PRIVATE AND PUBLIC INVESTMENT ANALYSIS

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Preface

This brief, self-contained book is designed to make the methods of project evaluation used by professional investment analysts comprehensible and directly applicable for both college students and the general public. It is intended as a supplemental text in business management and economics and may be used in such investment-oriented courses as real estate, security markets, and engineering economics. The book will also be of interest to anyone with investment motives: real estate investors, security buyers, business people, and public administrators.

No previous background in economics or mathematics is assumed. We emphasize the basic understanding of the analyses rather than mechanical, arithmetic manipulation. To promote the reader's grasp of the procedures we develop some economic theory and show typical calculations in sequential steps. However, once the procedures are understood, the reader's own analysis of his or her investment opportunities can easily be done using the table values provided in the appendix or with an inexpensive, preprogrammed pocket calculator.

Part I (five chapters) deals with commercial project assessment methods and their underlying conceptual bases. The perspective is that of the rational, private individual in considering investment opportunities. Part II (four chapters and a retrospective overview) expands the discussion to cover social project evaluation. The viewpoint is that of a public servant analyzing investment options from the public perspective. Each chapter is summarized; no footnotes are used. The chapters are followed by exercises in a multiple-choice format, with the correct answer immediately available, and by short essay questions to aid the reader in organizing and assimilating the chapter material.

The book can serve specific aims in various course adoptions. In *microeconomic theory* and *managerial economics* courses, the established core texts concentrate heavily on single-period optimization—the short run. The emphasis is on the current efficient operation of an existing facility. Actual businesses, however, are conducted over time, and that implies the desirability of multi-period optimization—the long run.

Indeed, to decide whether to undertake a given project, the decision-maker needs to assess the expected flows of costs and benefits. To make these calculations, he or she needs to perform short-run microanalysis for each period forthcoming, given the technical characteristics of the project and reliable market projections. With these the analyst can estimate the revenues and costs and thus the implied profits for each period. The long run consists of nothing more than the individual short runs that will constitute the life of the project. *Investment analysis is thus synonymous with long-run microeconomic analysis*. That is the topic of our book.

The available alternatives must not only be compared on a common basis (monetary value) but they also have to be converted to a common point in time. To do the latter, reliance is placed on an interest-discount operation. Despite the importance of the topic in project analysis, the standard practice has been to discuss the role of interest, when it is discussed at all, in the subjective, ideological context of income distribution or to simply relegate the topic to macroeconomics and monetary theory.

To deal with these limitations in the existing literature, our book makes two contributions. We identify expected profits as the motive force in the investment, capital formation process. The producer's surplus is identified and explained as total revenue less variable costs. The concept is then systematically used in one family of project evaluation methods discussed in detail. The stream of pure profits forms the numerical basis for an alternative set of procedures.

Our second emphasis is on a clear and consistent explanation of the nature and origins of interest and the reasons for its use in discounting future cost and benefit streams. We carefully relate the theoretical issues involving the potential profitability of alternative investments over time to the origin and meaning of time preference and the productivity of capital. The discounting concept and process are explained rather than viewed as an exercise in algebra.

Courses in *engineering economics* are a standard requirement in engineering curricula and are often taught in the engineering schools themselves. While there are obvious advantages to the core text being prepared by engineers, there are disadvantages as well. However well the presentations may illustrate engineering possibilities, the emphasis in established texts is on the mechanics of the discounting process on given numbers; students already well trained in mathematics find that their time is being focused on straightforward calculations. By contrast, our emphasis is on developing the student's understanding of the interest discount rate concept and on the rationale for the discounting process. Similarly, since the working engineer as a project evaluator will need to know the essential meaning of the cost-benefit flows in order to identify them for analysis, our book provides a brief but systematic treatment of the necessary economic theory.

Instructors of other investment related courses—whether in real

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estate, securities analysis, public administration, or other fields—will also find this volume of interest to their students. The authors, both microeconomists, have drawn on their combined backgrounds in planning, cost-benefit analysis, quantitative methods, environmental economics, comparative systems, and engineering economics to include a variety of topics, all organized around the theme of the rational analysis and evaluation of investment projects.

We would like to extend our appreciation to Rosa Housman, secretary to the Department of Economics at Portland State University, for her patience and professional typing and to Dr. David A. Moser for his careful reading of the manuscript and for his suggestions. The work is dedicated to our parents: Julie E. Palm, Erik V. Palm, Haji Mohamed Ilyas, and R. Mohamed Ilyas.

Thomas Palm
Abdul Qayum

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PART ONE

PART ONE

1 Introduction

1.1 The Aim of This Book

People in all walks of life—organized as households, businesses, and public agencies—must make investment decisions. In our private lives, we have to decide how to allocate the income and borrowed funds of our household between current consumption and saving. If we choose to save, we may do so by utilizing various bank accounts, government securities, or shares of stock, or we may start a business of our own. Thus, if we save, we also, in some sense, invest. In the business world, decisions are regularly made not only about production techniques and the product mix, but also about the size and nature of an enterprise itself. The birth, growth, and death of an enterprise all involve matters of choice. Similarly, the assets of the public have various competitive uses. Appropriate public employees must somehow decide which of the often conflicting goals of the public are to be pursued, and how that is to be done. In each case, investment decisions can be made well or badly, but they must be made.

This volume is intended as an introduction to the rational analysis and evaluation of investment projects. It develops conceptually sound, yet readily grasped, evaluative methods that are useful in assessing both existing and proposed activities. Although these techniques have been drawn from the contemporary literature on investment and cost/benefit analysis, the emphasis is on practicality rather than on theoretical detail. Nonetheless, this book develops conceptual issues sufficiently to permit an understanding of the evaluative techniques. General arguments are illustrated and developed with simple but suitable numerical values.

Although investment analysis is inherently mathematical, the tedium that once characterized "number crunching" is a thing of the past. Rapid developments in hand-held calculators and in computer technology have made it relatively easy, swift, and inexpensive to perform the necessary calculations. The examples and exercises in this volume can readily be processed by the preprogrammed financially oriented calculators on the market today. Alternatively, you may wish to use the calculated factors provided in the Appendix.

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1.2 Definitions of Capital, Investment, and Investment Appraisal

In formal economics, the term **capital** is restricted to reproducible assets, the physical stock of tools held by the members of a society or owned collectively by the society. This real capital is defined to include residences, industrial plants, equipment, and inventories. The process by which such real tools are created over time is known as capital formation, or real **investment**. Conversely, the process by which such stocks lose value due to physical deterioration or obsolescence is called **depreciation**, or disinvestment.

In more common usage, noneconomists think of capital as including both physical property and financial assets. Thus, investing in savings accounts, stocks, or bonds is seen as an alternative to building, say, a new apartment house. But stocks, bonds, titles, deeds, and, indeed, money itself represent control over other, real assets. An economist would point out that financial documents have value only if the underlying real capital does.

The investor does have to choose among the direct construction of new physical capital, the purchase of existing real assets, and the purchase of shares of stock, bonds, or other securities. Thus, for purposes of project analysis, we shall treat new construction (real capital formation), a change of ownership (an asset transfer), and indirect, financial participation in projects as investment alternatives. In the general sense used in this book, an *investment* means a commitment to some costs in exchange for an anticipated flow of benefits.

An **investment appraisal** is the evaluative process of deciding whether or not a proposed investment should be undertaken or, if there is already an ongoing process, whether that activity should be continued, altered, or terminated. We should be careful not to confuse the project with its evaluation. A *project* consists of a series of economic activities taking place over time; a *project analysis* is an evaluation of the expected nature of future events to determine the current attractiveness of the project. The appraisal process can be divided into two steps: (1) the *quantification* of the costs and benefits expected, and (2) the *evaluation* of the proposed investment.

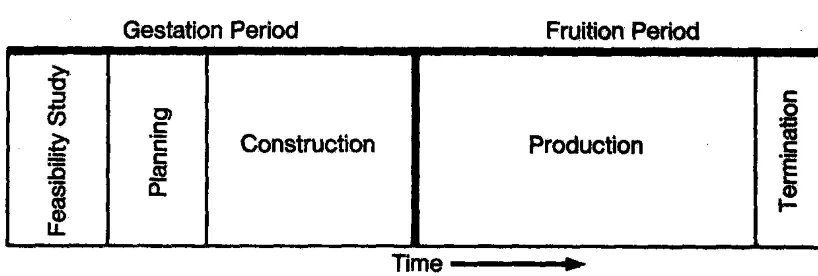
The first two chapters of this book emphasize the identification of the relevant costs and benefits of a project, whenever they are expected to occur. The focus then shifts to techniques for evaluating an investment, given the flows of costs and benefits per period over the life of the investment.

1.3 The Scope and Stages of a Project

To be amenable to analysis, a project must be well defined. Therefore, one must consider early in the evaluation the extent to which the various components of the undertaking are separable, both conceptually and in fact. If two activities are theoretically distinct but cannot be practically separated, it will be necessary to treat them as a single project. For example, a project to grow wool will require decisions about mutton as well. Sometimes activities are not necessarily related, yet a cursory analysis suggests the likelihood of gains from pursuing several goals simultaneously. For example, a dam being planned for the production of electricity immediately suggests added possibilities in terms of irrigation, flood control, and recreation. Such a case would typically be considered a single, multipurpose project.

A project may involve several stages that span activities ranging from the initial screening of the proposal to the eventual termination of production activities. This sequence is illustrated in Figure 1.1. The preproduction, or gestation, phase of the undertaking often begins with an initial screening process—the feasibility study—for physical and financial attributes. If, for example, a proposed site could not bear the weight of the suggested structure or if construction costs would almost certainly exceed the available funding, the project would be terminated at the outset. If the project appears to be feasible, detailed planning would follow, possibly leading to construction itself. Once built, the plant would be in its fruition phase and would engage in production activity until termination.

FIGURE 1.1
Project: A Proposed Factory



We have already noted that a particular investment analysis may not necessarily involve estimates for the values of all of the above phases since some of them may already have occurred. If the associated costs are not recoverable or reversible, they are called **sunk costs.** These might include fees for previous feasibility studies or options on land. The sunk costs are not relevant to the decision. Therefore, the present moves to the right on the diagram, eliminating the activities to the left of it, i.e., in the past, from the evaluation of the investment. The proposed investment also could be narrower than full ownership. We might consider becoming a partial owner of the factory through investing in shares, or we could become a creditor through investing in its bonds.

Whatever the investment, the same basic analytical techniques are involved. When the emphasis of the evaluation is on the physical attributes of a project, we speak of *engineering economics*. When we contemplate existing structures, we think of the analysis of *real estate*. When we consider indirect participation through stocks or bonds, we are doing *securities analysis*. Since new construction, purchase of existing real assets, and financial participation are often alternative forms of investment, it is not surprising that the analyses used are essentially equivalent. Therefore, the methods developed in this volume are of use to all investors, regardless of what they invest in.

1.4 Monetary Value as a Means of Comparison

Any good is produced only because it is expected to yield a service—a benefit—of some sort. But the provision of such benefits necessarily involves costs. Although we usually think of the monetary payments made to attract resources into a given project as the costs of the project, there is a far more fundamental concept of the costs involved.

In every society, all goods are made with some combination of raw materials, human effort, and tools. Economists refer to these inputs as resources of land, labor, and capital. Since no individual or society has enough resources to permit the satisfaction of all wants, it follows that every individual and society must decide which wants to satisfy and which wants to leave unsatisfied. The scarcity of resources itself implies that something must be left undone.

In the most fundamental sense, the real cost of anything is that which is sacrificed to attain the given goal. *Cost is a sacrificed opportunity, the best alternative forgone.* Since scarcity is a universal human condition, real opportunity cost applies to all societies, whether they are organized by markets, central planning, or otherwise. Although the cost of anything consists of the best alternative sacrificed to achieve it, that cost is usually measured in terms of money. The money spent on this book, for example, could have provided another book, a meal, or some other commodity. The money that society spends on schools could go into armaments, parks, etc., or it could be returned to the taxpayers. But why do we state prices and costs in money terms, rather than simply stating the actual alternatives?

Suppose that the goal of a public investor—a state development agency—is to facilitate the flow of commerce across a river. This goal could be accomplished by digging a tunnel, building a bridge, or by operating a ferry or flying shuttle service. The choices are as dissimilar as those facing the private investor contemplating the construction of new buildings or the purchase or lease of standing facilities. Although the alternatives differ widely, they all share important financial attributes. Each alternative implies forgone options with a monetary value—costs—and each is expected to yield a return—benefits. It is the expected monetary costs and benefits that make projects, public and private, comparable.

The monetary comparability of projects, in turn, enables us to identify the merit of a given proposal. Since money costs simply measure the best available alternative to a project, when the monetary benefits on an investment exceed the monetary costs, that project is determined to be preferable to the alternative. Should the benefits be equal to the costs on a given project, that investment would be merely comparable to its best alternative. When costs are expected to exceed the benefits on a proposal, the alternative is, of course, the better project, and the proposal would be rejected.

Sections 1.5, 1.6, and 1.7 consider the meaning of demand and supply and how these forces largely determine prices. The nature of production engineering, as exemplified in the law of diminishing returns, and the behavior of cost curves are developed. These ideas are related, in turn, to supply considerations. Monetary indices are then used to measure benefits and costs from both the demand side and the supply side.

1.5 Measuring Benefits—The Role of Demand

It is consistent with observation, and otherwise plausible, that for most consumer products (and for most resources) buyers will buy more of them the lower the price, other factors remaining constant. Economists call this common behavioral attitude the *law of demand*. A simple linear case of a demand curve for some commodity A is illustrated in Figure 1.2.

The demand curve asserts that there is a quantifiable relationship between the price charged for a product (or resource) and the quantity that would be bought in a specified time period. Thus, reading from Figure 1.2, we see that if the price were \$2.50, consumers would be willing to buy 500 units. If the good were given away, i.e., if the price were \$0.00, 1,000 units would be taken. If the price rose to \$5.00, sales would cease, and so on.

The demand curve of Figure 1.2 is represented by the equation

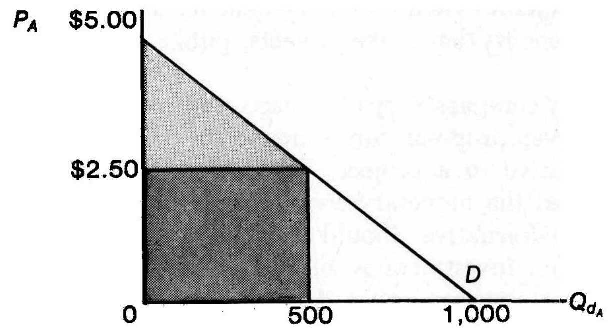
$$Q_{d_A} = 1{,}000 - 200P_A$$

or

$$P_A = \$5.00 - 0.005Q_{d_A}.$$

Once again we see that if the price were \$2.50, the quantity demanded (Q_{d_A}) would be $1{,}000 - 200(2.50) = 500$. If the price were \$0.00, then

FIGURE 1.2
A Linear Demand Curve



$Q_{d_A} = 1{,}000 - 200(0) = 1{,}000$. If we wanted to sell 500 units, what would the price have to be? By substitution, $P_A = \$5.00 - 0.005(500) = \$2.50$.

The law of demand is pertinent to investment analysis because it leads to practical techniques for measuring benefits. When we observe a person paying a certain price for something, we know that the benefits expected must be worth *at least* that much to the buyer; otherwise, the voluntary transaction could not have taken place. Since in the case illustrated each of the 500 units taken at a price of $2.50 must be worth in benefits at least what was paid for it, the 500 units together must be worth, as a minimum value, the $1,250 paid for them. One common measure of ***total benefits*** is, therefore, simply the total revenue paid to the sellers, which is equal to the total expenditure by the buyers. Total benefits or total revenue or total expenditure is measured by the darker shaded area in Figure 1.2.

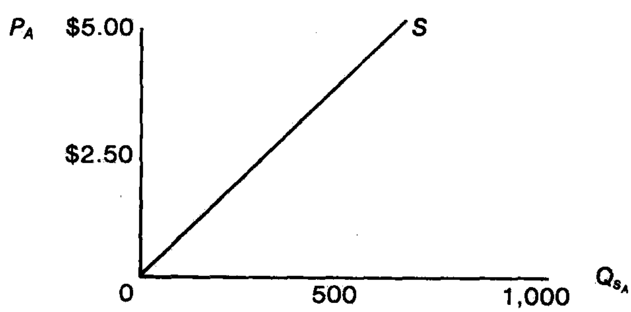
Notice, however, that at a price of $2.50, a buyer would be just barely willing to take the 500th unit, and would refuse the 501st. On the other hand, a buyer would have been willing to pay more than $2.50 for each of the "previous" units. The demand curve shows values greater than $2.50 for the quantities to the left of the 500th unit. The lightly shaded triangle of Figure 1.2 measures the additional amount—the so called **consumer's surplus**—that the buyer would have been willing to pay for the 500 units rather than go without the product. The two shaded areas together measure the ***maximum*** value of the benefits to the consumer from the 500 units of the product. The concept of the consumer's surplus is subject to certain restrictive assumptions that fall beyond this book, but it nonetheless provides a useful approximation.

The specific monetary value of this maximum total benefit can be easily calculated. Since the demand curve in Figure 1.2 is a straight line, the lighter shaded area is a triangle. It is 500 units wide at the base and \$2.50 high. Since the area of a triangle is 0.5 × base × height, this area is 0.5 × 500 × \$2.50 = \$625. The maximum value of total benefits is thus \$1,250 plus \$625. The consumer would be willing to pay no more than \$1,875 for the 500 units.

1.6 Measuring Costs—The Role of Supply

The behavior of sellers is, in many ways, just the opposite of that of buyers. It is consistent with observation, and otherwise plausible, that the higher the price of a product (or resource), the greater is the willingness of the producer to offer the good, other factors being constant. Economists call this predictable behavior the *law of supply*. A simple linear case of a supply curve for some commodity *A* is illustrated in Figure 1.3.

FIGURE 1.3
A Linear Supply Curve



The supply curve asserts that, for example, at a price of \$2.50, the sellers would offer 500 units of the good (or resource) in a specified time period. At a price of \$5.00, 1,000 units would be offered, while if the price were to fall to \$0.00, no goods would be forthcoming.

As might be expected, the same ideas can be presented algebraically. The supply curve of Figure 1.3 is that of the equation

$$P_A = 0.005Q_{s_A}$$

or

$$Q_{s_A} = 200P_A.$$

Thus, if 1,000 units are to be offered, the price will have to be 0.005(1,000), or \$5.00. Conversely, if the price is to be \$5.00, then the quantity forthcoming will be 200(5), or 1,000 units. When price or quantity supplied is set at zero, the other value is also zero.

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