

## CAPITAL BUDGETING:

### How a business firm decides whether or not to acquire durable real assets

In this write-up, I shall explain as simply as is possible (1) how modern business firms decide whether or not to purchase with the firm's investible funds long-lived assets (land, machines, buildings) that will be used by the firm for more than one period and (2) how they finance these purchases. We shall explore the second question first and then illustrate the first with a numerical example. In the end, we shall explore cool, trick question with which you can annoy people in high finance—your own parents possibly among them.

#### A. WHENCE DOES THE FIRM GET ITS FUNDS, AND WHAT IS THE COST TO THE FIRM PER DOLLAR AND PER YEAR OF SUCH FUNDS?

We shall assume that the firm gets its funds to make capital acquisitions from two major sources: (1) creditors, who give the firm funds in return for debt instruments, and (2) owners.

The simplest debt instrument is a bond, which is a piece of paper on which the firm promises to pay the bond's purchaser (the creditor) a stipulated amount of money (the "face value" of the bond) on a given future date, and in the meantime to pay a stipulated annual or semi-annual interest rate on the face of the bond to the creditors. Under our tax laws, this periodic interest is tax deductible. It means that when the firm pays annual interest rate of, say, 12%, and if it pays income taxes at a rate of, say, 40% on profits, then, from the firm's perspective, the actual after tax cost of borrowing is only  $(1 - .4)12\% = 7.2\%$ .

The firm gets its funds from owners in two distinct ways. First, it can simply retain earned profits that, in principle belong to the owners, and reinvest it in the company's assets on behalf of the owners. A huge fraction of corporate ownership financing—also called "equity financing"—is done this way. Second, as noted, the firm can sell to existing and new owners newly issued ownership certificates, also known as "common stock certificates" or simply as "shares of stock." As you surely know, once issued and sold in an initial offering to the investing public, these shares of stock are freely among investors on the stock exchanges.

The diagram overleaf illustrates this process schematically. There it is assumed that the firm wishes to acquire \$100 million worth of new assets (its "capital budget") and that it will finance these acquisitions by selling \$40 million worth of new debt instruments and by getting \$60 million from existing or additional owners who will be sold newly printed ownership certificates. We assume that the interest paid creditors on the bonds is 12% before taxes, that the firm pays a 40% tax rate on income, and that therefore the after-tax cost of debt is 7.2%. We assume further that the firm's owners have an opportunity cost of funds (or demand "normal profits" as the text would have it) of 15% on the funds they have surrendered to or left with the firm. The firm must yield the owners at least that rate of return on their investment in the firm, just to keep the owners whole on their opportunity costs. Under our tax laws, these opportunity costs of the owners are not a tax-deductible expense for the firm.

We saw earlier that these "normal profits" are part of the firm's fixed costs included in the average total cost curve and that, if the firm only for its owners only that rate of return, economists would say the firm has earned no "economic profits".

FIGURE 1

# FINANCING AND EVALUATING A FIRM'S NEW \$ 100 m CAPITAL BUDGET

## THE FIRM'S "BALANCE SHEET"

<u>USES OF FUNDS:</u>		<u>SOURCES OF FUNDS:</u>	
ASSETS		DEBT AND EQUITY	
NEW ASSETS \$ 100 m	ASSETS ALREADY OWNED	DEBT ALREADY OWED	NEW DEBT \$ 40 m @ (1-.4)12%
		EQUITY FUNDS ALREADY PROCURED	NEW EQUITY \$ 60 m @ 15%

EACH NEW ASSET MUST RETURN THE FUNDS SUNK INTO THAT ASSET, PLUS AN ANNUAL RETURN OF AT LEAST  $k_0$ , IN ANY GIVEN YEAR, PER \$ 1 STILL COMMITTED TO THE ASSET (NOT YET RETURNED BY THE ASSET) AS OF THE BEGINNING OF THAT YEAR.

THE WEIGHTED AVERAGE ANNUAL COST (THE WACC) PER \$ 1 OF THIS NEW \$100 m FINANCING, RAISED IN THE NEW DEBT-TO-EQUITY MIX OF 40:60, IS:

$$k_0 = (1-.4) 12\% (40/100) + 15\% (60/100) \\ = .1188 \text{ or } 11.88\%$$

**The firm's cost of financing:** With these preliminaries, we can now calculate what it costs the firm, on average, to raise \$1 in the financial markets or through retained earnings, per year, if the firm's funds are raised in the proportion 40% debt, 60% from owners. This weighted average cost of financing, per \$1 per year, is calculated as:

$$k = (1 - \text{tax rate})12\% (\$40/\$100) + 15\% (\$60/\$100) = 11.88\%$$

In the business world, this rate is called the *weighted average cost of capital* (or just WACC). The weights are the fraction of the total financing (here \$100 million) raised via debt (here 0.40 or 40%) and from owners (via "equity", here 0.60 or 60%).

The firm's WACC is also often called its "hurdle rate" for proposed new capital acquisitions, because, as we shall see below, these acquisitions do not make economic sense from the viewpoint of the firm's owners, firm unless the firm can earn on such investments a rate of return of at least **k** per dollar per year on funds sunk into such investments.

Let us now explore how this hurdle rate is used by business firms in the real world to evaluate proposed new capital acquisitions (land, buildings or machines).

## **B. HOW DOES THE FIRM DETERMINE WHETHER A NEW, SAY, MACHINE IS WORTH IS ACQUISITION PRICE?**

There are two distinct approaches to managing a firm's annual investments in capital projects (i.e., in long-lived assets).

**Fixed capital budget:** First, management can decide to spend a budget of no more than \$X for that purpose—its so-called "capital budget"—and then look for the most profitable set of capital acquisitions that fall within this overall budget constraint. It is the approach we have modeled in the diagram shown above. There the firm is assumed to have set a capital budget of \$100 million for the coming year. The firm will then do two things.

First, it will explore individual proposed projects one by one to see whether, viewed by itself, a given acquisition would make the firm's owners richer or poorer. If richer, the project is a viable candidate, if poorer, it is rejected. If neither richer or poorer, it is a matter of indifference.

Once the set of profitable candidates has been identified, the firm selects the most profitable candidates that can be accommodated within its predetermined capital budget.

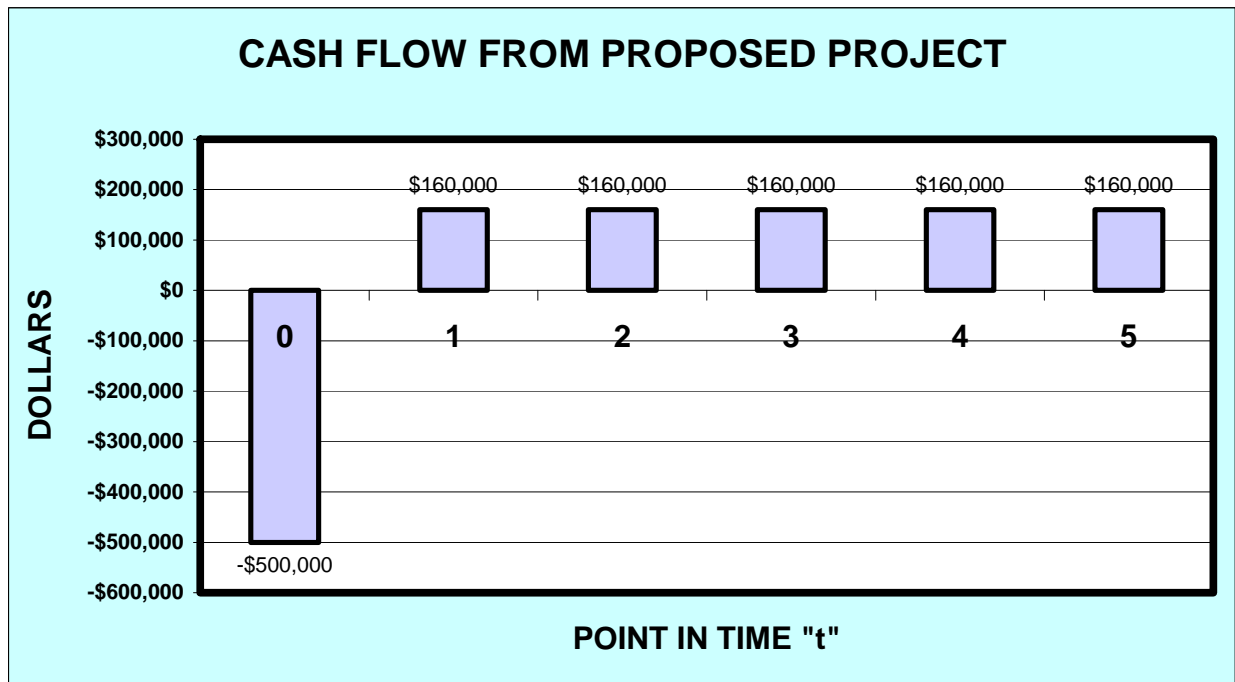
**Flexible capital budget:** Economists do not much like the fixed capital-budget approach because it may lead management to reject projects that would have made the firm's owners richer, but did not fit within the predetermined capital budget. Therefore, economists would recommend that the firm accept all profitable projects (that make the firm's owners richer) and then go out to raise with debt instruments or from owners the funds needed to finance the resulting capital budget.

In real life, firms often opt for the first approach, because a given management team can handle only so many new projects at any one time. Economists sometimes forget that facet of real life.

**A stylized numerical illustration:** Assume now that among the many different projects the firm's Treasury Department is considering for possible acquisition, there is the following proposed project:

- A new machine that can be purchased for \$500,000 in cash now
- It is expected to have a useful life of 5 years after which it will be disposed of at a cost just covered by its scrap value, that is, at net costs of zero.
- During its use life, the machine will yield the firm a net cash inflow of \$160,000 per year, for five years. For the sake of simplicity, we assume that these \$160,000 comes rolling in at one point in time during the year, namely, at the end of each year.

We can graph the proposed project's projected cash flow as follows:



The task of “capital budgeting” is to eyeball this cash flow and to determine whether signing on to it—by buying the machine—will enrich the firm's owners. To do that, we must convert the cash inflows due at points in time  $t = 1$ ,  $t = 2$ , ...  $t = 5$  into their so-called “present-value equivalent” as of time  $t = 0$ , which is “now,” the point of decision. We achieve this by “discounting” each cash flow at the firm's “hurdle rate”  $k$ , which we have calculated above as 11.88%. Thus the cash flow due at time  $t = 1$  has the present value equivalent

$$\$160,000 / (1 + .1188) = \$143,010.37$$

while the cash inflow due at time  $t = 3$  has the present value equivalent

$$\$160,000 / (1 + .1188)^3 = \$114,251.68$$

and so on.

The table below illustrates this process for the project's entire use life. When we add up all the present value equivalents of the future cash inflows and deduct from that sum the immediate cash outlay of \$500,000, we arrive at the project's so-called "*net present value*" or NPV. Here that NPV, calculated at a discount rate of 11.88%, is **\$78,482.91**. You will see it in cell in the right bottom corner.

### NET PRESENT VALUE OF PROJECT @ 11.88%

PINT IN TIME "t"	CASH FLOW AT POINT IN TIME "t"	CALCULATION OF PRESENT-VALUE EQUIVALENT	PRESENT -VALUE EQUIVALENT
0	-\$500,000.00	-\$500,000.00	-\$500,000.00
1	\$160,000.00	\$160,000/1.188	\$143,010.37
2	\$160,000.00	\$160,000/1.1188 <sup>2</sup>	\$127,824.78
3	\$160,000.00	\$160,000/1.1188 <sup>3</sup>	\$114,251.68
4	\$160,000.00	\$160,000/1.1188 <sup>4</sup>	\$102,119.85
5	\$160,000.00	\$160,000/1.1188 <sup>5</sup>	\$91,276.23
<b>SUM</b>	<b>\$300,000.00</b>	<b>N.A.</b>	<b>\$78,482.91</b>

**A short-cut formula:** When we have a simple project with one immediate outlay of \$C followed by N identical annual cash inflows \$X per year, then at a discount rate of k the present value of such a project can be calculated with the short-cut formula

$$NPV = -\$C + \$X (1 - 1/(1 + k)^N) / k$$

which in this case is

$$NPV = -\$500,000 + \$160,000(1 - 1/(1.1188)^N) / 0.1188$$

Calculate for yourself that this will come to \$78,482.92. <sup>1</sup>

**Interpreting the NPV:** What does this **NPV = \$78,482.92** tell us about whether or not the project will make the firm's owners wealthier?

The NPV us that, if we decide to acquire the machine and if all future cash flows come in as we now expect them to come in, then, in principle, we will have made the firm's owners \$78,482.92 richer by acquiring this machine. In terms of the theory of the firm we discussed

<sup>1</sup> To calculate  $1/(1.1188)^5$  follow these steps on your calculator: Enter 1.1188. Hit the button " $y^x$ ." Hit the equal-sign button "=". The hit the button " $1/x$ ". You'll have the value of  $1/(1.1188)^5 = 0.5704764$ .

earlier in the course, using the machine will yield us profits over and above normal profits (normal profits here are the owners' 15% opportunity costs which we have included in our cost-of-funds rate  $k$ ). In terms of another construct now widely used in the real world, the project has a positive "Economic Value Added" (widely known by the acronym EVA).

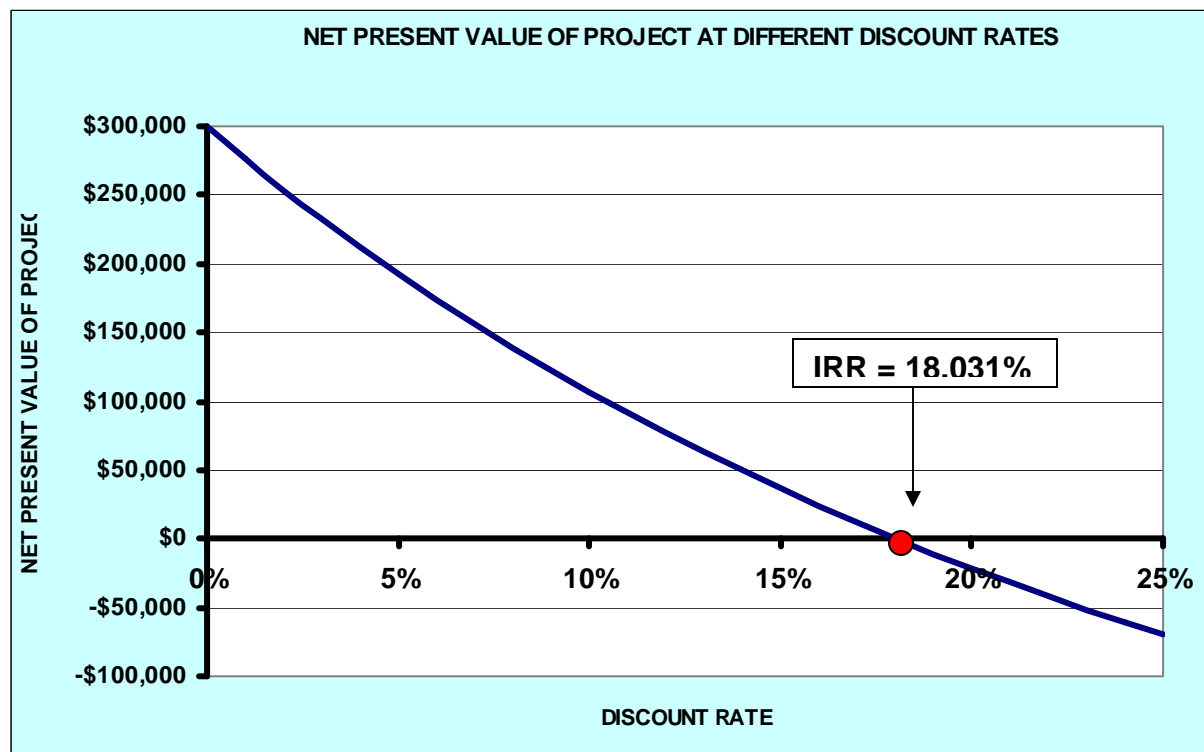
If this information about the project's NPV could be accurately conveyed to the stock market and if the traders there believed it and understood it, then the market value of the firm should, in theory, rise immediately by \$78,482.92. Of course, these are big IFs, as the folks in the real world of finance are not invariable as perceptive as economic theory suggests.

**A handy rule for capital acquisitions:** It follows from the preceding discussion that we can state the following handy rule for capital acquisitions:

If the net present value (NPV) of a project, calculated at the firm's weighted average cost of capital rate (its WACC) is greater than zero, the project should be undertaken—the asset should be purchased. If that NPV is negative, the asset purchase should not be made. If  $NPV = 0$ , then it is a matter of indifference.

### C. THE NPV CURVE FOR INVESTMENT PROJECTS AND THEIR IRRs

It is always a good idea to plot for investment projects such as the preceding one the associated NPV curve, as below. What does this NPV curve show us?



First, it shows us how sensitive the economic value of this project is to changes in the firm's cost of financing,  $k$ . We see that the project has a positive net present value (NPV) at any hurdle rate below 18.031%. This is reassuring, if the firm's managers believe that the cost of financing is unlikely to be that high.

But you also know by now the following supreme rule of economics:

**Whenever two curves intersect, or a curve intersects the horizontal or vertical axis, twitch in excitement! Something wondrous is bound to be happening at that intersection.**

**The project's Internal Rate of Return (IRR):** In this case, something truly wondrous IS happening at the discount rate at which the NPV line cuts the discount-rate axis: it is the discount rate at which the NPV of the project would be exactly equal to zero. In finance, this rate is called the project's "*internal rate of return*" or IRR. It is a much-used concept in the real world of business.

The IRR has its name because that rate is determined strictly by the cash flow of the project—is "internal" to it—and is not at all related to the firm's cost of financing ( $k$ ) at all.

For normal projects in which one or several cash outflows are followed by a series of only cash inflows, we can offer you the following decision rule concerning the IRR of a project<sup>2</sup>:

**If the IRR of a project exceeds the firm's WACC (i.e., hurdle rate  $k$ ), then the project should be accepted, because it earns more per year per dollar invested in the project than the firm's cost of funds. If the IRR is less than the WACC, the project should be rejected, as it impoverishes the firm's owners. If the IRR equals the WACC, it earns only normal profits (i.e., the owners' opportunity costs) and accepting it is a matter of indifference.**

In this case the project's IRR is  $18.031 > 11.88\%$ , therefore the IRR rule tells us the same as the NPV rule: this project will enrich the firm's owners.

We note in passing that in more advanced courses in finance you would learn about projects for which this rule cannot be used. Broadly speaking, they are projects whose cash flows changes sign more than once—e.g., from negative to positive to negative again.<sup>3</sup>

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<sup>2</sup> If the cash flow of a project changes sign more than once—e.g., if one or two outlays are followed by some inflows and then by another outflow—then this rule does not apply. Indeed, the project may then have more than one IRR. You have to take ECON 318 to learn how to cope with this mess.

<sup>3</sup> Let the geeks among you note that the NPV equation for an N-year project is really an N-degree polynomial of the form

$$NPV = X_0 + X_1 + X_2 + \dots + X_N,$$

## D. PROJECT EVALUATION IN THE REAL WORLD

Although the preceding example was stylized to focus on the essentials of capital budgeting, it does describe pretty much what goes on in the real world. The only modifications would be:

1. Calculating the firm's hurdle rate (the WACC) may involve more classes of debt and capital from owners. Calculating the firm's cost of equity capital properly is quite a sophisticated enterprise.
2. There may be cash outflows for several years, at more than one point in time, and the cash inflows may not be identical; they may fluctuate quite a bit over time. Thus, usually we cannot use the short-cut formula shown above, but instead must use spread sheets (such as the table shown earlier).
3. Projecting the annual cash flows associated with a project is quite complex, as they are driven by many variables (sales price, labor costs, etc). and also will involve complex tax effects. (For example, some tax-deductible expenses associated with the project may not cause a cash outflow at all, but help shield the firm from income taxes. Such tax savings are treated as cash inflows "earned" by the project, because they avoid cash outflows the firm would otherwise have had to make.
- 4. Sophisticated Treasury Departments routinely present decision makers (senior management and the Board of Directors) with sensitivity analyses that can indicate how sensitive the NPV a project is to changes in (1) the cost of financing and (2) the several factors that drive the net cash flow of the project—e.g., factors that determine future revenues or particular expense items that drive future cash outlays. Sensitivity analyses of this sort are the most practical form of risk assessment.**

**In practice, few business people of the so-called "real world" have as yet adopted these sound practices that are standard fare now in college. I have never understood what makes properly trained MBAs forget so quickly what they were taught in the class room and why that happens.**

But aside from these wrinkles, what has been illustrated above is used in corporate Board rooms all over America. If you understand it, you are way ahead of the pack.

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where, in general,  $X_t = (\text{CASH FLOW at point in time } t) / (1 + k)^t$ . It follows that the IRR is a real root of this polynomial. If the  $X_t$  switch signs only once, the polynomial has only one real root, which means the project has only one IRR. But if the  $X_t$  switch sign more than once, there may be more than one real root, which means the project could have more than one IRR. This is a mess for which you need advanced work in economics—e.g. Econ 318.



