

# **Capital Budgeting: Theory and Practice**

**Pamela P. Peterson, Ph.D., CFA**

**Frank J. Fabozzi, Ph.D., CFA**



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**PPP**

To my kids, Erica and Ken

**FJF**

To my wife, Donna,  
and my children, Karly, Patricia, and Francesco

## **About the Authors**

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## Preface

Corporate financial managers continually invest funds in assets, and these assets produce income and cash flows that the firm can then either reinvest in more assets or distribute to the owners of the firm. Capital investment refers to the firm's investment in assets, and these investments may be either short term or long term in nature. Capital budgeting decisions involve the long-term commitment of a firm's scarce resources in capital investments. When such a decision is made, the firm is committed to a current and possibly future outlay of funds.

Capital budgeting decisions play a prominent role in determining whether a firm will be successful. The commitment of funds to a particular capital project can be enormous and may be irreversible. While some capital budgeting decisions are routine decisions that do not change the course or risk of a firm, there are strategic capital budgeting decisions that will either have an effect on the firm's future market position in its current product lines or permit it to expand into new product lines in the future. The annals of business history are replete with examples of how capital budgeting decisions turned the tide for a company. For example, the producer of photographic copying paper, the Haloid Corporation, made a decision to commit a substantial portion of its capital to the development of xerography. How important was that decision? Well, in 1958, the Haloid Corporation changes its name to Haloid-Xerox. In 1961 it became Xerox.

In *Capital Budgeting: Theory and Practice*, we discuss and illustrate the different aspects of the capital budgeting decision process. In Section I we discuss the capital budgeting decision and cash flows. In Chapter 1 we explain the investment problem. In that chapter we describe the five stages in the capital budgeting process—investment screening and selection, capital budgeting proposal, budgeting approval and authorization, project tracking, and postcompletion audit—and the classification of investment projects—according to their economic life, according to their risk, and according to their dependence on other projects. We discuss the critical task of cash flow estimation in Chapter 2 and offer two hypothetical examples to illustrate cash flow estimation in Chapter 3.

In Section II, we cover the techniques for evaluating capital budgeting proposals and for selecting projects. We explain each technique in terms of the maximization of owners' wealth and how each technique deals with the following: (1) Does the technique consider all cash flows from the project? (2) Does the technique consider the timing of cash flows? and (3) Does the technique consider the riskiness of cash flows? The techniques covered include the payback and discounted payback, net present value, profitability index, internal rate of return, and modified internal rate of return. In Chapter 9 we conclude Section II with a discussion of several issues: scale differences (including capital rationing), choosing the appropriate technique, capital budgeting in practice (including conflicts with responsibility center performance evaluation measures), and the justification of new technology.

Capital budgeting projects typically involve risk. In Section III we explain how to incorporate risk into the capital budgeting decision. This involves considering the following factors: future cash flows, the degree of uncertainty of these cash flows, and the value of these cash flows given the level of uncertainty about realizing them. In Chapter 10 we cover the measurement of project risk—measuring a project's stand-alone risk, sensitivity analysis, simulation analysis, and measuring a project's market risk. In Chapter 11, we demonstrate how to incorporate risk into the capital budgeting process by adjusting the discount rate, describe how a project can be evaluated using certainty equivalents, and then discuss the treatment of risk using real options. The real option approach applies the well-developed theory of options pricing to capital budgeting.

In the last section, we explain a common capital budgeting decision: the decision to buy an asset with borrowed funds or lease the same asset. This is the "lease versus borrow-to-buy decision." A key factor in the analysis is the ability of the firm to use the tax benefits associated with ownership of an asset—depreciation and tax credits, if any. Several models have been proposed to assess whether to buy or lease. A model to value a lease for a firm that is in a current taxpaying position is explained in Chapter 12. In Chapter 13 we explain how uncertainty is incorporated into the lease valuation model. The model explained in Chapter 12 is generalized in Chapter

14 to cases where the firm is currently in a nontaxpaying position but expects to resume paying taxes at some specified future date. We provide the fundamentals of leasing in the appendix to the book.

*Pamela P. Peterson*  
*Frank J. Fabozzi*



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# Section I

## Making Investment Decisions

The value of a particular asset isn't always easy to determine. However, managers are continually faced with decisions about which assets to invest in. In this chapter, we will look at the different types of investment decisions the financial manager faces. We will also discuss ways to estimate the benefits and costs associated with these decisions.

The financial manager's objective is to maximize owners' wealth. To accomplish this, the manager must evaluate investment opportunities and determine which ones will add value to the firm. For example, consider three firms, Firms A, B, and C, each having identical assets and investment opportunities, except that:

- Firm A's management does not take advantage of its investment opportunities and simply pays all of its earnings to its owners;
- Firm B's management only makes those investments necessary to replace deteriorating plant and equipment, paying out any left-over earnings to its owners; and
- Firm C's management invests in all those opportunities that provide a return better than what the owners could have earned if they had invested the funds themselves.

In the case of Firm A, the owners' investment in the firm will not be as profitable as it would be if the firm had taken advantage of better investment opportunities. By failing to invest even to replace deteriorating plant and equipment, Firm A will eventually shrink until it has no more assets. Firm B's management is not taking advantage of all profitable investments. This means that there are forgone opportunities, and owners' wealth is not maximized. But Firm C's management is making all profitable investments and thus

maximizing owners' wealth. Firm C will continue to grow as long as there are profitable investment opportunities and as long as its management takes advantage of them.

In Chapter 1, we will describe the process of making investment decisions. We will look at estimating how much a firm's cash flows will change in the future as a result of an investment decision. The main topic of Chapter 2, estimating cash flow, is an imprecise art at best. Therefore, after we describe in detail a method for estimating cash flows in Chapter 2. In Chapter 3 we provide two integrative examples. We conclude Chapter 3 with an explanation of some ways in which managers sometimes deviate from our ideal method in actual practice.

In Section II, we will analyze the change in the firm's cash flows using techniques that lead the financial manager to a decision regarding whether to invest in a project. In Section III, we see how uncertainty affects the cost of capital and, hence, the investment decision.



## Chapter 1

# The Investment Problem and Capital Budgeting

Firms continually invest funds in assets, and these assets produce income and cash flows that the firm can then either reinvest in more assets or pay to the owners. These assets represent the firm's capital. *Capital* is the firm's total assets. It includes all tangible and intangible assets. These assets include physical assets (such as land, buildings, equipment, and machinery), as well as assets that represent property rights (such as accounts receivable, securities, patents, and copyrights). When we refer to *capital investment*, we are referring to the firm's investment in its assets.

The term "capital" also has come to mean the funds used to finance the firm's assets. In this sense, capital consists of notes, bonds, stock, and short-term financing. We use the term "capital structure" to refer to the mix of these different sources of capital used to finance a firm's assets.

The firm's capital investment decision may be comprised of a number of distinct decisions, each referred to as a *project*. A *capital project* is a set of assets that are contingent on one another and are considered together. For example, suppose a firm is considering the production of a new product. This capital project would require the firm to acquire land, build facilities, and purchase production equipment. And this project may also require the firm to increase its investment in its *working capital* — inventory, cash, or accounts receivable. Working capital is the collection of assets needed for day-to-day operations that support a firm's long-term investments.

The investment decisions of the firm are decisions concerning a firm's capital investment. When we refer to a particular decision that financial managers must make, we are referring to a decision pertaining to a capital project.

## INVESTMENT DECISIONS AND OWNERS' WEALTH MAXIMIZATION

Managers must evaluate a number of factors in making investment decisions. Not only does the financial manager need to estimate how much the firm's future cash flows will change if it invests in a project, but the manager must also evaluate the uncertainty associated with these future cash flows.

We already know that the value of the firm today is the present value of all its future cash flows. But we need to understand better where these future cash flows come from. They come from:

- Assets that are already in place, which are the assets accumulated as a result of all past investment decisions, and
- Future investment opportunities

The value of the firm, is therefore,

$$\begin{aligned}\text{Value of firm} &= \text{Present value of all future cash flows} \\ &= \text{Present value of cash flows from all assets in place} \\ &+ \text{Present value of cash flows from future investment opportunities}\end{aligned}$$

Future cash flows are discounted at a rate that represents investors' assessments of the uncertainty that these cash flows will flow in the amounts and when expected. To evaluate the value of the firm, we need to evaluate the risk of these future cash flows.

Cash flow risk comes from two basic sources:

- *Sales risk*, which is the degree of uncertainty related to the number of units that will be sold and the price of the good or service; and
- *Operating risk*, which is the degree of uncertainty concerning operating cash flows that arises from the particular mix of fixed and variable operating costs

Sales risk is related to the economy and the market in which the firm's goods and services are sold. Operating risk, for the most part, is determined by the product or service that the firm provides and is

related to the sensitivity of operating cash flows to changes in sales. We refer to the combination of these two risks as *business risk*.

A project's business risk is reflected in the discount rate, which is the rate of return required to compensate the suppliers of capital (bondholders and owners) for the amount of risk they bear. From the perspective of investors, the discount rate is the *required rate of return* (RRR). From the firm's perspective, the discount rate is the *cost of capital* — what it costs the firm to raise a dollar of new capital.

For example, suppose a firm invests in a new project. How does the investment affect the firm's value? If the project generates cash flows that *just* compensate the suppliers of capital for the risk they bear on this project (that is, it earns the cost of capital), the value of the firm does not change. If the project generates cash flows *greater* than needed to compensate them for the risk they take on, it earns more than the cost of capital, increasing the value of the firm. If the project generates cash flows *less* than needed, it earns less than the cost of capital, decreasing the value of the firm.

How do we know whether the cash flows are more than or less than needed to compensate for the risk that they will indeed need? If we discount all the cash flows at the cost of capital, we can assess how this project affects the present value of the firm. If the expected change in the value of the firm from an investment is:

- positive, the project returns more than the cost of capital;
- negative, the project returns less than the cost of capital;
- zero, the project returns the cost of capital.

*Capital budgeting* is the process of identifying and selecting investments in long-lived assets, or assets expected to produce benefits over more than one year. In Section II, we discuss how to evaluate cash flows in deciding whether or not to invest. We cover how to determine cash flow risk and factor this risk into capital budgeting decisions in Section III.

## CAPITAL BUDGETING

Because a firm must continually evaluate possible investments, capital budgeting is an ongoing process. However, before a firm begins

thinking about capital budgeting, it must first determine its *corporate strategy* — its broad set of objectives for future investment. For example, the Walt Disney Company’s objective is to “be the world’s premier family entertainment company through the ongoing development of its powerful brand and character franchises.”<sup>1</sup>

Consider the corporate strategy of Mattel, Inc., manufacturer of toys such as Barbie and Disney toys. Mattel’s strategy is to become a full-line toy company and grow through expansion into the international toy market. In the early 1990’s, Mattel entered into the activity toy, games, and plush toy markets, and, through acquisitions in Mexico, France, and Japan, increased its presence in the international toy market.<sup>2</sup>

How does a firm achieve its corporate strategy? By making investments in long-lived assets that will maximize owners’ wealth. Selecting these projects is what capital budgeting is all about.

### **Stages in the Capital Budgeting Process**

There are five stages in the capital budgeting process.

#### Stage 1: Investment screening and selection

Projects consistent with the corporate strategy are identified by production, marketing, and research and development management of the firm. Once identified, projects are evaluated and screened by estimating how they affect the future cash flows of the firm and, hence, the value of the firm.

#### Stage 2: Capital budget proposal

A capital budget is proposed for the projects surviving the screening and selection process. The budget lists the recommended projects and the dollar amount of investment needed for each. This proposal may start as an estimate of expected revenues and costs, but as the project analysis is refined, data from marketing, purchasing, engineering, accounting, and finance functions are put together.

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<sup>1</sup> *The Walt Disney Company Annual Report 2000*: 10.

<sup>2</sup> *Mattel, Inc., 1991 Annual Report*: 4–5, 15.

**Stage 3: Budgeting approval and authorization**

Projects included in the capital budget are authorized, allowing further fact gathering and analysis, and approved, allowing expenditures for the projects. In some firms, the projects are authorized and approved at the same time. In others, a project must first be authorized, requiring more research before it can be formally approved. Formal authorization and approval procedures are typically used on larger expenditures; smaller expenditures are at the discretion of management.

**Stage 4: Project tracking**

After a project is approved, work on it begins. The manager reports periodically on its expenditures, as well as on any revenues associated with it. This is referred to as *project tracking*, the communication link between the decision makers and the operating management of the firm. For example: tracking can identify cost over-runs and uncover the need for more marketing research.

**Stage 5: Postcompletion audit**

Following a period of time, perhaps two or three years after approval, projects are reviewed to see whether they should be continued. This reevaluation is referred to as a *postcompletion audit*. Thorough postcompletion audits are typically performed on selected projects, usually the largest projects in a given year's budget for the firm or for each division. Postcompletion audits show the firm's management how well the cash flows realized correspond with the cash flows forecasted several years earlier.

**Classifying Investment Projects**

In this section, we discuss different ways managers classify capital investment projects. One way of classifying projects is by project life, whether short-term or long-term. We do this because in the case of

long-term projects, the time value of money plays an important role in long-term projects. Another way of classifying projects is by their risk. The riskier the project's future cash flows, the greater the role of the cost of capital in decision-making. Still another way of classifying projects is by their dependence on other projects. The relationship between a project's cash flows and the cash flows of some other project of the firm must be incorporated explicitly into the analysis since we want to analyze how a project affects the total cash flows of the firm.

### ***Classification According to Their Economic Life***

An investment generally provides benefits over a limited period of time, referred to as its economic life. The *economic life* or *useful life* of an asset is determined by:

- physical deterioration;
- obsolescence; or
- the degree of competition in the market for a product.

The economic life is an estimate of the length of time that the asset will provide benefits to the firm. After its useful life, the revenues generated by the asset tend to decline rapidly and its expenses tend to increase.

Typically, an investment requires an immediate expenditure and provides benefits in the form of cash flows received in the future. If benefits are received only within the current period — within one year of making the investment — we refer to the investment as a *short-term investment*. If these benefits are received beyond the current period, we refer to the investment as a *long-term investment* and refer to the expenditure as a *capital expenditure*. An investment project may comprise one or more capital expenditures. For example, a new product may require investment in production equipment, a building, and transportation equipment.

Short-term investment decisions involve, primarily, investments in current assets: cash, marketable securities, accounts receivable, and inventory. The objective of investing in short-term assets is the same as long-term assets: maximizing owners' wealth. Nevertheless, we consider them separately for two practical reasons:

1. Decisions about long-term assets are based on projections of

cash flows far into the future and require us to consider the time value of money.

2. Long-term assets do not figure into the daily operating needs of the firm.

Decisions regarding short-term investments, or current assets, are concerned with day-to-day operations. And a firm needs some level of current assets to act as a cushion in case of unusually poor operating periods, when cash flows from operations are less than expected.

### ***Classification According to Their Risk***

Suppose you are faced with two investments, A and B, each promising a \$100 cash inflow ten years from today. If A is riskier than B, what are they worth to you today? If you do not like risk, you would consider A less valuable than B because the chance of getting the \$100 in ten years is less for A than for B. Therefore, valuing a project requires considering the risk associated with its future cash flows.

The investment's risk of return can be classified according to the nature of the project represented by the investment:

- *Replacement projects*: investments in the replacement of existing equipment or facilities
- *Expansion projects*: investments in projects that broaden existing product lines and existing markets
- *New products and markets*: projects that involve introducing a new product or entering into a new market
- *Mandated projects*: projects required by government laws or agency rules

*Replacement projects* include the maintenance of existing assets to continue the current level of operating activity. Projects that reduce costs, such as replacing old equipment or improving the efficiency, are also considered replacement projects. To evaluate replacement projects we need to compare the value of the firm with the replacement asset to the value of the firm without that same replacement asset. What we're really doing in this comparison is looking at *opportunity costs*: what cash flows would have been if

the firm had stayed with the old asset.

There's little risk in the cash flows from replacement projects. The firm is simply replacing equipment or buildings already operating and producing cash flows. And the firm typically has experience in managing similar new equipment.

Expansion projects, which are intended to enlarge a firm's established product or market, also involve little risk. However, investment projects that involve introducing new products or entering into new markets are riskier because the firm has little or no management experience in the new product or market.

A firm is forced or coerced into its mandated projects. These are government-mandated projects typically found in "heavy" industries, such as utilities, transportation, and chemicals, all industries requiring a large portion of their assets in production activities. Government agencies, such as the Occupational Health and Safety Agency (OSHA) or the Environmental Protection Agency (EPA), may impose requirements that firms install specific equipment or alter their activities (such as how they dispose of waste).

We can further classify mandated projects into two types: contingent and retroactive. Suppose, as a steel manufacturer, we are required by law to include pollution control devices on all smoke stacks. If we are considering a new plant, this mandated equipment is really part of our new plant investment decision — the investment in pollution control equipment is contingent on our building the new plant.

On the other hand, if we are required by law to place pollution control devices on existing smoke stacks, the law is retroactive. We do not have a choice. We must invest in the equipment whether it increases the value of the firm or not. In this case, either select from among possible equipment that satisfies the mandate or we weigh the decision whether to halt production in the offending plant.

### ***Classification According to Their Dependence on Other Projects***

In addition to considering the future cash flows generated by a project, a firm must consider how it affects the assets already in place — the results of previous project decisions — as well as other



projects that may be undertaken. Projects can be classified according to the degree of dependence with other projects: independent projects, mutually exclusive projects, contingent projects, and complementary projects.

An *independent project* is one whose cash flows are not related to the cash flows of any other project. Accepting or rejecting an independent project does not affect the acceptance or rejection of other projects. Projects are *mutually exclusive* if the acceptance of one precludes the acceptance of other projects. For example, suppose a manufacturer is considering whether to replace its production facilities with more modern equipment. The firm may solicit bids among the different manufacturers of this equipment. The decision consists of comparing two choices, either keeping its existing production facilities or replacing the facilities with the modern equipment of one manufacturer. Since the firm cannot use more than one production facility, it must evaluate each bid and choose the most attractive one. The alternative production facilities are mutually exclusive projects: the firm can accept only one bid.

*Contingent projects* are dependent on the acceptance of another project. Suppose a greeting card company develops a new character, Pippy, and is considering starting a line of Pippy cards. If Pippy catches on, the firm will consider producing a line of Pippy T-shirts — but *only* if the Pippy character becomes popular. The T-shirt project is a contingent project.

Another form of dependence is found in *complementary projects*, where the investment in one enhances the cash flows of one or more other projects. Consider a manufacturer of personal computer equipment and software. If it develops new software that enhances the abilities of a computer mouse, the introduction of this new software may enhance its mouse sales as well.

