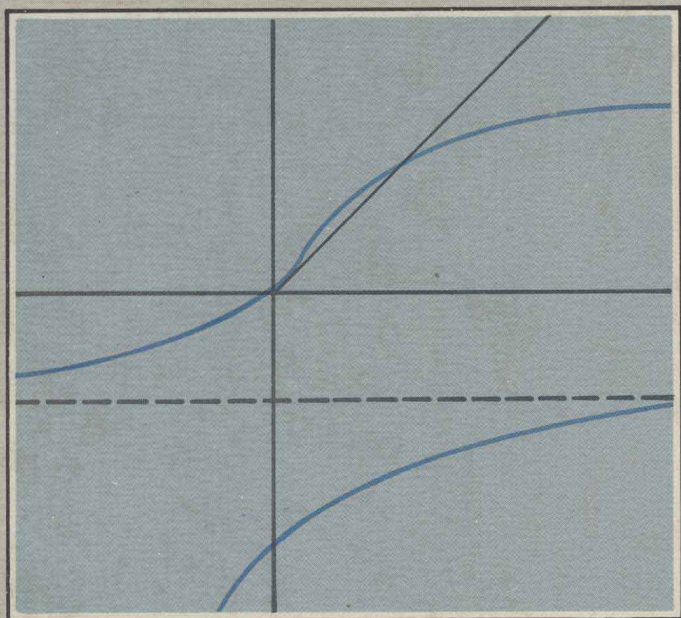


ANTHONY F. HERBST

# Capital Budgeting

Theory, Quantitative Methods,  
and Applications



# **CAPITAL BUDGETING**

## **Theory, Quantitative Methods, and Applications**

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# **CAPITAL BUDGETING**

# Preface

The aim of this book is to tie together the theory, quantitative methods, and applications of capital budgeting. Consequently, its coverage omits few, if any, topics important to capital investment. My intention was to effect a harmonious blend of the old, such as the MAPI method of capital investment appraisal, with the new, such as the Capital Asset Pricing Model (CAPM). I have tried to provide a balanced treatment of the different approaches to capital project evaluation and have explored both the strengths and weaknesses of various project selection methods.

A work on this subject necessarily uses mathematics, but the level of mathematical sophistication required here is generally not above basic algebra. Although I have favored clarity and readability over mathematical pyrotechnics, the book's level of mathematical rigor should be sufficiently high to satisfy most users.

The book's treatment of risk is deliberately deferred to later chapters. The decision to do this, rather than treating risk earlier, was based on my belief that readers new to the subject are less overwhelmed by the added complexities of risk considerations—and better able to comprehend them—after they have become thoroughly familiar with capital budgeting in an environment assumed to be risk-free.

In Chapter 21 I try to present a balanced treatment of the CAPM, including some of the important criticisms of its use in capital budgeting. I know that some readers prefer an earlier introduction of the CAPM, as well as its subsequent use as a unifying theme. (See the last paragraph of A Note on Course Uses for the chapter sequence which meets that need.) I chose not to employ that structure for three reasons.

First, although the CAPM may be adaptable to capital budgeting decisions involving major projects (e.g., the acquisition of a new company division), serious questions exist concerning its applicability to more typical projects for which estimation of expected returns alone is difficult, to say nothing of also estimating the project's beta. Second, company managers increasingly appear to be placing primary emphasis on the survival of the firm rather than on diversification in their capital investment decisions, thereby diluting the implications of the CAPM. In other words, top management does indeed care about unsystematic (or company) risk, which portfolio diversification may, in some cases, undermine. To the management of a company, such risk may not always be reduced easily, and, if intensified by diversification, may imperil the company.

Third, the CAPM is concerned with risk. For the reasons stated earlier, I felt that the book would better serve its audience if it examined capital investment under assumed uncertainty first, without the added complexities that a simultaneous treatment of risk would entail.

I want to thank those reviewers and others who helped to improve the book through their constructive criticism and suggestions, especially Don Panton, University of New Mexico; James B. Henry, University of South Carolina; G. David Quirin, University of Toronto; J. Daniel Williams, University of Akron; Ron Rizzuto, University of Denver; Wayne Perg, Bowling Green State University; and Phil Horvath, Bradley University. For any remaining errors or omissions in the final text, I alone bear responsibility. I would appreciate hearing from users of the book who are willing to pass on their suggestions for improvement to me at the Department of Finance and Real Estate, UTA Box 19449, The University of Texas at Arlington, Arlington, TX 76019.

Finally, I want to thank my wife Betty, and our children, Mya and Geoff. Betty typed the entire manuscript at least three times and took care of the details relating to correspondence and permissions. Only those who have themselves gone through the writing of a book can appreciate the sacrifices the author's family members are called upon to make.

A.F.H.

# A Note on Course Uses

Choices had to be made in the sequencing of this book's chapters. The final arrangement represents the author's own preferences, but others may well choose a different sequence of chapter topics, depending upon their course objectives, their time constraints, and their students' backgrounds. Some instructors, for example, may prefer to omit the chapter on leveraged leasing, whereas others may give it detailed consideration.

Instructors of courses in which students have had an introductory-level finance course may wish to move fairly quickly through the early chapters, using them to review material previously studied and to emphasize certain points.

The special topics and methods covered in Chapters 9 through 16 are independent of one another, so each of these chapters may be dealt with individually in whatever sequence the instructor prefers, or omitted altogether. However, there is certainly no reason not to cover all of them if time permits.

There are as many alternative sequences for teaching capital budgeting as there are ways to teach the subject. If one's students have sufficient background, it is possible to cover Chapters 1 through 8 quickly and use the time gained to assign several cases. I often compress the time allocated to these chapters and include cases with Chapters 4 and 9, and following Chapter 22. With MBA classes I always include cases, even though some students may have to work harder to keep up. The specific cases employed are described in the Instructor's Manual that accompanies the text. They have been selected to provide in-depth applications of concepts and methods contained in the chapters.

In a 16-week semester course carrying three credits and meeting twice a week, I suggest

the following sequence: First week, Chapters 1, 2, and beginning of 3; second week, finish Chapters 3 and 4; third week, Chapter 5 and beginning of 6; fourth week, finish Chapters 6 and 7; fifth week, Chapter 8, plus first examination; sixth week, Chapter 9; seventh week, Chapter 10; eighth week, Chapter 11; ninth week, Chapters 12 or 13 and 14; tenth week, Chapter 15, plus second examination; eleventh week, Chapter 16 and first part of 17; twelfth week, finish Chapter 17, cover 18; thirteenth week, Chapter 19; fourteenth week, Chapter 20; fifteenth week, Chapter 21; sixteenth week, Chapter 22 and course review.

In an 11-week, quarter-system course of 4 credits meeting twice a week, I propose this sequence and approximate time on each subject: First week, Chapters 1, 2, and first part of 3; second week, second part of Chapter 3 and first part of Chapter 4; third week, second part of Chapter 4 and Chapter 5; fourth week, Chapters 6 and 7; fifth week, Chapters 8 and 9, plus midterm examination; sixth week, Chapter 10; seventh week, Chapter 11 and Chapter 12 or 13; eighth week, Chapters 14 and 15; ninth week, Chapters 16 and 17; tenth week, Chapters 18 and 19; eleventh week, Chapters 20 and 21.

Another alternative sequence based on 1 1/2-hour lecture periods is suggested by Don Panton, University of New Mexico: Chapters 1 and 2 combined into one lecture; Chapters 3 and 4 each split into two lectures; Chapter 5, one lecture; Chapter 6 split into two lectures; Chapters 7 and 8, one lecture each. Chapters 10 and 11 combined into two lectures; Chapters 17, 18, and 19, one lecture each; Chapter 21, two lectures. Then Chapters 12 and 13 combined into one lecture, and finally Chapter 16 in one lecture. He would omit Chapters 9, 15, 19, 22, and 14 in undergraduate classes.

For those who wish to cover the Capital Asset Pricing Model earlier in the course, another sequence would be to assign chapters in this order: 1, 2, 3, 4, 5, 6, 7, 8, then 17, 18, 19, and 21 (which contains the CAPM). Then a selection from Chapters 9, 10, 11, 12, 13, 14, 15, 16, 20, and 22 might be made, according to class needs and instructor's interests, in whatever sequence seems appropriate.



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# **Part I**

# **THE BASIC**

# **FRAMEWORK**



# Chapter 1

## Introduction

Once we consciously think about the nature of capital investment decisions, we realize that such decisions have been made for millenia, since humans first awakened to the idea that capital<sup>1</sup> accumulation could improve life. The earliest investment decisions involved what today would be considered very primitive. But to the early nomadic hunter-forager the first capital investment decisions were quite significant. To the extent that time and energy had to be diverted from the immediate quest for food and for security from enemies, to the production of tools for the hunt and to defense installations, food storage facilities, and so on, capital investments were made. Such primitive capital creation required time and effort. And the benefits that could have been expected to result were uncertain; it took foresight to build capital.

As society evolved, the benefits of capital accumulation gradually became more indirect and complex, involving specialization and cooperation not previously envisioned, and the associated commitment of resources more permanent. Additionally, social norms and institutions had to be developed to facilitate the evolution. For example, the changeover from nomadic to agrarian life required a great in-

<sup>1</sup>The word *capital* is used in several senses. It may refer to physical plant and equipment (economic capital) or to the ownership claims on the tangible capital (financial capital). In this book, unless otherwise indicated in a specific instance, the word shall refer to physical or economic capital.



#### 4 THE BASIC FRAMEWORK

crease in capital: in the form of land clearing, construction of granaries, mills, irrigation, canals, tools, and fortifications. The fortifications were a necessary adjunct to deter those who would, by force, seize the benefits achieved. The change-over required a commitment that, at least in the short run, tended to be irreversible. And it became more and more irreversible, for the change caused social and economic institutions to be developed to support it and coordinate the various requisite activities.<sup>2</sup>

#### MAGNITUDE OF CAPITAL INVESTMENT

In the United States in 1979, business capital expenditure on new plant and equipment amounted to \$177 billion out of a gross national product (GNP) of \$2369 billion. This meant that 7.5 percent of measured national economic activity was used for business capital investment. If government expenditure on capital goods (plant and equipment) was reported separately from total government expenditure on goods and services, the total of business and government capital expenditure would likely exceed 10 percent of GNP. Inclusion of expenditures on owner-occupied dwellings would raise the total still higher.<sup>3</sup> Figure 1.1 displays the trend in business investment since 1972, in contrast to government spending over the same period. Figure 1.2 illustrates business spending on plant and equipment alongside corporate profits and taxes. It is readily apparent that capital investment is an important component of economic activity, both absolutely and relatively.

#### GENERAL PERSPECTIVE ON CAPITAL INVESTMENT

Because resources are scarce (as economists have long maintained) and because capital investment figures prominently in the economy, decisions on capital budgets ought to be made on as sound and rational a basis as possible. The general irreversibility of capital investments, and their legacy for future costs as well as benefits, make such decisions of great importance both from the standpoint of the individual firm and at the level of national policy.

Economic theory recognizes that for any given level of technology, the factors of production (land, labor, and capital) *together in combination* are required to produce goods and services. Production of any good or service, then, is a function of combined factors, with the function corresponding to the state of known technology.

At the national policy level the dual goals of high employment (low unemployment) and increasing standard of living are normally accorded primary importance. These goals require that for given levels of technology the stock of capital increases

<sup>2</sup>C. Northcote Parkinson writes of such differences between agricultural and nomadic societies in his book *East and West* (New York: New American Library, 1963).

<sup>3</sup>"Gross private domestic investment" as a percentage of GNP in the United States was slightly above 16 percent for 1979.