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# ECONOMIC DECISION ANALYSIS

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W. J. FABRYCKY  
G. J. THUESEN

*Second edition*

**second edition**

# **ECONOMIC DECISION ANALYSIS**

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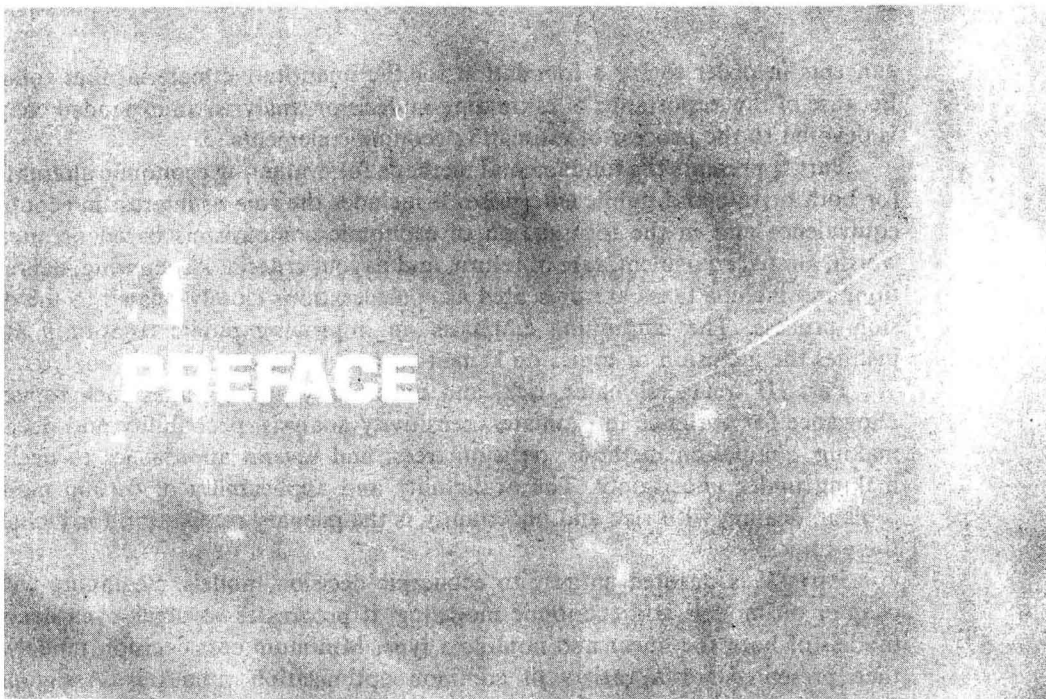
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Matters of national and international economic concern such as taxation, inflation, and the balance of payments are subjects that normally lead to considerable debate. However, when it comes to the economic analysis of specific internal operations of business and industry, the bases for disagreement seem to diminish. Much credit for this is due to the recently accumulated body of systematic knowledge about economic decision making developed by applied economists, operations researchers, management scientists, and others.

This second edition of *Economic Decision Analysis*, like its predecessor, presents methods and techniques of analysis for optimizing the economic outcome of managerial decisions. The observation that economic criteria are of primary importance in most decision situations provides ample justification for the book's consideration by decision makers in professional practice as well as decision makers in training.

This is an applied text planned for use by students in such college courses as business, industrial, or managerial economics; agricultural and forest economics; and engineering technology economics. It is also designed to be used by business and industrial economists, management analysts, and technical staff personnel in business, industry, and government whose task is to assist with the decision making process.

Part I provides background material of a prerequisite nature. The four steps in formulating economic decisions precede a chapter devoted to basic economic

concepts in order to lay a foundation for the quantitative material that follows. Because of the importance of estimating in decision analysis, an expanded chapter is devoted to the process of estimating economic elements.

Part II presents the fundamental methods for evaluating economic alternatives for both private and public enterprise. It includes the role of interest in economic equivalence and in the formulation of economic comparisons based on present worth, annual equivalent, rate of return, and payout criteria. Accounting, depreciation, and income taxes are presented as considerations closely related to the decision process. The continuing emphasis on improving public decision making justifies the inclusion of topics on benefit-cost and cost-effectiveness analysis.

Part III treats estimates, risk, and uncertainty and includes such topics as allowance for variance in estimates, sensitivity analysis, probability and decision making, simulation methods, decision trees, and several approaches to decision making under uncertainty. The availability and applicability of certain modern tools in dealing with risk and uncertainty is the primary motivation for including these topics.

Part IV is devoted entirely to economic decision models. Beginning with a chapter on models and economic modeling, it progresses to break-even decision models of both the linear and nonlinear type. Minimum cost decision models are then presented for a variety of common optimization situations. Assignment, transportation, and general linear programming models follow to illustrate economic decision making in the face of constraints.

Only a minimum background in mathematics, equivalent to one course in college algebra, is needed for a successful study of this book. Knowledge of the calculus would be helpful, but it is not essential for a basic understanding. Our objective is to give students and practitioners alike access to the methods and techniques of economic analysis not heretofore presented in a manner suitable for a broad audience.

Special credit should be given to the many students who have assisted us in refining our thinking about this subject matter and its manner of presentation. We also gratefully acknowledge the editorial and typing assistance provided by Mrs. Marion R. Wheary and the assistance on the solution manual given by Dr. C. S. Park.

W. J. FABRYCKY  
G. J. THUESEN

# CONTENTS

## PREFACE

xi

## part I

## INTRODUCTION

### chapter 1 FORMULATING ECONOMIC DECISIONS

3

- 1.1 The Creative Step 3
- 1.2 The Definition Step 5
- 1.3 The Conversion Step 7
- 1.4 The Decision Step 9

### chapter 2 SOME BASIC ECONOMIC CONCEPTS

12

- 2.1 The Nature of Human Wants 12
- 2.2 Concepts of Value and Utility 13
- 2.3 Consumer and Producer Goods 14
- 2.4 The Economics of Exchange 16
- 2.5 Economic Aspects of Organization 18
- 2.6 The Concept of Supply and Demand 20
- 2.7 The Law of Diminishing Returns 22

vii

**chapter 3     ESTIMATING ECONOMIC ELEMENTS     24**

- 3.1 The Elements to Be Estimated 24
- 3.2 Estimating Income and Outlay 27
- 3.3 Profit as a Measure of Success 29
- 3.4 Classifications of Cost 30
- 3.5 Cost Estimating Methods 34
- 3.6 Adjustment of Cost Data 36
- 3.7 Judgment in Estimating 40

**part II****EVALUATING ECONOMIC ALTERNATIVES****chapter 4     INTEREST AND ECONOMIC EQUIVALENCE     45**

- 4.1 Interest Rate and Interest 45
- 4.2 The Earning Power of Money 47
- 4.3 The Time Value of Money 48
- 4.4 Derivation of Interest Factors 52
- 4.5 The Meaning of Equivalence 64
- 4.6 Equivalence Involving a Single Factor 66
- 4.7 Equivalence Involving Several Factors 72
- 4.8 Nominal and Effective Interest Rates 75
- 4.9 Equivalence Involving More Frequent Compounding 78
- 4.10 Inflation and Interest 83

**chapter 5     METHODS FOR COMPARING ALTERNATIVES     94**

- 5.1 Describing Investment Opportunities 94
- 5.2 Types of Investment Proposals 96
- 5.3 Mutually Exclusive Alternatives and Decision Making 98
- 5.4 Present-Worth Comparisons 102
- 5.5 Annual Equivalent Comparisons 110
- 5.6 Rate-of-Return Comparisons 114
- 5.7 Comparisons Based on the Payout Period 122
- 5.8 Alternatives With Unequal Service Lives 123

**chapter 6     EVALUATING REPLACEMENT ALTERNATIVES     140**

- 6.1 The General Nature of Replacement Analysis 141
- 6.2 Evaluation of Replacements Involving Sunk Costs 143
- 6.3 Replacement Analysis for Unequal Lives 149
- 6.4 The Economic Life of an Asset 152
- 6.5 Replacement Analysis Based on Economic Life 156
- 6.6 Examples of Replacement Analyses 159

**chapter 7 ACCOUNTING, DEPRECIATION, AND INCOME TAXES 172**

- 7.1 General Accounting 172
- 7.2 Cost Accounting 175
- 7.3 Depreciation Accounting 178
- 7.4 Depletion Accounting 184
- 7.5 Depreciation and Tax Considerations 187
- 7.6 Corporation Federal Income Tax 193
- 7.7 Individual Federal Income Tax 198
- 7.8 After-Tax Economic Analyses 202

**chapter 8 EVALUATING PUBLIC ACTIVITIES 214**

- 8.1 General Welfare Aim of Government 214
- 8.2 The Nature of Public Activities 216
- 8.3 Financing Public Activities 218
- 8.4 Benefit-Cost Analysis 221
- 8.5 Identifying Benefits and Disbenefits 229
- 8.6 Cost-Effectiveness Analysis 232

**part III****ESTIMATES, RISK, AND UNCERTAINTY****chapter 9 TREATMENT OF ESTIMATES 245**

- 9.1 An Example Decision Based on Estimates 245
- 9.2 Allowance for Variances in Estimates 247
- 9.3 Considering a Range of Estimates 249
- 9.4 Sensitivity Analysis 250

**chapter 10 DECISION MAKING INVOLVING RISK 256**

- 10.1 Expected Value Decision Making 256
- 10.2 Expectation Variance Decision Making 260
- 10.3 Decision Making by Simulation Methods 261
- 10.4 Decision Making With Decision Trees 267

**chapter 11 DECISION MAKING UNDER UNCERTAINTY 285**

- 11.1 The Payoff Matrix 285
- 11.2 The Laplace Rule 287
- 11.3 The Maximin and Maximax Rules 288
- 11.4 The Hurwicz Rule 289
- 11.5 The Minimax Regret Rule 291
- 11.6 Summary of Decision Rules 292



**part IV****ECONOMIC DECISION MODELS**

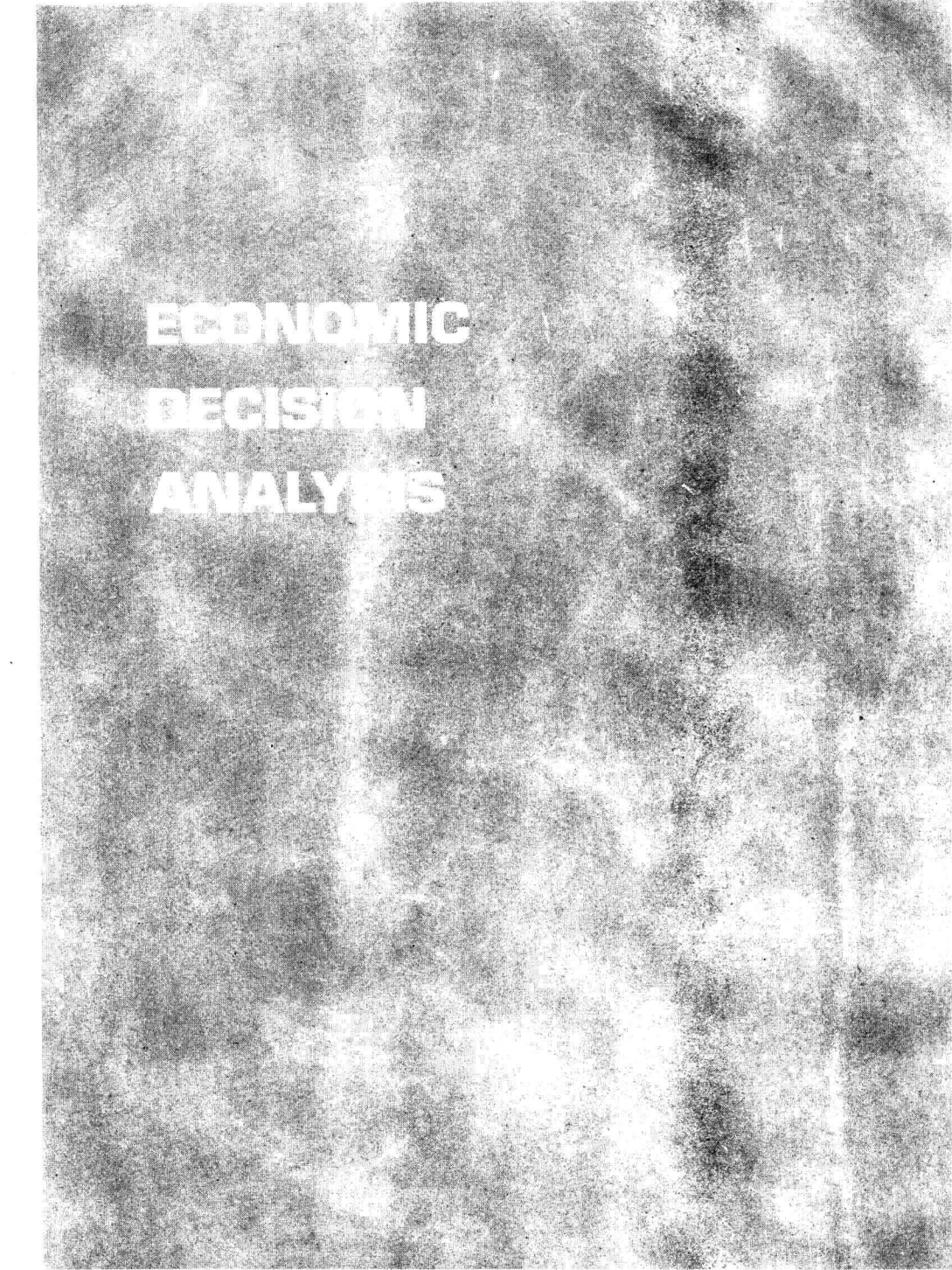
<b>chapter 12</b>	<b>MODELS AND ECONOMIC MODELING</b>	<b>299</b>
12.1	Models and Simulation	299
12.2	Formulating Decision Models	301
12.3	Economic Modeling of Operations	302
<b>chapter 13</b>	<b>BREAK-EVEN DECISION MODELS</b>	<b>306</b>
13.1	Break-Even Analysis of Alternatives	306
13.2	Linear Break-Even Models for Profit Analysis	312
13.3	Nonlinear Break-Even Analysis	317
13.4	Break-Even Analysis Involving Price	322
<b>chapter 14</b>	<b>MINIMUM COST DECISION MODELS</b>	<b>329</b>
14.1	Formulation of the Minimum Cost Model	329
14.2	Minimum Cost Models for Inventory Operations	331
14.3	The Manufacture or Purchase Decision	337
14.4	Minimum Cost Models for Queuing Operations	338
14.5	The Minimum Cost Life of an Asset	344
<b>chapter 15</b>	<b>LINEAR PROGRAMMING MODELS</b>	<b>348</b>
15.1	The Assignment Model	348
15.2	The Transportation Model	354
15.3	The General Linear Programming Model	362

**part V****APPENDICES**

<b>appendix A</b>	<b>FORMING MUTUALLY EXCLUSIVE ALTERNATIVES</b>	<b>375</b>
<b>appendix B</b>	<b>APPLYING DECISION CRITERIA WHEN MONEY IS LIMITED</b>	<b>378</b>
<b>appendix C</b>	<b>BASIC PROBABILITY THEORY</b>	<b>381</b>
<b>appendix D</b>	<b>THE SIMPLEX OPTIMIZATION METHOD</b>	<b>386</b>
<b>appendix E</b>	<b>INTEREST TABLES</b>	<b>391</b>
<b>appendix F</b>	<b>SELECTED REFERENCES</b>	<b>418</b>
<b>INDEX</b>		<b>421</b>

**part I**

# **INTRODUCTION**

The background of the cover is a dark, grainy, and textured surface. A prominent vertical light streak or highlight runs down the center of the image, creating a sense of depth and contrast. The overall appearance is reminiscent of a high-contrast, black-and-white photograph of a rough or metallic surface.

# **ECONOMIC DECISION ANALYSIS**

# **chapter 1**

## **FORMULATING ECONOMIC DECISIONS**

Both individuals and enterprises pursue objectives in the face of limited resources. This makes it desirable to obtain the greatest output for a given input; that is, to operate at high efficiency. The search should not be for a fair or good opportunity for the use of limited resources, but for the best opportunity. The subject of this text is concerned with decision making for the efficient use of limited resources.

A good overview of economic decision analysis can be obtained by considering the four essential steps in formulating economic decisions. These are the creative step, the definition step, the conversion step, and the decision step. Taken together, these steps constitute a systematic approach to the efficient use of limited resources which will aid in arriving at profitable decisions.

### **1.1. THE CREATIVE STEP**

When known opportunities fail to offer sufficient promise for the profitable employment of limited resources, more promising opportunities are sought. People with vision are those who accept the premise that better opportunities exist than are known to them. This view, accompanied by initiative, leads to exploration, investigation, research, and similar activities aimed at finding better opportunities. In such activities steps are taken into the unknown to find new opportunities and then to determine their value compared to known opportunities. Such steps are



creative in nature and are part of the challenging task of discovering new opportunities.

**The Economic Opening.** Opportunities are not made; they are discovered. The person who concludes that there is no better way makes a self-fulfilling prophecy. When the belief is held that there is no better way, a search for one will not be made, and a better way will not be discovered.

The *creative step* in economic decision analysis consists essentially of finding an opening through a barrier of economic and physical limitations. When aluminum was discovered, uses had to be found that would enable it to be marketed, and means had to be found whereby its physical characteristics could be improved and its production cost reduced. The legality of collecting fees for regulating parking as contrasted to making a charge for the use of parking space was the factor on which exploitation of the parking meter depended.

Economic limitations are continually changing with the needs and wants of people. Physical limitations are continually being pushed back by the advance of science and technology. Consequently, new openings that reveal new opportunities are continually developing. For each successful venture, an opening through the barrier of economic and physical limitations has been found.

**Search for Facts and New Combinations of Facts.** Any situation embraces groups of facts, some known and some unknown. The material for new opportunities for profit must be fashioned from the facts as they exist.

Many successful ideas are simply new combinations of commonly known facts. The highly successful device called a skateboard is the result of combining two simple ideas. The wheels from skates and a small version of the board used in surfing were combined to make it possible for people to experience aspects of both skating and surfing. The exploiters of the resulting new combination are reported to have profited handsomely.

Some successful ideas are dependent upon the discovery of new facts. New facts may become known through research or by accident. *Research* is effort consciously directed to the discovery of new facts. In *basic research*, facts are sought without regard for their specific usefulness, on the premise that knowledge will in some way contribute to people's welfare. *Applied research* is effort consciously directed to the discovery of new facts needed to solve a specific problem.

Aside from the often-quoted statement that "inspiration is ninety percent perspiration," there are few guides to creativeness. It appears that both conscious application and inspiration may contribute to creativeness. Some people seem to be endowed with exceptional aptitudes for conceiving new and unusual ideas.

It may be presumed that a knowledge of facts in a field is a necessity for creativeness in that field. For example, it appears that a person who is proficient in the technology of combustion and machine design is more likely to contrive a superior automobile engine than a person who has little or no such knowledge.



It also appears that knowledge of people's desires as well as of economic facts which exist is necessary to conceive of opportunities for profit.

**Circumventing Factors Limiting Success.** Circumventing factors limiting success are related to the search for better means for achieving objectives. Once these *limiting factors* have been identified, each may be examined to ascertain if one or more can be conveniently altered or overcome to permit attainment of the objective. A limiting factor that may be expediently resolved or removed is called a *strategic factor*.

The understanding that results from the delineation of limiting factors, and their further consideration to arrive at the strategic factors, often stimulates the conception of improvements. There is obviously no point in operating upon some factors. Consider, for example, a situation in which a truck driver is hampered because he had difficulty in loading his truck with a heavy box. Three factors are involved: the pull of gravity, the mass of the box, and the strength of the man. Not much success would be expected from an attempt to lessen the pull of gravity, nor is it likely that it is feasible to reduce the mass of the box except, possibly, by repackaging. A stronger man might be assigned, but it seems more logical to consider overcoming the need for strength by devices to supplement the strength of the man. A consideration of the strength factors would thus lead to consideration of devices that might circumvent the limiting factor of strength.

The creative step has been given emphasis, for it is believed to be of first importance in the profitable employment of limited resources. It is directly related to the delineation and selection of objectives that are, without doubt, the first steps toward success in any field of endeavor. Since the mental processes involved are in large measure illogical, this step must be approached with considerable alertness and curiosity and a willingness to consider new ideas and unconventional patterns of thought.

## 1.2. THE DEFINITION STEP

In the *definition step*, alternatives which have originated in the creative step, or which have been selected for comparison in some other way, are defined. The aim should be to delineate each alternative on the basis of its major and subordinate activities. The purpose of this is to ensure that all factors associated with each alternative will be considered in its evaluation. Both quantitative and qualitative factors should be included. Although qualitative items cannot be expressed numerically, they are often of major importance and should be listed separately for consideration in the final evaluation.

**Choice Is Between Alternatives.** Except in unusual situations, there are several possible courses of action available to an individual or an organization. But each choice involves limitations of resources, time, and place. Thus, an individual may

have the resources, time, talent, and desire to pursue activity *A* or activity *B* to successful conclusion. But one may find that both *A* and *B* cannot be pursued, and a choice must be made.

Courses of action between which choice is contemplated are conveniently called alternatives. The conception of alternatives is a creative process. A complete, all-inclusive alternative rarely emerges in its final state. It begins as a hazy but interesting idea. The attention of the individual or group is then directed to analysis and synthesis, and the result is a definite proposal. In its final form, an alternative should consist of a complete description of its objectives and its requirements in terms of resource inputs.

The term *alternative* implies both a means and an end. For example, purchasing from vendor *A* is a course of action which results in the accumulation of an inventory. But accumulating an inventory may be considered as a course of action which will result in the support of manufacturing operations. All proposed alternatives are not equally desirable, since each will involve the consumption of different amounts of scarce resources. The accumulation of an inventory required for the support of manufacturing operations may be accomplished by means other than purchasing from vendor *A*. The course of action most appropriate in the light of the overall objective sought and the resources consumed will be considered to be best.

Alternatives are frequently proposed for analysis even though there seems to be little likelihood that they will prove feasible. This is done on the thought that it is better to consider many unprofitable alternatives than to overlook one that is profitable. Alternatives that are not considered cannot be adopted no matter how desirable they might prove to be. The criterion for judging the desirability of an alternative is its expected result in comparison with the anticipated result of other alternatives that may be undertaken.

It may also be noted that there are costs associated with seeking out and deciding upon undertakings. The cost of seeking out desirable undertakings is a charge that must be deducted from the income potentialities of the activities that are decided upon. This limits the outlay that can be justified for search on the basis of economy. The measure of the net success of a venture may be thought of as being the difference between its potentialities for income and the sum of the outlay incurred in finding and deciding to undertake it and the outlay incurred in its completion.

**Not All Alternatives Can Be Considered.** The objective of economic decision analysis is to find the best opportunity for the employment of limited resources. However, this objective can rarely be realized, for this would require that all possible alternatives of a situation be delineated for comparison with each other. It is essential to remember that alternatives are not outlined and evaluated without cost and the passage of time.

As an example, consider the following situation. The attention of a superintendent was directed to a loss of heat from a bare pipe in his chemical plant. The

superintendent calculated the heat loss and found it to be \$260 per month. Insulation that would reduce the heat loss by \$240 per month was offered by a salesperson for \$680. The superintendent thought he could secure the needed covering for less and actually accepted a bid for \$630 three weeks later. Thus, the lapse of time in seeking a better alternative had resulted in a saving of \$50 on the insulation and a heat loss of \$180 that could have been prevented by accepting the first offer.

Similarly, the cost of considering alternatives will ordinarily force a choice before all possibilities are considered. Suppose that a computing service company is seeking a location for a branch office. Such an office might be located in many cities. Obviously, the cost of investigating all the possibilities would be prohibitive. Any cost of investigating a location beyond the first must be recovered through increased profit. This establishes a limit beyond which additional study cannot be justified.

Alternatives may be limited by a progressive series of assumptions. If the limiting assumptions are sound, no desirable alternatives will have been excluded. Knowledge and judgment which will enable consideration of none but desirable alternatives without excluding any that are desirable are most valuable.

Consider the problem of selecting a dam site for a reservoir. The cost of constructing a dam with the required storage capacity can be estimated for each point along a river. To make each estimate, a detailed study of the foundation requirements, available and required access roads, distance from construction materials, and other items would have to be made for each site. Then this large amount of cost data would be compiled and the dam site with the least cost selected.

Actually, the construction engineer would proceed with detailed cost estimates for only a few desirable alternatives. By utilizing a topographic map, he may pick out a few promising sites and disregard the rest. The engineer may do this with confidence if he is sufficiently familiar with dam construction to know that the excluded sites would have a higher cost. Next, he may make approximate estimates of the cost of these sites assuming normal foundation conditions. Finally, the two or three sites which promise to result in the lowest cost are studied in detail through test borings to obtain accurate foundation cost information. The selection of the site for the dam is then based on detailed cost information for these sites.

### 1.3. THE CONVERSION STEP

Alternatives may be compared directly if they are converted to a common measure. The common denominator applicable in economic comparisons is value expressed in terms of money. Most other measures which appear in various activities, such as time, distance, and quantity, may often be converted to monetary terms. This is because of the pervasive nature of the economic system in which we live.

The first phase of the *conversion step* is to convert the prospective output and

input items enumerated in the definition step into receipts and disbursements at specified dates. This phase consists of appraising the unit value of each item of output or input and determining their total amounts by computation. On completion, each alternative should be expressed in terms of definite cash flows occurring at specified dates in the future, plus an enumeration of qualitative considerations that are impossible to reduce to money terms. For such items the term *irreducibles* is often employed.

The second phase of the conversion step consists of placing the estimated future cash flows for all alternatives on a comparable basis, considering the time value of money. This involves employment of the techniques presented in Part II of this text. Selection of the particular technique depends upon the situation, and its appropriateness is a matter of judgment.

Consideration of inherent inaccuracies in estimates of future outputs and inputs is part of the conversion step and should not be overlooked. Part III of this text addresses this topic and also presents techniques for decision making under risk and uncertainty.

The conversion step often requires the formulation of an economic decision model to aid the decision maker. When this is the case, an effectiveness function is formulated for the situation which relates variables under direct control of the decision maker to those not directly under his control. Values for the decision variables which will result in optimum effectiveness are then sought. Part IV of this text treats the process of decision making with the use of decision models.

The final phase of the conversion step is to communicate the essential aspects of the study, together with an enumeration of irreducibles, so that they may be considered by those responsible for making the decision. A proposal should be explained in terms that will best interpret its significance to those who will control its acceptance. The aim of a presentation should be to take persons concerned with a proposal on an excursion into the future to experience what will happen if the proposal is accepted or rejected.

Suppose that a proposal for a new pollution control system is to be presented. Since those who must decide if it should be adopted rarely have the time and background to go into and appreciate all the technical details involved, the significance of these details in terms of economic results must be made clear. Of interest to those in a position to decide will be such things as the present outlay required, capital recovery period, flexibility of the system in event of production volume changes, effect upon product price and quality, and difficulties of financing. Cost and other data should be broken down and presented so that attention may be easily focused upon pertinent aspects of the proposal. Diagrams, graphs, pictures, and even physical models should be used where these devices will contribute to understanding.

The aim of economic analysis is to contribute to a sound decision. Thus, a first consideration should be to present a proposal in terms that will help those who must decide to understand the implications of the proposal to the fullest extent possible.