

Part 7. Capital Budgeting

What is Capital Budgeting?

Nancy Garcia and Digital Solutions

Digital Solutions, a software development house, is considering a number of new projects, including a joint venture with another company. Digital Solutions would provide the software expertise to do the development, while the other company, American Financial Consultants (AFC) would be responsible for the marketing. Nancy Garcia of Digital Solutions would be responsible for assessing the financial viability of the plan. Information about the costs and revenues of the project would come from the accounting, production and marketing groups of the two companies; however, Ms. Garcia would have to put the information together, and provide a preliminary analysis that she would present to the company's managers.

Capital budgeting is the process of making a decision about the financial desirability of a project. The proposed software development project at Digital Solutions is an example of this kind of problem. We will see how Nancy Garcia approaches this problem as a way to learn the techniques of capital budgeting.

The Big Picture

Businesses are about increasing the wealth of their owners, which means that they should pursue all the profitable projects that they can. Capital budgeting is about deciding which projects are profitable and add to the value of the firm.

Sometimes the firm has to choose between two or more projects and can only pick one. For example, you may have a choice between two air-conditioning systems with different installation costs and energy costs. Your decision to install one *rules out* the installation of the other. Both systems may be wealth improving but you can't accept both. You want to pick the one that increases wealth by the most. When you have **mutually exclusive projects**, such as in this situation, you take a **ranking approach** to decision making, by ranking projects in order from best to worst.

Other times, there are **independent projects**, where the choice to do one project does not affect the returns of the other projects. For example, an airline may be considering proposals to expand into 10 different cities. It could choose to add routes to all cities, to some cities, or to none. This leads to the **accept-reject approach** to making decisions. You accept *all* proposals that increase owners' wealth and reject those that don't.

Of course, even if projects are not technically mutually exclusive, businesses can find themselves limited in the projects they can do by **capital rationing**. Capital rationing means that there are limits on the amount of funds a company can raise to finance capital expansion. Ideally, capital markets should provide funds for all wealth improving projects, however, in certain circumstances firms may be restricted in what they can do. For example, the airline may not be able to issue enough debt to buy new airplanes to service all ten new cities. Or it may be that a business is reluctant to issue new stock because of concerns of diluting ownership. When there is capital rationing, firms need to treat their new projects like mutually exclusive projects and use a

ranking approach. The airline should rank which cities provide the greatest potential for profits and expand into those cities first.

Sometimes the number of projects that can be done may also be limited by other resources of the company such as managerial expertise or specialized machinery. In this case, you also need to rank projects according to desirability, while recognizing that this is probably a short-run constraint. Once some projects are done, the company can move on to other projects; and given time, it can also hire additional employees and equipment.

Nancy Garcia's Plan of Action

Nancy's instructions are, for the moment, to treat this proposal as an independent project, and so not worry about other projects the firm is considering. Given this, she now needs to develop a plan of how to proceed. She (and we) will approach the problem in five steps:

1. Determine the relevant cash flows including different possible outcomes.
2. Assess the rough financial viability of the most-likely outcome.
3. Use more sophisticated capital budgeting techniques to evaluate the project.
4. Provide quantitative measures of risks the project faces.
- 5 Determine how these risks affect the decision to do the project.

The Time-Line of a Capital Project

The first step in any capital budgeting decision is to list all the relevant cash flows. This is the hardest part of the process since it depends on having a detailed understanding of the business and requires the manager to forecast what will happen with the project in the future. It is also the most important part of the process, since if the cash flows are wrong, measures of the profitability of the project will be wrong too.

Many capital projects have a similar structure: An initial investment by a firm, followed by a number of periods of regular cash inflow, followed by a terminal payment that ends the project. Our methods of evaluating projects don't depend on this structure, but it can be helpful to think of a project this way when determining cash flows in order to be sure that you don't forget any beginning or ending payments or costs.

Nancy's project has this kind of structure. The plan is for Digital Solutions to use its own software engineers and some temporary contract workers to develop the software over the next two years. Over the subsequent four years, Digital Solutions and AFC will share the revenue from sales according to a preset formula. At the end of the four years, AFC will have the option of buying all rights to the software at a fixed price.

The basic structure of the cash flows for Digital Solutions is as follows:

- Year 1: outflow: development costs
- Year 2: outflow: development costs
- Year 3: inflow: revenue from software sales
- Year 4: inflow: revenue from software sales
- Year 5: inflow: revenue from software sales
- Year 6: inflow: revenue from software sales
- + inflow: sale of future rights to ACF

Whenever you are measuring cash flows it is important to be thorough and list all the flows, both in and out, that are affected by the project. Since there are a number of common pitfalls to measuring cash flows, we will go through several rules that you should follow.

Use Cash Flows Not Accounting Profits

What matters to the company is the amount of cash coming in and going out. Accounting measures of profits will differ from cash flow calculations because of the inclusion and timing of non-cash expenses such as depreciation. A correct decision requires using the timing of the cash payments.

Example: Depreciation is a non-cash expense that is deducted from revenue. If a company needs to buy machinery to do a project, the cash might be paid when the machinery is purchased, but the cost of the machinery is represented in the accounting statements by depreciation, which would be spread out over a number of years. Because the depreciation, but not the cash, is deferred to the future, the accounting statements will underestimate the cost of the machinery.

Be Sure to Include Taxes

The owners of the company only get the net cash generated from the project after the company pays taxes. A project should be evaluated on an after-tax basis. This provides an exception to our rule not to use accounting profits. Taxes are based on accounting profits, not directly on cash flows. Because of this, you may need to calculate both cash flows and accounting profits. The accounting profits are used to calculate the taxes associated with the project, which are then factored back into the cash flows.

Example: When the company depreciates the machinery (in the previous example) it reduces the taxes the company has to pay, increasing the cash flow to the company. When calculating the cash flow it is important to calculate accounting earnings because this determines the taxes the company will pay.

Only Include Incremental Cash Flows

We are not interested in all the cash flows generated by the firm, but only the *extra* cash flows that this project creates. We are comparing the cash flows if we take the project and the cash flows if we don't do this project. The difference is the incremental cash flows of the project. The next few paragraphs give some examples of using the 'only incremental cash flow' principal.

Don't Include Sunk Costs

Sunk costs are costs that have been already been paid and so can't be changed. If costs can't be changed then they shouldn't be included in the calculation – this is just an application of our incremental cash flow rule.

Example: You have just been appointed CFO of a small movie studio specializing in low budget horror movies. The movie studio's latest project "Bride of the Zombie" has been halfway produced at a cost of \$500,000. However, there are concerns that the horror movie craze is diminishing and revenues will be less than expected. It is projected that the film will earn \$400,000 in its first year of release (next year) and \$30,000 per year for the following 10 years from various revenue sources. It is estimated that it will cost an additional \$500,000 to complete the movie. The president of the company argues that the movie will be a money loser and so should not be completed. He points out that the cost of the movie is \$1,000,000, while total revenue adds up to \$700,000 with a big chunk of that coming in the future. Is he right?

The key fact is that the initial \$500,000 spent on the movie is gone whether you finish the movie or not. You should only look at costs that affect your decision. You should compare the \$500,000 it takes to complete the movie with the stream of revenue that you get by completing the movie.

In the case of Digital Solutions, an example of this kind of cost would be if they had already spent a year developing this kind of software (assuming it still takes the two years we assumed). If so, the cost has already been paid, and whether they pursue the project or not, it will not affect that cost. If there were any previous development costs, they should be ignored.

Include Opportunity Costs

When you take some action, you often give up the opportunity to do something else. These costs should be included as part of the project.

Example: An airline is considering expanding to a new city using planes it owns that aren't being used on any other route. While it might seem like there is no cost to using these planes, the company could conceivably sell them, or lease them out to another airline. By expanding they are giving up that opportunity. The (foregone) potential revenue from selling the planes needs to be added to the cost of the project.

Include External Effects

Sometimes the activity on one project will affect the cash flow of other projects. A common example of this is when sales of one project cannibalizes sales of another project.

Example: General Groceries is planning on introducing a new "cinnamon raisin bran" breakfast cereal. Once established in the market place, it believes that it will generate revenues of \$50 million per year. Does it need to look at any other costs besides the costs of developing and selling this cereal?

An important thing to check is if General Groceries makes any other similar kinds of cereal, for example, a regular raisin bran. If it did, then it is likely that some of the sales of the cinnamon raisin bran would come at the cost of lower sales of the regular raisin brand. The reduction in profits of the regular raisin brand should be included as a cost of introducing the new cereal.

Be Careful When Allocating Overhead Costs

Overhead costs are costs not related to any particular project, but pay for functions that support all the activities of the firm. This could include personnel involved in general management, finance and accounting, and human resources, the cost of buildings used by more than one division or project, or various activities such as advertising and promotion.

Since these costs cannot be allocated to any specific project they are sometimes allocated mechanically, perhaps as a fraction of sales or costs. The problem with that approach is that it doesn't tell us the incremental cost. How much extra are we spending on overhead because of this project? If the answer is zero, then we should not be adding this to the cost of the project.

The answer can get a little more complicated if we recognize that our project specifically might not require additional overhead, but if the company did enough new projects then sooner or later it would have to expand general management and incur additional overhead costs. If this is true, and the company expects to expand, our project should reflect part of those overhead cost.

Include All Terminal and Replacement Costs

This is just a reminder not to forget any costs and benefits that come at the end of a project

Example: You are considering starting up a flower shop that you will run until you retire. As part of this venture you would buy a small retail space. While the costs of buying this space would be obvious to include, you don't want to forget the revenue you get from selling the shop when you retire.

Example: You are a purchasing manager for a local city and are choosing between two street sweeping machines. The first machine is expected to last 10 years. The second machine is more expensive but is expected to last four years longer. Since you are going to have to buy replacement street sweepers when they wear out, how long they last will certainly affect their value. We will see how to handle this situation later on.

Be Consistent in Adjusting for Inflation

When calculating cash flows it is necessary to include the effect of inflation. One way to do this is to directly factor in inflation. For example, if we expect prices to increase by three percent per year, future revenues and costs that are not fixed should be increased by the same amount each year. An equivalent way to do the calculation is to measure all costs and benefits in real terms (that is, adjusted for inflation). Needless to say, it is important to be consistent, do one or the other. Also, when we get to the capital budgeting decision we will be using interest rates to discount future payments. We must be consistent here as well. If we are including inflation in our cash flows we should use nominal interest rates. If we are adjusting our cash flows for inflation, we should use real interest rates.

Example: We are evaluating a project that earns income of \$100,000 now, with a similar level of business continuing into the future. We expect inflation be 3% per year over the life of the project, which should increase the income we get in the future. The nominal interest rate used to evaluate this project is 7%. We have two ways to factor inflation into our evaluation of the project. The first way is to increase our estimates of

future income by the inflation rate, and then discount those payments using the 7% nominal interest rate. An alternate approach is to keep the payments at the (inflation-adjusted) level of \$100,000 and use a real interest rate to calculate the present value. Both approaches will give us the correct answer as long as we are consistent in our treatment of inflation across the payments and the interest rate. (A technical note: we will get the same answer as long as we calculate the real interest rate as $1+r = (1+i)/(1+\pi^e)$. If we use the approximation $r = i - \pi^e$, the numbers will be slightly off, but still close enough for most applications)

Do Not Include the Cost of Financing

We do not want to be including financing costs as part of our cash flows as the relevant financing costs will enter at the evaluation stage

Example: We are buying a truck for \$20,000 that will generate income from a hauling service. To buy the truck we will get a loan at 8% interest that will require payments over the next 3 years. For purposes of evaluating this venture, the interest payments are not included as a negative cash flow. Rather, the 8% interest rate will be factored in when we make our decision. We will discuss this in more detail in a moment.

Back to Digital Solutions

As part of the project evaluation, Nancy Garcia would sit down with each of the parties and go through their estimates of their costs. Some of our concerns will be important while others will not matter much. For this project, she decides that all costs will be adjusted for inflation. Opportunity costs show up in this project if it requires resources that might be used for other projects. For example, if using the software engineers meant that the company couldn't pursue other projects, then any profits the company missed out on should be included as a cost of this project. Similarly, if doing this project requires using office space owned by the company that could also be rented out, the lost rent should be included as part of the project

On the other hand, what if the engineers would just be sitting idle if the company didn't pursue this project? In this case, the salaries of the engineers are a sunk cost (they will be paid in any case) and there is no opportunity cost to using the engineers in this project. Because it is a sunk cost, the salaries of the engineers would not be included. Since Digital Solutions is not selling any other software, this does not apply, although we can think of the opportunity cost of the software engineers as an example of an indirect cost.

For this project, it looks like there will be little affect on overhead costs, except for human resources, since so much of the software engineering will be outsourced. Some extra cost associated with this will be added to the project.

After making the appropriate investigations, Ms. Garcia comes up with estimates of the cash flows. Because these expenses are mostly in the future, they are uncertain and so she requested that the managers provide a most-likely estimate of what the costs and revenues would be, and some idea of the range of possible outcomes.

We will think about how to evaluate risks of a project more thoroughly in the next section; at this point we are just collecting data. Whenever you are coming up with estimates of cash flows you want to provide a range of possible outcomes and some guide to how likely the different

outcomes are. Also, you would want to present specific alternate scenarios, such as what would happen to costs if it took longer than expected to design the software, or what revenue would be if the competition introduced a similar product and so your sales were lower than expected.

Forecasts of this type can be quite complicated, but to keep things simple, we will report the basic information for the most-likely estimate and an optimistic and pessimistic estimate. Outflows are shown as negative numbers and inflows as positive numbers.

Table 1. Estimates of Cash Flows for Proposed Project

Year	Activity	Pessimistic	Most likely	Optimistic
1	Development	-\$350,000	-\$300,000	-\$250,000
2	Development	-\$600,000	-\$400,000	-\$200,000
3	Sales	\$0	\$100,000	\$150,000
4	Sales	\$50,000	\$200,000	\$400,000
5	Sales	\$50,000	\$300,000	\$500,000
6	Sales	\$50,000	\$300,000	\$500,000
7	Sell Software	\$600,000	\$600,000	\$600,000

There is a fair amount of uncertainty about the outcome of the project, particularly in the amount of sales in future years. Underlying these figures would be detailed calculations showing where the costs come from and the assumptions about price and units sold that determine sales revenue. This detailed information can be important as it allows us to ask hypothetical questions such as, what would happen to our costs if the labor market changes making temporary software engineers more expensive, or if we could only sell half as many units at our assumed price?

For convenience, the revenue from selling the rights to the software in year 7 is treated as a certain amount, even though in our initial description of the contract this was given as an option.

How to Evaluate Projects

Once we have determined all the cash flows, the next step is to determine if the project should be done. This section introduces the three major ways of making the decision: Payback Period, Net Present Value, and Internal Rate of Return. We will start off by looking some simple examples of each approach, and then return to the Digital Solutions project at the end of the section.

All of these approaches assess the profitability of the project, that is, does the revenue from the project exceed the costs? However, what makes capital budgeting a special task is that the payments are often made at different times and so we have to adjust for the time value of money.

Payback Period

Imagine that we have a project that costs \$80,000 and returns \$20,000 each year over the next 5 years. The sum of the returns (\$100,000) exceeds the cost, so on its face the project is worth doing. However, we have ignored the fact that some of the returns to the project are being paid in the future. For example, consider a project that offered returns of \$10,000 over the next 10 years. The total return is still \$100,000, but we would probably think that this project is not as good as the first one. The returns are coming farther in the future and we know money in future is worth less. Also, the farther into the future the payments are, the more time there is for things to

change, and perhaps make the returns to the project worse. To make a correct decision, we need to take into account when the payments are made.

Payback period asks how long it takes for the accumulating returns to pay for the initial cost of the capital improvement. For example, if you install a new air conditioner that costs \$1,600 and that saves you \$200 in energy costs per year, then the payback period would be 8 years (after 8 years of saving \$200 we have earned \$1,600, to equal our initial cost). If this is less than the maximum acceptable payback period then we would decide to install the new air conditioner. The farther in the future the payments are, the longer the payback period, and so it is less likely that the project would be accepted. (What would the payback period be if we saved \$100 per year?)

Example: A project costs \$1,500 and pays \$1,000 over the next three years. What is the payback period?

The payback period is 1.5 years assuming that the cash flow is evenly spread over the period. Often, because of the degree of uncertainty about cash flows, it is not necessary to be exact, and we can round off the payback period. For example, a payback period of 7.6 years, might be called 7-8 years, or rounded up to 8.

Right off the bat you can see there are some problems with this method; we are adding up dollars across years and yet we know from our discussion on present value that payments in different years are not the same. We are also not taking into account the risk associated with the cash flows, or including any of the cash flows after the 8 years. And how do we know if 8 years is too long, anyway? Given all these problems, why would anyone ever look at the payback period?

The answer is that it is quick and easy to calculate and it captures some of the *intuition* behind capital budgeting decisions. The longer the payback period, the worse the project probably is. If it takes more years for the cash flows to accumulate to cover the initial investment, it means that we have to wait longer for our money. Since we know that money in the future is worth less, this is not desirable. Also, the longer we have to wait to get the positive cash flows, the more time there is for something to change, and so the cash flows are less certain and therefore less desirable.

The payback period provides a rough and ready way of evaluating a project. You can use it to get an initial idea of the project's worth, and sometimes that is enough. If the cash generated by the project does not cover the initial cost, there is no payback period, and so we should definitely not do the project. On the other hand, if the payback period is a year and a half, with further payments to come it would seem to be a very good project, since there would be little discounting and so the benefits would surely cover the costs.

However, most capital budgeting decisions require a more careful treatment. We need to be explicit about our adjustments for risk and the time value of money. The next two techniques can do just that.

Net Present Value

A better method of evaluation (in fact, the best method) is called net present value (NPV). The NPV of a project is the just the present value of all the cash flows of the project, including the

initial investment. In fact, NPV is just another example of discounted cash flow analysis. Once we know a project's NPV, we can make a decision about whether we should do it.

Rules for evaluating projects using NPV are:

- If the projects under evaluation are independent, then you should accept all projects with a positive NPV and reject those with a negative NPV.
- If the projects are mutually exclusive, choose the project with the highest NPV (as long as it is greater than 0)

Example: An air conditioner costs \$1,600 and saves \$300 per year for the next 10 years. The discount rate used to value future cash payments is 10%. The present value of the cost savings is \$1,843. We subtract away the cost to give an NPV of \$243. Since the NPV of the project is positive, we should do this project.

The discount rate plays an important part in NPV, but where does it come from? We will examine this more thoroughly in a later section, but the basic idea is that it is the cost to the company of obtaining the funds to do this project. For example, if we borrowed the \$1,600 to buy the air conditioner, we can think of the discount rate as the interest rate we would pay on the loan. In order to generate the savings, we had to borrow money at 10% and so any future proceeds from the project should be discounted at 10%.

Example: We have a project that costs \$100,000 and pays \$20,000 per year for the next 6 years. To fund this project we would need to get a bank loan at 8%. The present value of the payments to us is \$92,458, which is less than \$100,000, so the project has a negative NPV. Another way to evaluate the project would be to calculate 6 equal payments for a loan of \$100,000 at 8%, which is what we would need to finance this project. The interest costs would be \$21,632, which exceeds the cash payments, so this would be a bad project to do. This is the same answer we get from NPV since NPV incorporates the opportunity cost of funds in its discount rate.

What if we already had the money and didn't need to get a loan? Is our cost of funding equal to 0? No, there is still an opportunity cost of using the funds in this project. If we didn't buy the air conditioner we could invest in another project or save the money, or return it to the owners of the company.

In most large companies, the non-financial managers will be responsible for determining cash flows and understanding capital budgeting techniques, but the actual calculation of the cost of capital, for the company as a whole, will be done by the Finance Department.

Internal Rate of Return

A method very similar to NPV is the internal rate of return (IRR). However, instead of reporting the dollar amount of the project, it gives a rate of return. IRR is calculated as the discount rate that equates the present value of cash inflows with the initial investment associated with the project. Another way of saying this is that IRR is the discount rate that sets the NPV of the project equal to zero.

Example: A project costs \$10,000 now and returns \$12,000 in two years. The NPV of the project is given by $12,000/(1+k)^2 - \$10,000$ (the present value of the payments). If we set the present value equal to 0, we get the equation $12,000/(1+k)^2 - \$10,000 = 0$, and we can solve for $k = 9.54\%$

The rules for using IRR are:

- For independent projects, if the IRR is greater than the cost of capital, accept the project. If it is less than the cost of capital, reject the project.
- For mutually exclusive projects, choose the project with the highest IRR, assuming that it is also above the cost of capital.

In the last example, the IRR of the project was 9.54%, so the project just breaks even, in terms of NPV, at 9.54%. If the actual cost of capital is 7% then we know that the NPV will be positive and so we should do the project. If instead, the cost of capital is 15% we would know that the NPV is negative, since the NPV is just equal to 0 at 9.54%

Unlike NPV, when there are multiple and unequal payments the math can get complicated. Spreadsheets are the way to handle these problems. However, if there are regular payments, we can use our annuity math and a financial calculator to find the answer.

Example. Return to the air conditioner problem. Solving this by hand would be tedious but a spreadsheet or a financial calculator can do the work for us. Using a financial calculator, we enter the following numbers ($N = 10$, $PV = -1,600$, $PMT = 300$, $FV = 0$, $I=?$) The IRR for this project is 13.43%, which is greater than the 10% cost of capital, and so we should do this project.

Comparing NPV and IRR

NPV and IRR are very closely related; however, there are a few differences. Some of the differences are technical (which we will not pursue here) while others are easier to see.

Differing Assumptions about the Reinvestment Rate

NPV assumes that money is reinvested at the cost of capital. Money earned early on in the project can be reinvested over the life of the project at that interest rate. IRR assumes that money is reinvested at the IRR rate, which for acceptable projects will be above the cost of capital. This may not be a reliable assumption. For example, if you come across a very special project that offers you a 50% IRR you may not be able to earn that return elsewhere when investing cash generated by that project.

Differing Types of Numbers Reported

NPV reports a dollar amount while IRR reports a percentage. For example, the return on a project might be given as \$100,000 or 10%. People are often more comfortable looking at rates of return when making decisions, which leads to IRR's popularity as a decision rule.

Sometimes Reach Different Conclusions

Generally, NPV and IRR will produce the same answers for accept-reject decisions, but they may rank mutually exclusive projects differently. If they give different answers, NPV provides the correct answer.

The bottom line is that NPV is the better approach, but IRR is often easier to interpret, and since they both provide similar answers, IRR is often used in practice. Since both are straightforward to calculate, you should be sure to calculate the NPV, but also have the IRR on hand if someone wants to know it.

Back to Digital Solutions

Nancy finds out from the Finance Department at her company that she should discount future payments by 8% annually. She constructs a table that lists the (most likely) payment, and the value of the discount factor $1/(1+k)^n$ for each year. She then calculates the present value of each of the payments.

Year	Payment	Discount	Present Value
1	-300,000	0.925926	-277,778
2	-400,000	0.857339	-342,936
3	100,000	0.793832	79,383
4	200,000	0.73503	147,006
5	300,000	0.680583	204,175
6	300,000	0.63017	189,051
7	600,000	0.58349	350,094
NPV			348,996

Adding up the present values of each of the payments gives a NPV for the project of \$348,996. Since this is greater than zero, the company should do this project. Of course, we are not certain about the value of payments in the future. The next section will discuss ways of coming to grips with this uncertainty.