52 Stylon Corp.	6.02	6.45	0.39	0.90	0.51

Name of Company	Av. Percentage of Profits as a Percentage of Sales (a)	Sales Volume in 1956 (b)	Forecast Profits $p_f = a \times \frac{6}{100}$	Actual Profits p_a	Difference Between Actual and Forecast Profits ($p_a - p_f$)
53 Unexcelled Chemical Corp.	- 3.29	$1.04	$(0.03)	$(0.17)	$0.14
54 Victor Products Corp.	6.37	5.42	0.35	(0.22)	0.57
55 Wayne Screw Products Co.	7.16	1.18	0.08	(0.06)	0.14
56 Wilson Brothers	1.63	19.55	0.32	0.14	0.18
57 Yolande Corp.	2.64	2.19	0.06	(0.09)	0.15
					24.27

TABLE V

DIFFERENCE BETWEEN ACTUAL AND FORECAST PROFITS - BREAK-EVEN METHOD
($ Amounts in Millions)

	1 (x)	2 (a)	3 (b)	4 (bx)	5 (a+bx)	6 p_f = x-(a+bx)	7 p_a	8 (p_a-p_f)
1 Baush Machine Tool Co.	$4.03	$0.35	0.74	$2.98	$3.33	$0.70	$0.44	$0.26
2 Bell Co.	6.64	3.40	0.67	4.45	7.85	(1.21)	(0.28)	0.93
3 Bishop and Babcock Manufacturing Co.	5.72	0.19	0.93	5.32	5.51	0.21	(0.15)	0.36
4 Brown-McLaren Manufacturing Co.	1.62	0.20	0.78	1.26	1.46	0.16	(0.10)	0.26
5 Carpenter (L.E.) & Co.	3.45	0.53	0.88	3.04	3.57	(0.12)	(0.43)	0.31
6 Chief Consolidated Mining Co.	0.56	0.37	0.71	0.40	0.77	(0.21)	(0.07)	0.14
7 Cleveland Sandusky Brewing Corp.	1.38	0.25	0.75	1.04	1.29	0.09	0.02	0.07
8 Consolidated Retail Stores, Inc.	21.04	10.42	0.62	13.04	23.46	(2.42)	(1.77)	0.65
9 Cooper Tire and Rubber Co.	23.74	0.24	0.94	22.32	22.56	1.18	1.07	0.11
10 Curtis Lighting, Inc.	3.73	0.24	0.86	3.21	3.45	0.28	0.15	0.13
11 Dixon (Joseph) Crucible Co.	12.65	1.31	0.83	10.50	11.81	0.84	0.98	0.14
12 E & B Brewing Co. Inc.	0.92	0.09	0.89	0.82	0.91	0.01	0.05	0.04
13 Flagg-Utica Corp.	17.18	5.24	0.69	11.85	17.09	0.09	0.64	0.55
14 Flotill Products, Inc.	21.41	2.30	0.80	17.13	19.43	1.98	1.92	0.06
15 Flour Mills of America, Inc.	48.55	1.70	0.97	47.09	48.79	(0.24)	0.97	1.21
16 Gerotor May Corp.	1.34	0.64	0.78	1.05	1.69	(0.35)	(0.25)	0.10
17 Gum Products, Inc.	2.10	0.07	0.96	2.02	2.09	0.01	0.13	0.12
18 Hathaway Bakeries, Inc.	18.89	1.85	0.93	17.57	19.42	(0.53)	(1.00)	0.47
19 Hiller Helicopters	9.83	1.48	0.77	7.57	9.05	0.78	0.32	0.46
20 Jacob Ruppert	47.57	3.86	0.90	42.81	46.67	0.90	(0.19)	1.09
21 Jeannette Glass Co.	5.18	1.11	0.66	3.42	4.53	0.65	0.44	0.21
22 Jessop Steel Co.	24.85	3.21	0.68	16.90	20.11	4.74	3.47	1.27
23 Lanston Industries, Inc.	2.91	0.34	0.90	2.62	2.96	(0.05)	(0.02)	0.03
24 Longchamps, Inc.	7.73	0.85	0.87	6.73	7.57	0.16	(0.02)	0.18
25 MacMillan Petroleum Corp.	14.16	2.04	0.82	11.61	13.65	0.51	0.53	0.02
26 Maguire Industries, Inc.	2.50	0.23	0.91	2.28	2.51	(0.01)	0.08	0.09
27 Mandel Brothers, Inc.	31.55	4.99	0.85	26.82	31.81	(0.26)	(0.36)	0.10
28 Merrimac Hat Corp.	3.04	0.65	0.89	2.71	3.36	(0.32)	0.15	0.47

	1	2	3	4	5	6	7	8
	(x)	(a)	(b)	(bx)	(a+bx)	p_f = x-(a+bx)	p_a	(p_a-p_f)
29 Michigan Bakeries, Inc.	$8.38	$0.52	0.90	$7.54	$8.06	$0.32	$0.27	$0.05
30 Morgan's Inc.	4.76	0.65	0.79	3.76	4.41	0.35	0.05	0.30
31 National Research Corporation	7.14	0.02	1.00	7.14	7.16	(0.02)	0.49	0.51
32 Nelson (N.O.) Company	15.62	1.26	0.92	14.37	15.63	(0.01)	(0.09)	0.08
33 Oceanic Oil Company	1.85	0.34	0.51	0.94	1.28	0.57	0.58	0.01
34 O'Sullivan Rubber Corp.	6.35	0.12	0.93	5.91	6.03	0.32	0.08	0.24
35 Peck, Stow & Wilcox Co.	2.51	0.29	0.87	2.18	2.47	0.04	0.29	0.25
36 Plastic Wire and Cable Corp.	11.43	0.43	0.83	9.49	9.92	1.51	1.48	0.03
37 Plume & Atwood Manufacturing Co.	10.16	1.34	0.83	8.43	9.77	0.39	0.00	0.39
38 Powdrell & Alexander, Inc.	4.75	1.22	0.68	3.23	4.45	0.30	0.73	0.43
39 Queen Anne Candy Co.	2.73	0.69	0.72	1.97	2.66	0.07	0.08	0.01
40 Reis (Robert) & Co.	4.83	1.52	0.70	3.38	4.90	(0.07)	0.06	0.13
41 Reymer & Brothers Inc.	1.73	0.34	0.84	1.45	1.79	(0.06)	(0.07)	0.01
42 Richmond Cedar Works	1.51	0.27	0.99	1.49	1.76	(0.25)	(0.19)	0.06
43 Rochester & Pittsburg Coal Co.	45.76	7.48	0.79	36.15	43.63	2.13	1.87	0.26
44 Rock-Ola Manufacturing Co.	5.97	1.79	0.61	3.64	5.43	0.54	0.73	0.19
45 Rudy Manufacturing Co.	9.03	0.19	0.91	8.22	8.41	0.62	1.05	0.43
46 Sandura Company	8.67	0.75	0.84	7.28	8.03	0.64	1.00	0.36
47 Scranton Lace Co.	6.05	1.25	0.75	4.54	5.79	0.26	(0.09)	0.35
48 Seneca Falls Machine Co.	2.44	0.31	0.71	1.73	2.04	0.40	(0.06)	0.46
49 Shasta Water Co.	2.32	0.21	0.90	2.09	2.30	0.02	0.04	0.02
50 Sherman Products, Inc.	5.84	0.34	0.78	4.56	4.90	0.94	0.58	0.36
51 Sidney Blumenthal & Co.	20.23	3.60	0.81	16.39	19.99	0.24	0.27	0.03
52 Stylon Corp.	6.45	0.49	0.73	4.71	5.20	1.25	0.90	0.35
53 Unexcelled Chemical Corp.	1.04	0.11	0.99	1.03	1.14	(0.10)	(0.17)	0.07
54 Victor Products Corp.	5.42	1.15	0.79	4.28	5.43	(0.01)	(0.22)	0.21
55 Wayne Screw Products Co.	1.18	0.18	0.78	0.92	1.10	0.08	(0.06)	0.14
56 Wilson Brothers	19.55	0.19	1.03	20.14	20.33	(0.78)	0.14	0.92
57 Yolande Corp.	2.19	0.91	0.64	1.40	2.31	(0.12)	(0.09)	0.03
								16.51

See Note next page.

NOTE: Column 1 = Volume or Sales Revenue

2 = Fixed Costs

3 = Slope of the Trend Line

4 = Variable Costs

5 = Total Costs

6 = Forecast Profits

7 = Actual Profits

8 = Difference between Actual and Forecast Profits.

operating profits and the actual operating profits, by the break-even method, for the 57 sample firms, totals \$16.51m. The mean difference, in this case, is \$0.2896m, that is, \$16.51m divided by 57.

On the basis of the results shown in Tables IV and V, one would be tempted to conclude that the break-even method produces more accurate forecasts than the percentage of sales method. This, however, would be a rather hasty conclusion unless one subjects the results to a test of significance to determine whether the difference in the results of the two methods was brought about by chance factors. For example, it may be possible that, if the sample of 57 firms had been picked from a different page in the Tables of Random Numbers, the difference in the results might have been in favour of the percentage of sales method or there might not have been any difference in the results.

Therefore, a conclusion regarding the accuracy of the two methods should be arrived at, only after a test of significance has been carried out. For this test, let the symbol, p_1 represent the mean difference obtained by the percentage of sales method and p_2, the mean difference obtained by the break-even method. It is already known that p_1 is equal to \$0.4257m and p_2 is equal to \$0.2896m. As discussed in chapter I, the best way to go about determining whether there is a significant difference between the two means is to set up the null hypothesis that p_1 is equal to p_2 and is also equal to the mean of the universe (π). The rejection of the null hypothesis will mean that there is a significant difference between the two means, while acceptance of the null hypothesis will mean that there is no significant difference between the two means. In order to do this, it is necessary to determine the value of z, where z is the ratio of $p_1 - p_2$ to an estimate of the standard error of the difference between the two sample means. The standard error of the difference between the sample means is:

$$\sigma_{p_1 - p_2} = \sqrt{\sigma^2_{p_1} + \sigma^2_{p_2}}$$

$$= \sqrt{\frac{\pi \tau}{n_1} + \frac{\pi \tau}{n_2}}$$

where: $\sigma_{p_1 - p_2}$ = The standard error of the difference between p_1 and p_2

σ_{p_1} = the standard error of p_1

σ_{p_2} = the standard error of p_2

π = mean of the universe

τ = $1 - \pi$

n = size of the sample

In this study, π is not known. If it is known, it would be better to test p_1 against π and p_2 against π, rather than to examine the significance of $p_1 - p_2$. Since,

π is not known, an estimate, $\bar{p}$, has to be made for it, based on the information in the two samples. Thus:

$$\bar{p} = \frac{p_1 + p_2}{2}$$

$$= \frac{\$0.4257m + \$0.2896m}{2}$$

$$= \frac{\$0.7153m}{2}$$

$$= \$0.35765m.$$

Under the circumstances, the earlier formula:

$$\sigma_{p_1 - p_2} = \sqrt{\frac{\pi \tau}{n_1} + \frac{\pi \tau}{n_2}}$$

now becomes:

$$\hat{\sigma}_{p_1 - p_2} = \sqrt{\frac{\bar{p}(1-\bar{p})}{n_1} + \frac{\bar{p}(1-\bar{p})}{n_2}}$$

This is the same as:

$$\hat{\sigma}_{p_1 - p_2} = \sqrt{\bar{p}(1-\bar{p})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}$$

since:

$p_1 = \$0.4257m$

$p_2 = \$0.2896m$

$\bar{p} = \$0.35765m$

and $n_1 = n_2 = 57$

Therefore:

$$\hat{\sigma}_{p_1-p_2} = \sqrt{\bar{p}\ (1-\bar{p})\ (\frac{1}{n_1} + \frac{1}{n_2})} = \sqrt{\$0.35765m\ (1-\$0.35765m)\ (\frac{1}{57} + \frac{1}{57})}$$

$$= \sqrt{\$0.35765m \times \$0.64235m \times \frac{2}{57}} = \sqrt{\$0.22974m \times \$0.03508m}$$

$$= \sqrt{\$0.00806m} = \$0.08978m$$

$$p_1 - p_2 = \$0.4257m - \$0.2896m = \$0.1361m$$

Since: $z = \dfrac{p_1 - p_2}{\hat{\sigma}_{p_1 - p_2}}$

Therefore: $z = \dfrac{\$0.1361m}{\$0.08978m} = 1.5156$

The determination of the z value, however, alone will not indicate whether the difference between the sample means is significant or not, unless and until the criterion of significance has been established. In chapter I, it was explained that a level of significance of 0.01 should be used and it was also pointed out that since, at this level of significance the value of z is 2.667, the null hypothesis should therefore be accepted if $z \leqslant 2.667$ and should be rejected if $z > 2.667$. It has already been shown that, in this study the value of z is equal to 1.5156. Under the circumstances, the null hypothesis should be accepted and the hypothesis should be rejected. On this basis, a conclusion may be drawn that there is no difference between break-even analysis and the percentage of sales method as a technique for forecasting the future operating profits of firms.

But, it must be pointed out that this conclusion does not hold at all levels of significance. From the t-table in Appendix II, it may be found that, for 57 degrees of freedom, at the 0.10 level of significance, the z value is equal to 1.673 and at the 0.20 level of significance, the z value is equal to 1.297. By interpolation, 1.516 becomes the value of z at the 0.14 level of significance. This means that if a criterion of significance of more than 0.14 level of significance is used, the difference between the two sample means will be significant and the null hypothesis that $p_1 = p_2$ will have to be rejected and the hypothesis that $p_1 > p_2$ will have to be accepted. On the other hand, if a criterion of significance of less than 0.14 level of significance is used, the reverse will be true.

Summary

It was stated in chapter I that the hypothesis is that break-even analysis can be better than the percentage of sales method as a technique for forecasting the future operating profits of firms and the null hypothesis is that there is no difference between break-even analysis and the percentage of sales method as a technique for forecasting the future operating profits of firms.

If the results of the forecasts of break-even analysis and the percentage of sales method are not subjected to a test of significance, the conclusion may be drawn that the former produces more accurate forecasts of operating profits than the latter since the mean of the difference between forecast operating profits and actual operating profits arrived at by the former is smaller than that arrived at by the latter. The null hypothesis would, therefore, be rejected and the hypothesis would be accepted. But, a conclusion of this nature would be somewhat dubious since chance factors could have caused the difference in the means obtained by the two methods.

A test of significance would certainly lend greater validity to the conclusion. But, unfortunately, the results of tests of significance, depend to a large extent on the criterion of significance chosen. It was shown that if a level of significance of greater than 0.14 is chosen, then the difference in the means obtained by the two methods would turn out to be significant. This would mean a rejection of the null hypothesis and acceptance of the hypothesis. On the other hand, if a level of significance of less than 0.14 is chosen, the difference in the means obtained by the two methods would turn out to be not significant. This would permit the acceptance of the null hypothesis and the rejection of the hypothesis, as they have been stated.

The choice of the level of significance depends on the type of error that is to be avoided. In chapter I, it was argued that type error I should be minimised and that a level of significance of 0.01 should be used. With this argument, the null hypothesis should be accepted and the conclusion is that there is no difference between break-even analysis and the percentage of sales method, as a technique for forecasting the future operating profits of firms.

CHAPTER V

SUMMARY AND CONCLUSION

Summary

Break-even analysis is a management aid, which shows the effect of changes in the level of activity on costs, revenue and profits, assuming that other things are equal and break-even charts are graphic presentations of cost-volume-profit relationships. In every break-even chart, there is a break-even point which shows the volume level at which total revenue exactly equals total costs. Break-even charts, however, can also be constructed such that the break-even point shows the point of time in the budgetary period when losses turn into profits. These break-even points are useful in the sense that they are prerequisites to the determination of the margin of safety and also because they indicate the portion of the budgetary period that remains for the accumulation of the contributions to profits. But, their usefulness should not be overemphasised, since they do not remain fixed for long but keep on changing as the factors affecting them undergo change. Besides, they are not as exact as their name seems to suggest.

It is claimed that break-even analysis can be used by management for various purposes. They include profit projections, cost control, price determination and decision-making involving make or buy problems and capital expenditure problems. But in putting break-even analysis to these uses, various assumptions have to be made. These assumptions are as follows:

(a) All costs can be reasonably separated into their fixed and variable components and whereas fixed costs remain fixed at all volumes, variable costs vary in direct proportion to volume.

(b) Selling prices remain constant at all volumes.

(c) Production equals or closely follows sales and all fixed costs incurred in a period are, therefore, deducted from that period's revenue.

(d) There is only one product or if several products are being produced and sold, the sales mix will remain constant.

A test was carried out to determine the usefulness of break-even analysis as a technique for forecasting profits. In this test, break-even analysis was compared with the percentage of sales method. For this test, no adjustments were made to the data, which were taken from Moody's Industrial Manuals. It was found that, at the 0.01 level of significance, there was no difference in the accuracy of the forecasts of the two techniques. The hypothesis that break-even analysis can be better than the percentage of sales method as a technique for forecasting the future operating profits of firms was, therefore, rejected.

Conclusion

Break-even analysis may be relevant for various managerial economic problems. But, in using break-even analysis many restrictive assumptions have to be made. The validity of these assumptions varies with firms. In some firms,

(a) The total costs may be predominated by the cost of items whose prices fluctuate widely.

(b) There may be a great difference between production volume and sales volume in any given budgetary period of time.

(c) Advertising and sales promotion may be very important and highly shiftable.

(d) Many products may be produced and sold. These products may have different margins of return over variable costs and the sales mix may vary greatly.

(e) The product design or technology may change continuously over short periods.

For such firms, the restrictive assumptions are obviously very unrealistic. If break-even analysis is used, the results obtained will be so inaccurate that they will be virtually useless. Under the circumstances, management must either totally abandon the break-even device or make adjustments to overcome the limitations of the assumptions. Fortunately, not all firms are faced with these two alternatives. In some firms, even without adjustments, the assumptions are quite realistic and more accurate forecasts can be made.

In the test in this thesis, it was found that the percentage of sales method is as reliable as break-even analysis, as a technique for forecasting profits. But, it must be emphasised that in the test, in forecasting profits by the break-even method, no adjustments were made to the data. Hence, any conclusion drawn, based on the test, has to be restricted to situations in which no adjustments are made.

On the basis of this study, it may be concluded that management should use the percentage of sales method instead of break-even analysis to forecast profits, if it is not prepared to adjust its data to recognise the effects of changes in the determinants of profits, other than volume. On the other hand, if management is prepared to make the adjustments, it is only possible to state, as far as this study is concerned, that the forecasts by the break-even technique will now be more accurate than if adjustments were not made; but it is not possible to state whether they will be better than those by the percentage of sales method. Further, if adjustments are to be made, management must also realise that some of the advantages of break-even analysis, particularly simplicity and quickness of preparation, have to be sacrificed. Hence, if the managerial staff is pressed for time or if the funds of the firm are limited, it may be advisable not to use break-even analysis altogether. The increase in the accuracy, as a result of the adjustments, may not justify the increase in expense, time and effort that would be required, though it is recognised that other managerial functions such as planning, price-setting and preparation of budgets also require the analysis of cost behaviour and adjustments so that the additional expense, time and effort in making the adjustments, may not be very great.

On the whole, it may be said that this study has a negative approach in the sense that it merely shows the circumstances under which break-even analysis should not be used. But, it does not, in any way, suggest the circumstances under which it would be worthwhile to use the technique. With the co-operation of some firms, further research may be carried out to determine the usefulness of break-even analysis, if adjustments are made.

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APPENDIX I

TABLE OF RANDOM SAMPLING NUMBERS

Twenty-Third Thousand

	1-4	5-8	9-12	13-16	17-20	21-24	25-28	29-32	33-36	37-40
1	36 28	07 30	02 43	06 47	68 07	75 98	37 22	37 01	14 77	49 49
2	46 80	66 58	13 64	16 96	79 41	05 51	83 52	29 44	53 04	91 46
3	04 90	17 03	32 01	20 58	11 18	66 54	88 42	48 07	88 10	87 06
4	10 63	61 17	17 79	62 14	65 09	73 04	93 01	55 88	94 34	27 20
5	55 36	26 07	94 49	22 30	19 23	93 06	66 79	50 25	38 36	66 23
6	46 03	87 32	59 36	92 76	78 05	36 90	74 73	59 54	31 64	34 82
7	18 45	76 86	10 30	07 38	44 22	63 56	39 09	00 59	61 16	44 75
8	39 01	80 71	23 85	94 84	11 33	31 31	64 45	84 77	11 78	30 65
9	91 03	47 63	85 78	81 70	37 23	84 33	33 95	23 29	77 83	75 11
10	70 75	11 26	71 00	64 10	62 72	16 38	13 79	16 89	10 37	02 39
11	16 25	81 61	05 68	76 42	21 90	26 43	14 70	02 44	53 18	41 56
12	82 96	53 77	72 40	98 69	13 26	24 36	66 45	54 48	89 61	00 12
13	10 18	83 39	54 53	19 35	88 25	24 01	24 53	85 35	77 26	71 79
14	95 52	52 18	52 61	43 02	14 06	66 30	89 31	87 69	71 91	38 73
15	20 71	19 87	34 89	01 88	75 68	99 17	49 95	77 45	67 03	14 71
16	14 37	95 90	45 64	04 03	54 86	43 15	81 92	81 66	64 19	31 48
17	70 57	10 43	57 68	02 32	04 27	13 79	91 08	91 52	82 16	80 33
18	16 13	31 57	16 44	74 33	26 49	97 01	57 68	79 02	90 57	34 67
19	88 48	41 44	85 52	45 11	76 75	90 67	31 12	59 62	99 11	59 54
20	23 31	08 29	19 86	64 57	08 54	92 70	48 93	97 09	72 39	45 13
21	90 44	90 43	42 48	15 88	02 29	23 29	84 55	87 51	99 51	88 81
22	09 18	24 51	17 14	99 61	74 52	84 35	79 52	70 75	69 66	60 96
23	67 90	64 98	80 91	43 61	59 75	61 19	07 47	92 65	00 10	24 34
24	84 42	30 70	69 23	51 73	62 12	81 92	25 99	46 28	23 59	04 15
25	89 36	08 56	17 77	94 13	16 48	34 82	75 27	37 09	12 97	83 24

Twenty-fourth Thousand

	1-4	5-8	9-12	13-16	17-20	21-24	25-28	29-32	33-36	37-40
1	65 99	05 25	79 76	15 15	99 77	24 21	20 16	36 89	80 61	15 07
2	91 93	27 47	25 39	67 84	13 84	02 68	59 43	05 79	57 51	49 74
3	60 31	75 41	82 92	67 95	20 57	14 64	81 71	85 06	34 83	78 52
4	89 76	42 80	85 73	09 98	08 80	47 41	38 16	51 06	29 87	80 68
5	31 93	81 18	89 89	35 10	89 38	96 67	46 29	68 83	48 76	26 38
6	49 95	91 68	25 51	66 35	73 44	82 33	03 06	18 77	08 31	17 36
7	79 94	16 42	38 76	63 86	47 49	51 58	42 95	20 11	13 13	12 02
8	48 21	33 20	90 83	92 82	63 19	61 74	78 64	18 51	69 75	43 55
9	14 03	76 52	07 49	25 87	74 67	89 46	90 15	10 67	20 51	06 82
10	08 40	96 14	90 02	33 85	64 27	51 91	27 87	79 54	24 91	01 54
11	61 52	43 78	24 85	44 62	03 11	01 43	47 24	97 73	02 06	21 10
12	49 74	69 27	69 18	93 63	48 41	63 61	88 58	71 55	66 81	00 05
13	43 09	13 36	60 03	58 46	52 50	54 72	99 15	25 30	53 32	33 74
14	76 51	25 20	45 09	53 50	09 32	99 34	55 73	17 25	25 65	65 96
15	58 86	38 07	05 96	85 32	15 37	85 87	78 67	21 01	00 81	53 70
16	37 81	07 33	29 09	60 95	10 69	56 85	84 73	31 02	24 69	78 64
17	89 07	56 65	77 52	20 21	68 58	76 43	55 75	41 21	98 56	60 74
18	92 12	43 89	80 02	65 31	35 83	09 44	54 84	12 87	28 44	07 99
19	16 31	96 77	42 60	56 28	95 13	84 07	88 31	10 83	21 22	46 66
20	87 14	56 15	86 18	54 31	41 06	68 65	61 67	07 97	70 74	56 46
21	66 18	44 68	49 91	73 58	70 83	29 66	13 38	15 10	03 46	77 79
22	88 99	63 64	42 21	09 28	88 85	44 56	64 11	81 33	65 13	82 26
23	36 42	88 02	00 72	72 11	97 47	65 05	56 66	15 11	89 91	19 16
24	69 30	71 10	99 12	20 07	31 18	82 86	89 25	86 82	95 25	81 13
25	09 24	24 75	99 09	91 61	34 66	66 87	86 62	43 88	09 09	84 39

Source: M. G. Kendall and B. B. Smith, Tables of Random Sampling Numbers, Tracts for Computers N o. XXIV, Cambridge: Cambridge University Press, 1951, p. 15.

APPENDIX II

VALUES OF t

FOR GIVEN DEGREES OF FREEDOM (n) AND AT SPECIFIED LEVELS OF SIGNIFICANCE

n	LEVEL OF SIGNIFICANCE					n
	0.20	0.10	0.05	0.02	0.01	
1	3.078	6.314	12.706	31.821	63.657	1
2	1.886	2.920	4.303	6.965	9.925	2
3	1.638	2.353	3.182	4.541	5.841	3
4	1.533	2.132	2.776	3.747	4.604	4
5	1.476	2.015	2.571	3.365	4.032	5
6	1.440	1.943	2.447	3.143	3.707	6
7	1.415	1.895	2.365	2.998	3.499	7
8	1.397	1.860	2.306	2.896	3.355	8
9	1.383	1.833	2.262	2.821	3.250	9
10	1.372	1.812	2.228	2.764	3.169	10
20	1.325	1.725	2.086	2.528	2.845	20
30	1.310	1.697	2.042	2.457	2.750	30
40	1.303	1.684	2.021	2.423	2.704	40
60	1.296	1.671	2.000	2.390	2.660	60
100	1.289	1.658	1.980	2.358	2.617	120
00	1.282	1.645	1.960	2.326	2.576	00

Source: Frederick E. Croxton and Dudley J. Cowden, <u>Applied General Statistics</u>, New York: Prentice-Hall, Inc., 1955, pp. 750-751, Appendix I.

APPENDIX III

OPERATING REVENUE
(In millions of dollars)

Name of Company	1955	1954	1953	1952	1951	1950	1949	1948	1947	1946
1 Auto-Soler Co.	1.56	1.76	2.68	2.33	2.32	1.17	0.08	1.08	1.14	1.07
2 Balsa Chica Oil Corp.	0.97	0.89	0.76	0.71	0.78	0.87	0.69	1.76	0.58	0.48
3 Bausa Machine Tool Company	1.80	3.52	3.88	5.66	3.61	1.87	1.63	2.07	1.26	1.31
4 Bell Company	8.20	11.52	14.53	14.85	16.68	15.94	13.44	-	-	-
5 Bischop & Babcock Mfg. Co.	8.75	4.99	7.20	6.22	3.47	3.16	2.98	4.24	7.17	2.35
6 Brown McLaren Mfg. Co.	1.12	1.29	2.40	1.91	1.55	1.18	0.65	0.83	0.82	0.69
7 Carpenter (L.E.) & Co.	6.65	4.95	4.48	5.96	7.14	3.31	2.02	2.58	2.11	3.90
8 Chief Consolidated Mining Co.	1.06	1.36	0.91	1.33	1.35	1.59	1.63	1.98	1.19	0.95
9 Cleveland-Sandusky Brewing Corp.	1.45	1.42	1.35	1.28	1.27	1.72	1.27	1.12	1.45	1.28
10 Consolidated Retail Stores Inc.	26.49	25.75	28.13	30.02	29.72	29.24	31.51	35.65	31.59	31.62
11 Copper Tire and Rubber Co.	23.63	15.03	22.95	17.06	17.71	13.27	5.94	7.77	11.08	11.02
12 Curtis Lighting	2.64	2.55	1.87	0.98	3.04	2.60	1.69	2.74	2.58	2.21
13 Davega Stores Corp.	23.82	24.75	26.38	26.31	28.84	24.36	24.75	23.31	21.10	-
14 Diamond Motor Car Co.	37.93	25.83	82.11	79.93	50.06	27.09	21.28	37.47	41.68	22.69
15 Dixon (Joseph) Crumble Co.	11.63	10.00	10.38	9.62	11.55	9.01	7.24	8.80	10.04	9.94
16 E & B Brewing Co.Inc.	1.28	1.61	1.57	1.37	.70	0.76	0.79	0.56	0.97	1.32
17 Flagg Utica Corporation	17.42	15.92	18.23	13.41	-	-	-	-	-	-
18 Flotill Products Inc.	17.23	18.19	17.00	13.26	15.11	14.29	8.62	8.46	-	-
19 Flour Mills of America, Inc.	37.55	38.63	62.93	108.14	93.64	80.58	115.30	97.29	54.70	28.08
20 Gerotor May Corporation	1.30	1.84	4.30	4.88	4.81	2.35	1.97	1.66	2.58	1.88
21 Globe America Corporation	4.85	6.80	8.71	7.50	8.39	7.59	5.66	10.06	6.07	1.88

Name of Company	1955	1954	1953	1952	1951	1950	1949	1948	1947	1946
22 Gum Products Inc.	2.11	2.29	2.02	1.95	2.49	2.20	2.58	4.32	-	-
23 Hathaway Bakeries, Inc.	22.73	23.94	26.30	27.62	27.88	27.30	26.19	25.80	22.11	19.78
24 Hiller Helicopters	7.74	6.35	10.37	14.40	6.66	-	-	-	-	-
25 Jacob Rupert	49.12	52.51	57.22	49.83	38.81	30.31	25.80	39.76	43.73	38.63
26Jeannette Glass Company	5.14	4.62	4.66	4.33	4.41	3.42	2.71	2.82	3.73	5.52
27 Jessop Steel Co.	16.40	11.38	15.58	16.53	15.23	8.32	6.44	8.89	11.33	11.25
28 Lanston Industries Inc.	2.98	4.00	3.58	3.14	3.33	3.13	3.88	3.66	2.10	2.46
29 Longchamps Inc.	7.78	7.99	8.77	7.78	7.66	7.90	8.29	8.20	-	-
30 MacMillan Petroleum Corp.	13.71	14.01	16.40	15.95	14.20	11.84	9.48	11.05	9.63	9.00
31 Maguire Industries,Inc.	1.98	1.76	2.14	2.33	2.96	2.70	2.68	3.60	-	-
32 Mandel Brothers Inc.	32.17	30.70	30.55	32.04	34.29	33.98	35.63	36.33	35.07	27.48
33 Merrimac Hat Corp.	2.60	5.99	6.95	7.25	7.68	8.78	8.58	8.80	11.93	13.55
34 Michigan Bakeries,Inc.	7.76	7.26	6.09	5.51	4.84	4.25	3.92	4.33	-	-
35 Mohawk Liquer Corp.	3.91	3.61	3.72	3.22	2.92	2.52	2.96	2.75	1.75	3.80
36 Morgan's Inc.	4.43	3.31	3.29	2.22	1.30	2.28	2.89	3.95	4.02	3.07
37 National Research Corp.	4.23	4.63	3.53	4.12	2.82	1.29	1.41	1.16	0.97	1.32
38 Nelson (N.O.) Company	17.72	15.64	2.68	2.99	4.19	4.30	2.81	4.29	-	-
39 New England Box Company	4.04	3.66	5.55	6.55	7.19	6.75	5.26	6.69	7.36	6.12
40 Oceanic Oil Company	1.88	2.05	1.09	0.81	0.91	-	-	-	-	-
41 O'Sullivan Rubber Corp.	6.48	6.61	6.84	6.61	6.29	5.92	3.97	3.03	4.38	6.20
42 Peck Stow & Willox Co.	2.20	4.33	5.00	5.00	5.09	4.13	4.08	5.13	-	-
43 Plastic Wire and Cable Corp.	8.51	6.20	8.57	9.40	6.06	2.92	2.03	2.31	3.05	2.21
44 Plume & Atwood Mfg.Co.	9.63	9.14	10.51	8.27	10.06	8.82	5.46	6.73	6.70	-
45 Powdrell & Alexander Inc.	6.19	7.51	12.89	15.95	17.83	21.62	18.31	23.06	21.89	20.57
46 Queen Anne Candy Co.	2.84	3.27	3.51	3.54	3.07	3.15	3.05	2.03	2.92	3.34
47 Reis (Robert) & Co.	4.65	4.23	4.82	4.41	4.84	4.69	4.49	6.16	7.59	9.09
48 Reymer & Brothers Inc.	2.25	2.10	2.68	2.90	2.41	2.37	2.59	2.47	2.46	2.22
49 Richmond Cedar Works	1.65	1.68	2.87	2.46	2.85	2.27	2.75	-	-	-

Name of Company	1955	1954	1953	1952	1951	1950	1949	1948	1947	1946
50 Rochester & Pittsburg Coal Co.	38.10	31.80	41.95	42.76	47.88	45.77	-	-	-	-
51 Rock Ola Mfg. Corp.	4.81	4.76	3.28	3.79	4.15	5.22	5.15	5.52	8.12	3.95
52 Ronson Corporation	28.95	24.42	26.48	28.46	34.63	32.50	32.13	28.82	18.18	11.00
53 Rudy Mfg. Company	3.62	3.26	3.56	2.14	2.21	2.76	1.87	2.65	2.36	1.39
54 Sandura Company	4.76	3.56	3.84	5.35	4.43	7.13	4.92	3.86	-	-
55 Scranton Lace Company	6.41	5.82	6.65	7.02	6.97	6.60	6.84	9.08	7.10	5.26
56 Seneca Falls Machine Co.	1.60	3.46	4.07	3.72	2.64	1.10	0.75	0.63	0.77	0.13
57 Shasta Water Company	2.65	1.93	0.54	0.47	0.77	0.76	0.89	0.92	1.12	1.13
58 Sherman Products, Inc.	4.31	3.56	3.73	3.43	2.26	1.03	1.75	2.51	2.12	1.15
59 Sidney Blumenthal & Co. Inc.	22.74	18.49	24.19	25.96	31.34	21.85	15.89	21.85	21.94	22.26
60 Standard Commercial Tobacco Inc.	5.39	3.56	12.84	12.46	2.35	3.15	4.49	3.26	6.66	16.13
61 Stylon Corp.	6.05	3.90	2.16	1.25	2.15	-	-	-	-	-
62 12th Street Store	3.77	3.65	4.12	4.57	4.82	5.08	5.27	5.65	5.74	5.37
63 Unexcelled Chemical Corp.	1.21	4.68	8.45	6.35	3.60	2.72	2.38	3.85	4.83	6.16
64 Victor Products Corporation	6.06	6.63	8.40	7.82	8.49	9.59	8.14	10.81	10.07	5.70
65 Wayne Screw Products Co.	1.64	1.11	1.82	1.68	1.96	1.32	0.99	1.21	1.30	1.03
66 Wilson Brothers	20.39	19.51	21.10	21.11	24.09	21.88	16.73	16.42	16.96	13.28
67 Yolande Corporation	2.23	2.29	2.78	2.26	2.82	2.73	2.85	3.47	3.54	2.85

APPENDIX IV

OPERATING COSTS
(in millions of dollars)

	Name of Company	1955	1954	1953	1952	1951	1950	1949	1948	1947	1946
1	Auto Soler Company	1.43	1.55	2.24	1.96	2.01	1.09	0.84	0.97	0.89	0.84
2	Balsa Chica Oil Corp.	1.08	0.96	0.74	0.72	0.68	1.08	0.72	0.80	0.57	0.39
3	Baush Machine Tool Company	1.77	3.08	3.10	4.54	2.96	1.61	1.55	1.93	1.31	1.88
4	Bell Company	9.49	13.12	14.16	15.69	15.90	13.72	12.13	-	-	-
5	Bishop & Babcock Mfg.Co.	8.29	5.07	6.67	5.97	3.53	3.25	2.83	3.79	7.07	2.37
6	Brown McLaren Mfg. Co.	1.23	1.36	2.11	1.59	1.28	1.08	0.67	0.84	0.81	0.68
7	Carpenter (L.E.) & Co.	6.42	4.82	4.33	5.88	6.83	3.28	2.21	2.81	2.77	3.67
8	Chief Consolidated Mining Co.	1.22	.35	1.15	1.18	1.62	1.57	1.40	1.75	1.14	0.85
9	Cleveland-Sandusky Brewing Co.	1.41	1.46	1.26	1.18	1.15	1.61	1.26	1.22	1.09	1.07
10	Consolidated Retail Stores Inc.	28.21	25.97	27.68	29.42	28.03	28.19	30.20	33.34	29.43	29.04
11	Cooper Tire and Rubber Co.	22.71	14.84	21.93	16.77	16.65	12.16	6.22	7.80	10.76	9.92
12	Curtis Lighting	2.71	2.57	2.07	1.08	2.88	2.44	1.61	2.45	2.34	1.93
13	Davega-Stores Corp.	24.20	25.01	26.21	26.16	27.47	23.35	23.57	21.57	19.01	-
14	Diamond T. Motor Car.Co.	37.71	26.32	80.25	77.61	48.22	26.59	21.09	35.68	38.63	21.46
15	Dixon (Joseph) Crumble Co.	10.76	9.40	10.04	9.56	11.00	8.61	7.28	8.67	9.84	9.37
16	E & B Brewing Co. Inc.	1.30	1.40	1.29	8.87	0.50	1.09	1.02	0.86	1.90	0.80
17	Flagg Utica Corporation	16.88	16.09	18.10	14.56	-	-	-	-	-	-
18	Flotill Products, Inc.	15.87	17.46	16.96	13.57	13.44	12.17	9.07	9.72	-	-
19	Flour Mills of America, Inc.	38.34	39.20	68.02	107.85	92.79	79.36	113.30	93.47	50.44	28.88
20	Gerotor May Corp.	1.71	2.22	4.09	4.36	4.41	4.25	2.06	2.04	2.66	2.00
21	Globe America Corp.	6.02	7.21	8.12	6.88	7.53	6.63	5.27	9.26	6.21	2.50

	Name of Company	1955	1954	1953	1952	1951	1950	1949	1948	1947	1946
22	Gum Products Inc.	1.98	2.17	1.90	2.40	2.19	2.53	3.07	4.73	-	-
23	Hathaway Bakeries Inc.	23.21	24.26	25.02	26.70	26.92	25.92	25.05	24.30	21.24	18.39
24	Hiller Helicopters	7.77	6.46	9.70	12.42	6.11	-	-	-	-	-
25	Jacob Ruppert	49.02	51.59	56.16	48.56	39.06	32.16	28.03	39.76	42.85	35.80
26	Jeannette Glass Company	4.76	4.30	4.22	3.99	4.35	3.49	2.80	2.84	3.31	4.17
27	Jessop Steel Co.	14.67	11.19	14.06	13.83	12.56	7.74	7.29	9.51	12.03	11.56
28	Lanston Industries, Inc.	3.14	4.45	3.20	2.70	2.60	2.47	2.70	2.38	1.55	1.83
29	Longchamps Inc.	8.02	7.64	8.61	7.71	7.45	7.46	7.93	7.97	-	-
30	MacMillan Petroleum Corp.	13.55	13.95	16.45	15.34	13.41	11.65	9.60	10.40	9.06	8.45
31	Maguire Industries, Inc.	1.94	1.66	2.16	2.06	2.72	2.94	3.47	4.41	-	-
32	Mandel Brothers Inc.	32.77	31.91	31.85	33.11	33.78	34.02	35.05	35.47	33.36	26.45
33	Merrimac Hat Corp.	2.69	5.82	6.82	7.12	7.48	8.52	8.41	8.79	11.59	12.02
34	Michigan Bakeries, Inc.	7.52	7.20	6.13	5.66	4.79	4.15	3.71	4.06	-	-
35	Mohawk Liquer Corp.	3.71	3.43	3.44	3.20	2.83	2.39	2.92	2.61	2.11	3.09
36	Morgan's Inc.	4.31	3.38	3.28	2.23	1.76	2.47	3.06	3.71	3.62	2.81
37	National Research Corp.	4.73	4.54	3.53	3.97	2.40	1.33	1.34	1.18	1.17	1.38
38	Nelson (N.O.) Company	17.56	15.85	2.72	2.73	3.91	2.61	2.19	2.56	-	-
39	New England Box Company	3.83	3.67	5.44	6.41	6.84	6.41	5.27	6.16	6.44	5.47
40	Oceanic Oil Company	1.40	1.28	0.91	0.87	0.62	-	-	-	-	-
41	O'Sullivan Rubber Corp.	6.43	6.27	6.53	6.24	5.82	5.44	4.00	2.89	4.12	5.80
42	Peck Stow & Wilcox Co.	1.96	4.52	4.51	4.40	4.51	3.89	4.13	4.67	-	-
43	Plastic Wire and Cable Corp.	7.76	5.59	7.57	7.94	5.23	2.79	2.11	2.34	3.29	2.05
44	Plume & Atwood Mfg. Co.	9.91	9.08	9.86	8.26	9.26	8.54	6.23	6.62	6.43	-
45	Powdrell & Alexander Inc.	5.89	8.56	13.55	16.98	17.64	20.67	18.60	20.37	17.99	14.87
46	Queen Anne Candy Co.	2.72	3.12	3.25	3.26	2.87	2.85	2.92	2.10	3.10	2.97
47	Reis (Robert) & Co.	4.55	4.23	4.82	4.41	4.84	4.69	4.49	6.16	7.59	9.09
48	Reymer & Brothers Inc.	2.25	2.28	2.67	2.75	2.42	2.38	2.58	2.36	2.29	1.95
49	Richmond Cedar Works	1.66	1.39	3.23	2.55	2.59	2.21	2.61	-	-	-
50	Rochester & Pittsburg Coal Co.	37.71	32.43	40.54	41.40	45.34	43.22	-	-	-	-
51	Rock Ola Mfg. Corp.	4.44	4.49	3.81	4.13	4.74	5.34	4.84	5.46	6.59	3.68

Name of Company	1955	1954	1953	1952	1951	1950	1949	1948	1947	1946
52 Ronson Corporation	26.35	24.97	24.97	30.21	28.49	26.05	23.74	19.85	12.59	3.62
53 Rudy Mfg. Company	3.72	3.03	3.37	2.19	2.23	2.79	1.93	2.44	2.18	1.52
54 Sandura Co.	4.59	3.89	4.21	5.48	4.91	6.62	5.00	3.23	-	-
55 Scranton Lace Company	6.36	5.98	6.46	6.96	6.90	6.23	6.32	7.85	6.01	4.53
56 Seneca Falls Machine Co.	1.89	2.91	3.13	2.86	2.03	0.98	0.75	0.69	0.80	0.43
57 Shasta Water Company	2.64	1.85	0.54	0.48	0.80	0.80	0.80	0.82	1.08	1.05
58 Sherman Products, Inc.	3.89	3.31	3.22	3.01	1.84	1.29	1.90	2.06	1.70	1.43
59 Sidney Blumenthal & Co.	24.30	19.78	23.92	25.30	28.65	19.59	16.01	21.15	21.33	19.98
60 Standard Commercial Tobacco Co.	4.92	3.26	11.89	11.45	2.35	3.01	4.29	3.51	6.25	15.65
61 Stylon Corp.	4.78	3.48	2.13	1.30	2.00	-	-	-	-	-
62 12th Street Store	3.86	3.78	4.23	4.72	4.77	5.04	5.20	5.41	5.48	5.06
63 Unexcelled Chemical Corp.	1.44	4.61	8.97	6.52	3.71	2.71	2.45	4.47	4.86	5.39
64 Victor Products Corp.	6.29	7.01	8.09	7.22	7.67	8.77	7.89	9.68	8.44	4.54
65 Wayne Screw Products Co.	1.66	1.13	1.69	1.41	1.64	1.21	0.90	1.07	1.10	0.86
66 Wilson Brothers	20.11	19.44	20.96	21.07	23.86	21.11	16.86	15.96	16.46	12.53
67 Yolands Corporation	2.27	2.37	2.77	2.34	2.86	2.72	2.81	3.14	3.11	2.41

APPENDIX V

OPERATING PROFITS
(in millions of dollars)

	Name of Company	1955	1954	1953	1952	1951	1950	1949	1948	1947	1946
1.	Auto Soler Company	0.13	0.21	0.44	0.37	0.31	0.08	0.04	0.11	0.25	0.23
2	Balsa Chica Oil Corp.	-0.11	-0.07	0.02	-0.01	0.10	-0.19	-0.03	-0.04	0.01	0.09
3	Baush Machine Tool Co.	0.03	0.44	0.78	1.12	0.65	0.26	0.08	0.14	-0.05	0.32
4	Bell Company	-1.29	-1.60	0.37	-0.84	0.78	2.22	1.31	-	-	-
5	Bishop & Babcock Mfg.Co.	0.46	-0.08	0.53	0.25	-0.06	-0.09	0.15	0.45	1.10	-0.02
6	Brown McLaren Mfg. Co.	-0.11	-0.07	0.39	0.32	0.29	-0.10	-0.02	0.01	0.01	0.01
7	Carpenter (L.E.) & Co.	0.23	0.13	0.15	0.08	0.31	0.03	-0.19	-0.23	-0.06	0.23
8	Chief Consolidated Mining Co.	-0.16	0.01	-0.24	0.15	-0.27	0.02	0.23	0.23	0.05	0.10
9	Cleveland Sandusky Brewing Corp.	0.04	-0.04	0.09	0.10	0.12	0.11	0.01	-0.10	0.36	0.21
10	Consolidated Retail Stores, Inc.	-1.72	-0.22	0.45	0.60	0.89	1.05	1.31	2.31	2.16	2.58
11	Cooper Tire and Rubber Co.	0.93	0.19	1.02	0.89	1.06	1.11	-0.28	-0.23	0.32	1.10
12	Curtis Lighting	-0.13	-0.02	-0.02	-0.10	0.16	0.16	0.08	0.29	0.24	0.28
13	Davega Stores Corp.	-0.38	-0.26	0.17	0.15	1.37	1.01	1.18	1.74	2.09	-
14	Diamond Motor Car Company	0.22	-0.49	1.86	2.32	1.84	0.50	0.19	1.79	3.05	1.23
15	Dixon (Joseph) Crumble Co.	0.87	0.60	0.34	0.06	0.55	0.40	-0.04	0.13	0.20	0.57
16	E & B Brewing Co.Inc.	-0.02	0.21	0.28	0.50	0.20	-0.33	-0.23	-0.30	0.07	0.52
17	Flagg Utica Corporation	0.54	-0.17	0.13	-1.15	-	-	-	-	-	-
18	Flotill Products, Inc.	1.36	0.73	0.04	-0.31	1.67	2.12	-0.45	-1.26	-	-
19	Flour Mills of America,Inc.	-0.79	-0.57	-3.09	0.29	0.85	1.22	2.00	3.82	4.26	-0.80
20	Gerotor May Corp.	-0.41	-0.38	0.21	0.52	0.40	0.10	-0.09	-0.38	-0.08	-0.12
21	Glove America Corp.	-0.17	-0.41	0.59	0.62	0.86	0.96	0.39	0.80	-0.14	-0.62
22	Gum Products Inc.	0.13	0.12	0.12	-0.45	0.30	-0.33	-0.49	-0.41	-	-
23	Hathaway Breweries,Inc.	-0.42	-0.32	0.38	0.92	0.96	1.38	1.14	1.50	0.87	1.39

Name of Company	1955	1954	1953	1952	1951	1950	1949	1948	1947	1946
24 Hiller Helicopters	-0.03	-0.11	0.67	1.98	0.55	-	-	-	-	-
25 Jacob Rupert	0.10	0.92	1.06	1.27	-0.25	-1.85	-2.23	0.00	0.88	2.83
26 Jeannette Glass Company	0.38	0.32	0.44	0.34	0.06	-0.07	-0.09	-0.02	0.42	1.35
27 Jessop Steel Co.	1.73	0.19	1.52	2.70	2.67	0.58	-0.85	-0.62	-0.70	-0.31
28 Lanston Industries, Inc.	-0.16	-0.45	0.38	0.44	0.73	0.66	1.18	1.28	0.55	0.63
29 Longchamps Inc.	-0.24	0.35	0.16	0.07	0.21	0.44	0.36	0.23	-	-
30 MacMillan Petroleum Corp.	0.16	0.06	-0.05	0.61	0.79	0.19	-0.12	0.65	0.57	0.55
31 Maguire Industries, Inc.	0.04	0.10	-0.02	0.27	0.24	-0.24	-0.79	-0.81	-	-
32 Mandel Brothers, Inc.	-0.60	-1.21	-1.30	-1.07	0.51	-0.04	0.58	0.86	1.71	1.31
33 Merrimac Hat Corp.	-0.09	0.17	0.13	0.13	0.20	0.26	0.17	0.01	0.34	1.53
34 Michigan Bakeries, Inc.	0.24	0.06	-0.04	-0.15	0.05	0.10	0.21	0.27	-	-
35 Mohawk Liquer Corp.	0.20	0.18	0.28	0.02	0.09	0.13	0.04	0.14	-0.36	0.71
36 Morgan's Inc.	0.12	-0.07	0.01	-0.01	-0.46	-0.19	-0.17	0.24	0.40	0.26
37 National Research Corp.	-0.50	0.09	0.00	0.15	0.42	-0.04	-0.07	0.02	-0.20	-0.06
38 Nelson (N.O.) Company	0.16	-0.21	-0.04	0.26	1.28	1.69	0.62	1.73	-	-
39 New England Box Company	0.21	-0.01	0.11	0.14	0.35	0.34	-0.01	0.53	0.92	0.65
40 Oceanic Oil Company	0.48	0.77	0.18	-0.06	0.29	-	-	-	-	-
41 O'Sullivan Rubber Corp.	0.05	0.34	0.31	0.37	0.47	0.48	-0.03	0.14	0.26	0.40
42 Peck Stow & Wilcox Co.	0.24	-0.19	0.49	0.60	0.58	0.28	-0.05	0.46	-	-
43 Plastic Wire & Cable Corp.	0.75	0.61	1.00	1.46	0.83	0.13	-0.83	-0.03	-0.24	0.16
44 Plume & Atwood Mfg. Co.	-0.28	0.06	0.65	0.01	0.80	0.28	-0.77	0.11	0.27	-
45 Powdrell & Alexander Inc.	0.30	-1.05	-0.66	-1.03	0.15	0.95	-0.29	2.69	3.90	5.70
46 Queen Anne Candy Company	0.12	0.15	0.26	0.28	0.20	0.30	0.13	-0.07	-0.18	0.37
47 Reis (Robert) & Co.	0.10	0.03	-0.02	-0.23	-0.12	-0.08	-0.19	-0.30	0.67	1.53
48 Reymer & Brothers, Inc.	0.00	0.18	0.01	0.15	-0.01	-0.01	0.01	0.11	0.17	0.27
49 Richmond Cedar Works	-0.01	0.29	-0.36	-0.09	0.26	0.06	0.14	-	-	-
50 Rochester & Pittsburg Coal Co.	0.39	-0.63	1.41	1.36	2.54	2.55	-	-	-	-
51 Rock Ola Mfg. Corp.	0.37	0.27	-0.53	-0.34	-0.59	-0.12	0.31	0.06	1.53	0.27
52 Ronson Corporation	2.60	-0.55	1.51	-1.75	6.14	6.45	8.39	8.97	5.59	3.38
53 Rudy Mfg. Company	-0.10	0.23	0.19	-0.05	-0.02	-0.03	-0.06	0.21	0.18	-0.13
54 Sandura Company	0.17	-0.33	-0.37	-0.13	-0.48	0.51	-0.08	0.63	-	-

	Name of Company	1955	1954	1953	1952	1951	1950	1949	1948	1947	1946
55	Scranton Lace Company	0.05	-0.16	0.19	0.06	0.07	0.37	0.52	1.23	1.09	0.73
56	Seneca Falls Machine Co.	-0.29	0.55	0.94	0.86	0.61	0.12	0.00	-0.06	-0.03	-0.30
57	Shasta Water Company	0.01	0.08	0.00	-0.01	-0.03	-0.04	0.09	0.10	0.04	0.08
58	Sherman Products, Inc.	0.42	0.25	0.51	0.42	0.42	0.26	-0.15	0.45	0.42	-0.28
59	Sidney Blumenthal & Co. Inc.	-1.56	-1.29	0.27	0.66	2.69	2.26	-0.22	0.70	0.61	2.28
60	Standard Commercial Tobacco Co.	0.47	0.30	0.95	1.01	0.00	0.14	0.20	-0.25	0.41	0.48
61	Stylon Corp.	1.27	0.42	0.03	-0.05	0.15	-	-	-	-	-
62	12th Street Store	-0.09	-0.13	-0.11	-0.15	0.05	0.04	0.07	0.24	0.26	0.31
63	Unexcelled Chemical Corp	-0.23	0.07	-0.52	-0.17	-0.11	0.01	-0.07	-0.62	-0.03	0.77
64	Victor Products Corp.	-0.23	-0.38	0.31	0.60	0.82	0.82	0.25	1.13	1.63	1.16
65	Wayne Screw Products Co.	0.04	-0.02	0.13	0.27	0.32	0.11	0.09	0.14	0.20	0.17
66	Wilson Brothers	0.25	0.07	0.20	0.04	0.23	0.77	-0.13	0.46	0.50	0.75
67	Yolands Corporation	-0.04	-0.08	0.01	-0.08	-0.04	0.01	0.04	0.33	0.43	0.44

APPENDIX VI

As was mentioned in chapter IV, fortran programming was used to assist in arriving at the values of the constants, a and b in the equation of the straight line trend, $y = a + bx$. The data were submitted to the UBC computing centre in the manner shown in the Fortran Coding Form in the next page. The output of data is as given in Tables IV and V in chapter IV.

UBC Computing Centre

Programmer ________ **FORTRAN CODING FORM** Date ________ Page ____ of ____

STATEMENT NO. | CONT | FORTRAN STATEMENT | IDENTIFICATION

```
  1955  1.56  1.43  0.13
  1954  1.76  1.55  0.21
  1953  2.68  2.24  0.44
  1952  2.33  1.96  0.37
  1951  2.32  2.01  0.31
  1950  1.17  1.09  0.08
  1949  0.80  0.84 -0.04
  1948  1.08  0.97  0.11
  1947  1.14  0.89  0.25
  1946  1.07  0.84  0.23
END
 SAL.  COST PROFIT
AUTO-SOLER CO.
```