## What Is the Proper Discount Rate to Use in Calculating NPV?

It is critical to the success of a project that the proper discount rate be chosen for the calculation of NPV. The discount rate used is known as **required rate-of-return** or the **hurdle rate**. A firm should invest money in a project only if the project provides a return higher than this rate. Investments with a return higher than the hurdle rate will increase the value of the firm and thus stockholders' wealth.

The usual measure of the required rate-of-return is a firm's **Weighted Average Cost of Capital**. However, it is appropriate to use this rate **only** when the risk of the project is the same as the risk of the overall business. If the project is either riskier or less risky than the company's other business, the rate should be adjusted to reflect the increased or decreased risk. Cash flows for a riskier project should be discounted using a higher hurdle rate, while a hurdle rate of less than the firm's weighted average cost of capital may be used for a project that is judged to be safer than the company's other business. The hurdle rate may also be adjusted for different levels of inflation.

Note: The NPV method assumes that the **cash inflows** from the project will be able to be **reinvested at the rate that is used in the NPV calculation**, i.e., the discount rate used to discount the cash flows. However, this does not mean that they actually **will** be able to be reinvested at that rate. In fact, they probably will **not** be able to be reinvested at the same rate as is used to discount the cash flows.

The cash flows from the project probably cannot be reinvested in the project, because the project probably does not need any more money invested in it. Usually all of the money is invested at the beginning of the project, in Year 0. And even if the cash flows can be reinvested (for instance, if the project were to need an additional working capital investment halfway through), there is no reason to believe that the additional investment would cause the cash flows from the project to increase. So the cash flows from the project cannot earn a return from that capital project. They must be invested elsewhere. And the investment elsewhere of the cash flows may or may not be able to generate as high a rate of return as the capital project does.

Therefore, the assumption inherent in NPV analysis that the cash inflows from the project will be able to be reinvested at the rate used in the NPV calculation may lead to an incorrect evaluation of the true worth of the project.

### The Effect of the Discount Rate on NPV and NPV Profile

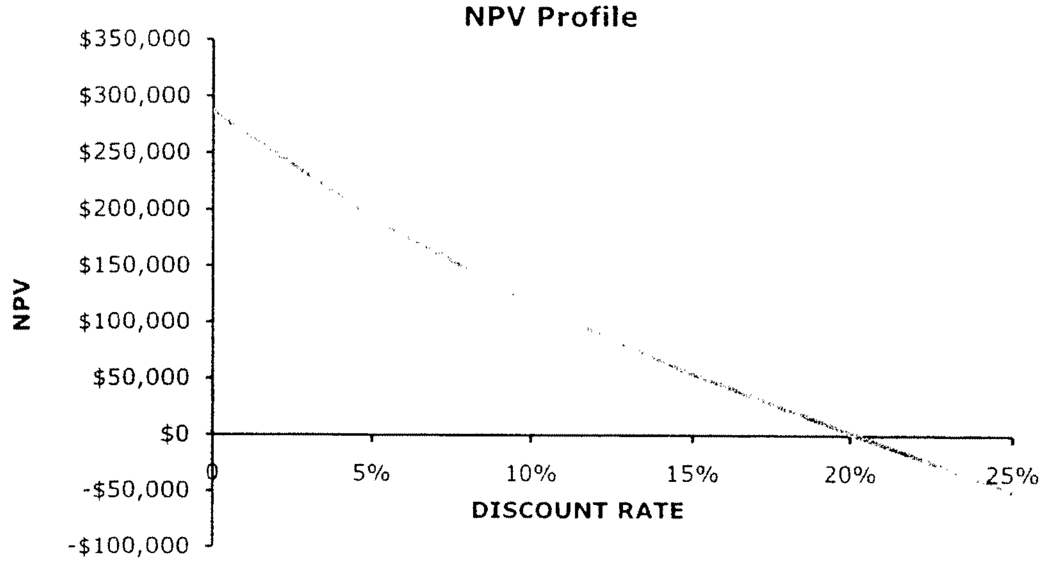
The discount rate chosen for an NPV analysis will have an important effect on the final NPV. The higher the discount rate that is used, the lower will be the NPV; and the lower the discount rate that is used, the higher will be the NPV.

Here is an example of one project and the various NPVs that result from using various hurdle rates to discount the cash flows:

| Hurdle Rate | Project NPV |
|---|---|
| 25% | −50,368 |
| 20% | 2,500 |
| 15% | 54,200 |
| 10% | 116,800 |
| 5% | 193,200 |
| 0% | 287,000 |

The NPV profile of a project is a graph that shows the relationship between the project's net present value and the discount rate used.

Here is this project's NPV Profile:




### Weighted Average Cost of Capital (WACC)

In computing the appropriate discount rate, we start with the **optimal capital structure**. Capital structure means the funding structure, or the composition of a company's long-term debt, common equity and preferred stock. The optimal capital structure is the unique capital structure that minimizes the firm's composite cost of long-term capital and therefore maximizes the firm's value.

The proportion of each capital component in the optimal capital structure is multiplied by its cost to obtain the **Weighted Average Cost of Capital (WACC)** of the company. The WACC is defined as the **opportunity cost of capital** for the company's existing assets. As we said above, the Weighted Average Cost of Capital is the appropriate discount rate to use in capital budgeting decisions and NPV calculations **as long as the riskiness of the project is the same as the riskiness of the firm**. For the risk premium to remain unchanged as a result of the capital expansion project, the following conditions must be met:

1) The new assets financed by the new capital must not change the firm's operating environment substantially.

2) The new capital must be raised in the same proportions as the existing capital, so that the firm's financial risk remains the same.

The optimal mix of the various sources of capital (debt, preferred stock and common stock equity) is a highly controversial issue in finance. By raising new capital in the same proportions as existing capital, the firm should leave its financial risk unchanged.

Assuming the above conditions are met, the firm's current Weighted Average Cost of Capital can be used as the required rate-of-return. The calculation of the Weighted Average Cost of Capital is covered in Section B and is not discussed here.

In the topic of "Risk in Capital Budgeting," we will talk about adjustments that need to be made to the discount rate used if either or both of the above conditions are not met and thus, the company's business risk or financial risk is changed by the project.

Question 52: The Keego Company is planning a $200,000 investment that has an estimated 5-year life and no salvage value. The company has projected the following cash flows for the investment:

| Year | Projected Cash Inflows | Present Value of $1 |
|---|---|---|
| 1 | $120,000 | .91 |
| 2 | 60,000 | .76 |
| 3 | 40,000 | .63 |
| 4 | 40,000 | .53 |
| 5 | 40,000 | .44 |

The net present value of the investment is:

a) $18,800

b) $218,800

c) $196,200

d) $91,743

(CMA Adapted)

Question 53: McLean is considering the purchase of a new machine that will cost $160,000. The machine has an estimated useful life of 3 years. Assume that 30% of the depreciable base will depreciate in the first year, 40% in the second year and 30% in the third year. The new machine will have a $10,000 resale value, which is equal to residual value at the end of its useful life. The machine is expected to save the company $85,000 in operating expenses each year. McLean uses a 40% estimated tax rate and a 16% hurdle rate to evaluate capital projects.

The discount rates for 16% are as follows:

| | PV of $1 | PV of a $1 Annuity |
|---|---|---|
| Year 1 | .862 | .862 |
| Year 2 | .743 | 1.605 |
| Year 3 | .641 | 2.246 |

What is the net present value of this project?

a) $3,278

b) $6,270

c) $5,842

d) $30,910

(CMA Adapted)

## Internal Rate-of-Return (IRR)

The IRR is the discount rate at which the NPV of an investment will be equal to 0. This is the discount rate at which the present value of the expected cash inflows from a project equals the present value of the expected cash outflows. If this rate is higher than the firm's required rate-of-return, the investment is acceptable. If this rate is lower than the required rate-of-return, the investment should not be made.

**If annual cash flows are the same for every year of the project's life,** IRR can be found by applying the following steps:

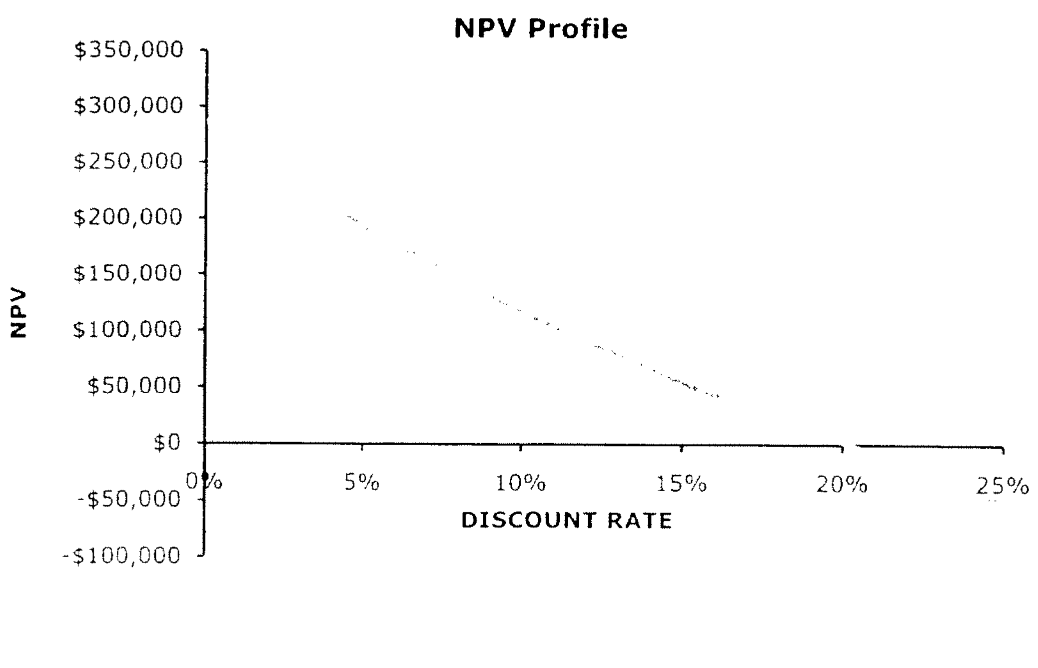
- First, divide the net initial investment by the annual cash flow amount. This will provide a factor that represents the present value of an annuity.
- Then, go to a present value of an annuity factor table. Look at the line for the number of years of the project's life, and look along that line until you locate the factor on that line that is closest to the factor you just calculated. Follow that column up to the rate at the top of the column, and you will have a rate-of-return that is close to the internal rate-of-return of the project.
- If necessary, you can then use that rate to interpolate a more accurate rate using the procedure described in Appendix B of this book.

**When annual cash flows are not the same** for every year of the project's life, the IRR can be found through trial and error by using different rates and then finding the rate for which the NPV is zero. This is a very large mathematical calculation and is outside the scope of the exam. There is a detailed example of this calculation in Appendix B.

The IRR can also be calculated using a financial calculator. Two financial calculators are permitted on the CMA exams: the Texas Instruments BA II Plus and the HP 10 B II.

### NPV Profile and the IRR

Recall the graph of a project's NPV that looks like the graph below. Notice on the graph that the NPV Profile line crosses the horizontal axis at approximately 20%. This is this project's IRR, because this is the discount rate at which the project's NPV becomes zero.



## Evaluating IRR

If the IRR is higher than the required rate of return, tor hurdle rate, established by the firm for the project, the project is acceptable. If the IRR is lower than the required rate of return, the project is not acceptable and should not be considered further.

Remember that IRR is a **rate**, in contrast to NPV, which is an absolute dollar amount.

IRR has a limitation in that it is possible for it to give more than one answer. This will occur when there is more than one change in the cash flows from positive to negative in any period. IRR is essentially calculating the rate at a turn in the curve and so if the cash flows change from positive to negative during the project, each turn will give another answer. This is discussed further in the topic of "Problems With IRR."

Note: Note: The IRR calculation assumes that the cash inflows from the project **can be reinvested at the Internal Rate of Return**. As with the NPV assumption (i.e., that the cash flows can be reinvested at the discount rate used to calculate the NPV), this may not be the situation. If this is not true, then the IRR that is calculated will not be accurate, because the monies received cannot be reinvested at that same rate.

The **modified IRR** attempts to deal with this problem. It assumes that the cash flows received from the project are **reinvested at the company's cost of capital rate**, rather than the IRR rate.

**Example:** Facts about a proposed capital budgeting project are as follows:

- The initial investment is $150,000.
- The project life is 5 years.
- The hurdle rate is 8%.
- The annual after-tax cash flow is $40,000.

**What is the project's Internal Rate of Return?**

**Solution:** Following the procedure outlined above, we divide $150,000 by the annual cash flow amount of $40,000. The result is 3.75. We then check a Present Value of an Annuity factor table. On the line for 5 periods, we look across until we find a factor or factors that are close to 3.75. Under 10% we see a factor of 3.7908, and under 11% we see a factor of 3.6959. 3.75 is about halfway in between these two numbers. Therefore, the IRR of this project is approximately 10.5%. Since that is higher than the hurdle rate, this project is acceptable.

If the NPV of this project were calculated using an 8% discount rate, the NPV would be the net of the present value of the positive cash flows of $40,000 (using the PV of an annuity factor for 8% for 5 years, which is 3.9927) minus the initial investment amount of $150,000, which is:

($40,000 × 3.9927) − $150,000 = $9,708.

The NPV is positive, so the project is acceptable according to NPV analysis. That evaluation is consistent with the evaluation of the project's IRR, which is that the project is acceptable because its IRR of 10.5% is higher than its hurdle rate of 8%.

## Problems With IRR

### Multiple IRRs

A conventional project begins with a cash outflow and that cash outflow is followed by several cash inflows. In other words, the direction of the cash flow changes just one time, from negative to positive. However, not all projects follow this conventional pattern. Some projects will begin with a negative cash flow, then have some years with positive cash flows but also have one or more years with negative cash flows. In these projects, the direction of the cash flow changes more than once.

Whenever a project has a negative cash flow or flows in any subsequent year(s) after Year 0, it is called a **nonconventional project**. A project like this can have more than one IRR, because more than one discount rate will cause the project's NPV to be zero. The number of IRRs will be equal to the number of sign changes in the cash flows.

This is usually not a major problem, because generally only one of the IRRs will be reasonable, while the other or others will be something like 500% or −50% or even 10,000%. However, the multiple solutions can cause a financial calculator to return an error message.

In this case, it is better to evaluate the project on its NPV.

### Mutually Exclusive Projects

#### Different Size Projects

Sometimes a firm will be evaluating several projects, and if it chooses one project it cannot choose any of the others. As an example of mutually exclusive projects, suppose a firm has one plot of land. It can use that land to build only one building, and it is determining what type of plant to build on it. In this situation, use of the Internal Rate of Return can be misleading when the sizes of the initial investments are different.

Since the IRR is a rate of return, a project with a smaller initial investment can show a higher IRR than a project requiring a larger initial investment, even though the project with the larger initial investment has a higher NPV.

Let's carry further the example of building a plant. The firm could erect a plant for $250,000 that it could use to manufacture molds for the plastics industry. Or, it could build a plant for $2,000,000 that it could use to manufacture organic solar cells used in the solar energy industry. Manufacture of organic solar cells would be more profitable, but it would require a much larger investment in the plant and equipment. Here are the two projects' expected cash flows, NPVs (using a required rate of return of 15%) and IRRs:

| | **Solar Cell Manufacturing Plant** | **Mold Manufacturing Plant** |
|---|---|---|
| Year 0 | −2,000,000 | −250,000 |
| Year 1 | 150,000 | 60,000 |
| Year 2 | 250,000 | 70,000 |
| Year 3 | 350,000 | 80,000 |
| Year 4 | 450,000 | 90,000 |
| Year 5 | 550,000 | 100,000 |
| Year 6 | 650,000 | 110,000 |
| Year 7 | 750,000 | 120,000 |
| Year 8 | 850,000 | 130,000 |
| Year 9 | 950,000 | 140,000 |
| Year 10 | 1,050,000 | 150,000 |
| NPV @ 15% | 391,968 | 192,105 |
| IRR | 19.11% | 31.74% |

If the company bases its decision on the two projects' IRRs only, it will choose to manufacture molds because the IRR for the mold manufacturing plant is 31.74% versus 19.11% for the solar cell manufacturing facility. But if it chooses to manufacture organic solar cells, it will be richer by $199,863 ($391,968 − $192,105). In this example, the solar cell plant is the better choice. IRR is not reliable for ranking projects of different sizes.

### Different Cash Flow Patterns

IRR is also not reliable for evaluating mutually exclusive projects when the projects' cash flows have different patterns. In the following example, we have two projects, both requiring the same amount of investment, but the cash flows are very different. Project A's cash flows are received early, whereas Project B's cash flows are received later. The net cash flow for Project B is significantly greater than the net cash flow for Project A ($545,000 over the life of the project versus $287,000 for Project A). However, the IRR for Project A (20.3%) is higher than the IRR for Project B (14.2%). This is due to the fact that the cash flows for Project A are received earlier.

| | Project A | Project B |
|---|---|---|
| Year 0 | −1,000,000 | −1,000,000 |
| Year 1 | 800,000 | 70,000 |
| Year 2 | 475,000 | 150,000 |
| Year 3 | 7,000 | 525,000 |
| Year 4 | 5,000 | 800,000 |
| **IRR** | **20.3%** | **14.2%** |

Now, let's look at these two projects' NPVs at some possible required rates of return, or hurdle rates.

| Hurdle Rate | Project A NPV | Project B NPV |
|---|---|---|
| 25% | −50,368 | −251,520 |
| 20% | 2,500 | −123,200 |
| 15% | 54,200 | −20,100 |
| 10% | 116,800 | 116,800 |
| 5% | 193,200 | 299,400 |
| 0% | 287,000 | 545,000 |

Notice several things about the table above:

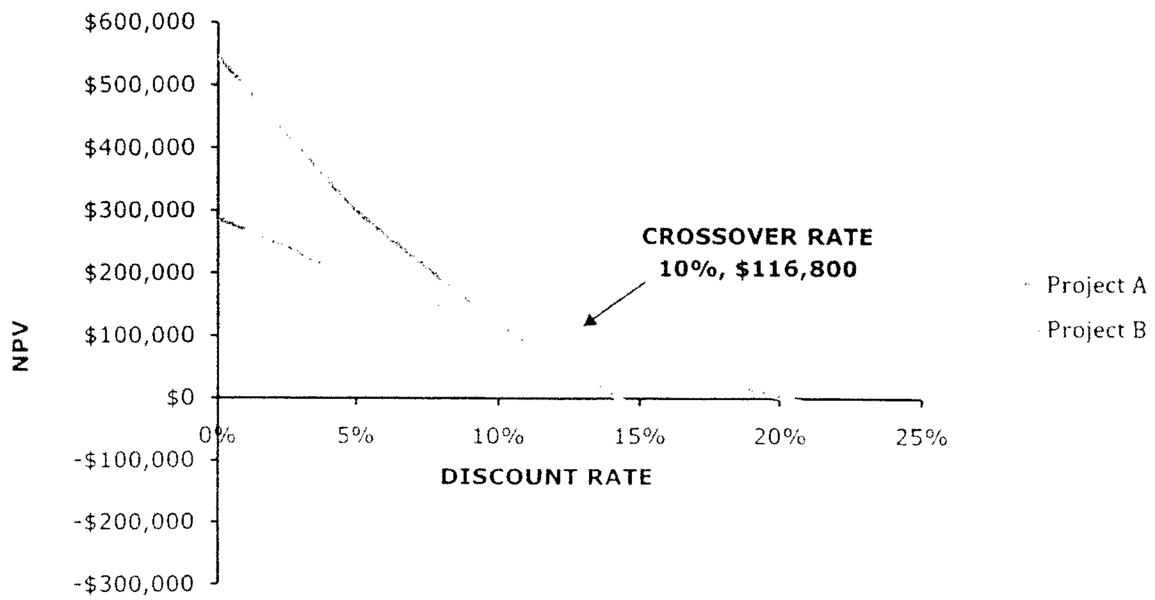
- At the hurdle rate of 10%, the two projects' NPVs are exactly the same: $116,800. For these two projects, 10% is the **crossover rate** because when both projects are discounted at this rate, their NPVs are the same.
- Which project has a higher NPV depends on what hurdle rate is used to discount the cash flows to their present value in the analysis, and the dividing point is the crossover rate.
  - When discounted at hurdle rates **higher** than the crossover rate, the NPVs and the IRRs give the same result: Project A is the better project.
  - But when discounted at hurdle rates **lower** than the crossover rate, NPV and IRR give **different** results. Project B is the more attractive project according to the NPVs, though Project A has a higher IRR.

This is the problem with IRR when the timing of cash flows of mutually exclusive projects is different. It can give results that conflict. NPV is a more reliable evaluation tool, because it results in a dollar amount of profit.

### NPV Profiles and the Crossover Rate

Remember we said that on an NPV Profile graph, the point where the profile line crosses the horizontal axis is the project's IRR. Notice that Project A's NPV Profile line crosses the horizontal axis at approximately 20%. Project A's IRR, per the chart above, is 20.3%. And Project B's NPV Profile line crosses the horizontal axis at a little below 15%. Project B's IRR is 14.2%. (These IRRs were calculated on a financial calculator.)

When we plot two projects on one NPV Profile graph, the point where the two lines cross is the crossover rate. Look at the NPV Profile graph of Project A and Project B on the following page.



**The following information is for the next two Questions:** A firm with an 18% cost of capital is considering the following projects (on January 1, Year 1):

| | January 1, Year 0 Cash Outflow | December 31, Year 5 Cash Inflow | Project Internal Rate-of-Return |
|---|---|---|---|
| Project A | $3,500,000 | $7,400,000 | 16% |
| Project B | $4,000,000 | $9,950,000 | ? |

Present Value of $1 Due at the End of "N" Periods

| N | 12% | 14% | 15% | 16% | 18% | 20% | 22% |
|---|---|---|---|---|---|---|---|
| 4 | .6355 | .5921 | .5718 | .5523 | .5158 | .4823 | .4230 |
| 5 | .5674 | .5194 | .4972 | .4761 | .4371 | .4019 | .3411 |
| 6 | .5066 | .4556 | .4323 | .4104 | .3704 | .3349 | .2751 |

Question 54: Using the net-present-value (NPV) method, project A's net present value is:

a) $316,920

b) $23,140

c) $(265,460)

d) $(316,920)

Question 55: Project B's internal rate-of-return is closest to:

a) 15%

b) 16%

c) 18%

d) 20%

(CIA Adapted)

## The Accounting Rate of Return

This is a ratio of the amount of the increase in the **accounting income** to the required investment. It is calculated as follows:

$$\frac{\textbf{Increase in Expected Annual } \textbf{\textit{Average After Tax}} \textbf{ Accounting Net Income}}{\textbf{Net Initial Investment}}$$

Since this method uses accrual accounting income, it includes depreciation. However, it does not take into account the time value of money, and for that reason, it is also called the **unadjusted rate of return** model.

Note: Sometimes the **average investment figure** is used in the denominator rather than the Net Initial Investment. This is usually calculated as the initial investment divided by 2, because the investment will have a book value of 0 at the end of the project.

When the Accounting Rate of Return method is used, management sets a required Accounting Rate of Return and projects whose returns exceed that rate are considered acceptable.

Example: AMC Petroleum, Inc., the oil wholesaler, plans to purchase an oil tanker that will cost $120,000 and will last for 6 years. AMC estimates the following cash flows and annual net income. The company's tax rate is 35%, and it uses straight-line depreciation for both book and tax purposes. AMC anticipates no salvage value at the end of 6 years.

| Book Value at Beg of Ea Year | Bef. Tax Ann. Cash Flow | Deprec. | Before Tax Ann. Net Acctg. Inc. | After Tax Ann. Net Acctg Inc. |
|---|---|---|---|---|
| 120,000 | 60,000 | 20,000 | 40,000 | 26,000 |
| 100,000 | 55,000 | 20,000 | 35,000 | 22,750 |
| 80,000 | 50,000 | 20,000 | 30,000 | 19,500 |
| 60,000 | 45,000 | 20,000 | 25,000 | 16,250 |
| 40,000 | 40,000 | 20,000 | 20,000 | 13,000 |
| 20,000 | 35,000 | 20,000 | 15,000 | 9,750 |
| | | | Total | 107,250 |
| | | | Average (Total ÷ 6) | 17,875 |

Accounting Rate of Return calculated using the **initial investment** in the denominator:

ARR = 17,875 / 120,000 = .149 or **14.9%**

Accounting Rate of Return calculated using the **average investment** in the denominator:

ARR = 17,875 / 60,000 = .298 or **29.8%**

Both Accounting Rate of Return and Internal Rate of Return produce a rate of return. However, ARR bases the calculation of this rate on **accrual net income**, not cash flow, and **does not consider the time value of money.** IRR, on the other hand, bases the calculation on **cash flow** and the **time value of money**. For capital budgeting purposes, IRR provides better information.

The advantage of ARR is that the computations are easy to do and understand. However, it does not track cash flow and ignores the time value of money. It focuses on operating income instead of cash flow.

## The Profitability (or Excess Present Value) Index

When capital resources are limited, the **Profitability Index** can be used to rank capital investment projects according to their attractiveness.

The Profitability Index is used to determine the ratio of the PV of net future cash inflows **to the amount of the initial investment outflow.** In this calculation, all future cash inflows are in the numerator and all initial cash outflows are in the denominator. There are two different ways to calculate the Profitability Index, and you should be familiar with both.

> Note: The two methods are different only if there is a net cash outflow in any year other than at the initial investment. If there are no negative cash flows during subsequent years of the project, the two methods will yield the same result.

**Method A: (No negative future cash flows)**

This calculation is used to determine the ratio of the PV of net future cash flows (both inflows and outflows) **to the amount of the initial investment.** In this calculation all future cash flows are in the numerator and all initial cash flows are in the denominator.

It is calculated as follows, using the same information from the NPV calculation:

$$\frac{\textbf{PV of future net cash inflows}}{\textbf{Net Initial Investment Cash Outflow}}$$

**Method B: (Negative future cash flows exist)**

If the project is expected to have any future net cash **outflows**, such as environmental cleanup expense in the final year of the project, the present value of the net future negative cash flows **may be omitted** from the numerator of the ratio and **added** to the denominator of the ratio. In this method the numerator contains all positive cash flows and the denominator contains all negative cash flows. It is calculated as follows:

$$\frac{\textbf{PV of future net positive cash flows}}{\textbf{Net Initial Investment + PV of future net negative cash flows}}$$

If the project is expected to have a negative cash flow in any of the subsequent years after the initial net investment takes place, those negative cash flow amounts are discounted back to Year 0, and the discounted amounts (as a positive number, not a negative number) are added to the Net Initial Investment in the denominator.

Note that for any given investment project, the NPV method and the PI method will give the same accept-reject result. And we can see why. Just by looking at these formulas, we can conclude that if a project has a positive net present value, the Profitability Index will be above 1.00. If it has a negative net present value, it will have a Profitability Index of less than 1.00. Therefore, if the Profitability Index is 1.00 or greater, the project is acceptable.

### Example of Profitability Index

We will use our example of the CMA Product's plan to purchase a new piece of equipment and its projected cash flows over the life of the project to illustrate the calculation of Profitability Index. Here are the relevant cash flows, discounted to Year 0:

| | Year 0 | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| Net Initial Investment | (125,000) | | | | | | | | | |
| Working Capital Increase | (25,000) | | | | | | | | | 25,000* |
| After-Tax Cash Flows from Operations | | 35,000 | 35,000 | 35,000 | 35,000 | 35,000 | 35,000 | 35,000 | 35,000 | 35,000 |
| Depr Tax Shield | | 5,359 | 9,184 | 6,559 | 4,684 | 3,349 | 3,345 | 3,349 | 1,671 | -0- |
| After-Tax Cash Flows from Disposal | | | | | | | | | | 7,000 |
| Total After Tax Cash Flows | (150,000) | 40,359 | 44,184 | 41,559 | 39,684 | 38,349 | 38,345 | 38,349 | 36,671 | 67,000 |
| PV of $1 Factor for 10% | | .90909 | .82645 | .75132 | .68301 | .62092 | .56447 | .51316 | .46651 | .42410 |
| Discounted Cash Flow | | 36,690 | 36,516 | 31,224 | 27,105 | 23,812 | 21,645 | 19,679 | 17,107 | 28,415 |
| Cumulative Discounted Cash Flows | (150,000) | (113,310) | (76,794) | (45,570) | (18,465) | 5,347 | 26,992 | 46,671 | 63,778 | 92,193 |

*Recovery of released working capital.

The Profitability Index for this project is:

$$PI = \frac{36,690 + 36,516 + 31,224 + 27,105 + 23,812 + 21,645 + 19,679 + 17,107 + 28,415}{150,000}$$

PI = 242,193 / 150,000 = **1.61**

Since the Profitability Index is greater than 1.0, this project is acceptable.

A shorter way to calculate the Profitability Index if you already know the NPV is to start with the NPV and add the negative cash flow(s) to it. That becomes your numerator. The present value of the negative cash flow(s) becomes the denominator. In this case, the NPV of the project has already been calculated to be $92,193.

$92,193 + $150,000 = $242,193

$242,193 / $150,000 = **1.61**

## Use of the Profitability Index

The Profitability Index is a benefit/cost ratio that represents the ratio of the benefits (net cash inflows) to the costs (net cash outflows) of a project. Therefore, it enables us to compare (or rank) the benefit/cost ratios of investments with different characteristics. The Profitability Index expresses profitability on a percentage basis rather than as a dollar amount. It is very useful when comparing **multiple investments** that are of different investment amounts, lengths and cash flow patterns.

Note however that when using the Profitability Index for ranking projects that are mutually exclusive, it is important to remember that only one of the projects can be accepted.

This method is not a good one for deciding whether or not a specific project should be undertaken, but it can be used for ranking them after the unacceptable projects have been screened out.

**When there are multiple independent investment opportunities, we will select the project or projects that have the highest Profitability Index.**

When the projects are independent alternatives of the same length and amount, the Profitability Index will provide the same accept/reject decisions that NPV provides. However, when the projects are of different time periods or amounts of initial investments, the Profitability Index may provide different rankings than NPV.

> Note: As do NPV and IRR, the Profitability Index also has an assumption about cash inflows from the project. Its assumption is similar to the NPV assumption: It assumes that the cash flows from the project will be reinvested at the discount rate used to discount the future cash flows. As with NPV and IRR, this may not be the case.

> Note: This use of Profitability Index makes it a **ranking** method of investment analysis. The other methods that we have looked at are **screening** methods. The difference is that screening methods help the company determine if a project is worth investing in at all. A ranking method helps the company determine which investment should be made first.

# Difficulties With the Different Capital Budgeting Methods

When analyzing one **independent** project that begins with a net cash outflow followed by several years of cash inflows, it is considered a **conventional project**, and all the capital budgeting methods will lead to the same accept-reject decision. However, not all projects are conventional projects, and this can affect capital budgeting analysis results.

- A project may start out with a cash **inflow**, followed by cash **outflows**.
- A project may start out with a cash outflow, but instead of being followed by several years of cash inflows, it may be followed by some years of cash inflows and some years of cash outflows.

We have already talked about the fact that a project with unconventional cash flows can have multiple IRRs.

Other considerations that can affect the interpretation of capital budgeting results are:

- A project may not be independent. An **independent project** does not depend on the acceptance of any other project or projects. However, a **dependent** project, or **contingent** project depends upon the acceptance of one or more other projects, and therefore, we cannot consider any one of the interdependent projects in isolation.
- Two or more projects may be **mutually exclusive and have different characteristics**. If projects are mutually exclusive, accepting one of them means not accepting the other or others. With mutually exclusive projects, we must determine which of the mutually exclusive options is better or best, even though the options may not be comparable in terms of scale, length or cash flow patterns.

When any of the above situations occur, they can cause IRR, NPV and PI to present conflicting information as to which project is preferable or even provide different accept-reject decisions.

Let us look at these situations more closely.

1) One project starts out with a cash **inflow**, followed by cash **outflows**. Another project starts out the conventional way, with a cash outflow followed by inflows. The effective result of the first project is that we have borrowed money instead of investing money. To compare these two projects, **rely on their NPVs**.

2) If a project starts out with a cash outflow and is followed by **some years of cash inflows and some years of cash outflows**, it may have **more than one IRR**. This is caused by the fact that if the sign of the cash flow changes more than once during the project's life, there may be a new IRR whenever the sign changes. Whether or not multiple sign changes actually do cause more than one IRR will depend upon the size of the cash flows. But whenever you see a cash flow that is not of the conventional model, be alert to the fact that there could be more than one IRR. When this happens, **rely on the NPV** instead of the IRR.

3) If a project is **not independent** – meaning that if it is accepted, then one or more other projects must be accepted also – then **all the interdependent projects must be evaluated together** and either **all accepted** or **all rejected**.

4) If two or more projects are **mutually exclusive** and only one can be accepted, it becomes even more critical to determine which one is preferable. If mutually exclusive projects are ranked differently using IRR, NPV, and PI, the conflict in rankings will be caused by one or more of the following differences between or among the projects under consideration:

   - **Scale differences.** The initial investment amounts are different. If a company has two mutually exclusive projects, one which involves an investment of $100,000 and one which involves an investment of $1,000,000, the IRR and PI of the **smaller** project could be higher than those of the larger project, while the NPV of the **larger** project would probably be higher than that of the smaller project.

     This is caused by the fact that IRR and PI both ignore the size of the investment. IRR is expressed as a percentage, and therefore the size of the investment is not considered.

     The Profitability Index also ignores the size of the investment, because it measures **relative** profitability – the benefit of the project compared with its cost. The results of the NPV calculation are expressed as the absolute dollar amount by which the company's value should increase as a result of a project.

     When this conflict occurs, the project with the **highest NPV** will be the one that will **maximize the wealth of the shareholders**. If it is the company's goal to maximize shareholder wealth, the project with the highest NPV will be the preferable one.

     However, if the company's goal is to **maximize the rate-of-return-on-its investments**, it will usually choose the project with the **highest IRR**, even though the absolute amount of increase in shareholder wealth may be lower.

   - **Cash flow timing differences.** If one project has cash flows that start out high in Year 1 but decrease over the length of the project, while another project has cash flows that start out low in Year 1 and increase over the length of the project, NPV and PI should give you the same ranking. However, IRR may give you a different ranking.

     When this happens, you will find that the results of each capital budgeting method will be a function of the discount rate used in the calculations. Using different discount rates in the calculations will give different rankings.

     In this situation, the unique discount rate where the NPVs and the PIs of both projects are the same is the **crossover rate**, or **Fisher's rate of intersection.** This rate is important, because if a discount rate of less than the crossover rate is used, the NPV and PI rankings will agree with one another but will conflict with the IRR ranking. If a discount rate of greater than the crossover rate is used, all three methods will be in agreement.

When this occurs, the **NPVs** (and PIs, which agree with NPV) should be used as the decision criteria. This is because the NPV and Profitability Index use the same discount rate for both of the projects being compared and assume that the cash flows from both projects will be reinvested at the same discount rate. Thus, they are comparable.

- However, the IRR assumes that the cash flows from a project can be reinvested at the IRR. Thus, if you are comparing two projects using their IRRs, you are assuming that each project will have a different rate-of-return on reinvestment of its cash flows. NPV and PI are better indicators in a comparison because they assume the same rate of reinvestment for the returns and are thus more comparable.
- **Variations in lives of projects.** If two mutually exclusive projects that are being compared have different lengths of useful lives, this could lead to NPV and PI returning the same result, but IRR returning the opposite result. When this happens, the **NPV** will give the proper rankings.

Therefore, a good rule to follow when the various capital budgeting methods conflict is to **rely on the NPV**, assuming that the company's goal is to maximize shareholder wealth.

To summarize the different capital budgeting methods and how they are used together:

- In most instances when there is a conflict, NPV and PI will agree, and the disagreement will be between them and IRR. In this case, **rely on the NPV**.
- The only time that NPV and PI will conflict with each other will be when there is a **scale difference** because the investments are of different amounts. In this case, PI and IRR will agree while NPV returns a different result. Here, the choice depends on whether the firm's goal is to maximize shareholder wealth – in which case it should rely on NPV – or whether its goal is to maximize the rate-of-return-on-investments – in which case it should rely on IRR. Short-lived projects with smaller, up-front investments will typically have very high IRRs. However, these projects may not add much value to the firm or to shareholder wealth.
- We may rely on IRR instead of NPV in the case of a scale difference, but **only** if the firm's goal is to maximize return-on-investment instead of maximizing shareholder wealth.

## Capital Rationing in Capital Budgeting

After all of these different figures have been calculated, the company must decide which project or projects to invest in. If the company has an unlimited amount of capital available, then it is a simple decision – it invests in all of the projects that have a positive NPV or an IRR higher than required, or whatever criteria have been set by the company. However, in a situation where there is a **limited amount of money for investment,** it becomes much more critical to rank these projects and then determine which individual project or projects will provide the highest rate-of-return.

When the capital rationing takes place over multiple periods, methods that incorporate **linear programming, integer programming** or **goal programming** need to be used to rank projects.

If the capital rationing is **for the current period only**, the **Profitability Index** is the best way to rank, or prioritize, the projects under consideration. NPV and IRR can also be used, although as we have seen, they work less well when the lengths and initial investment amounts differ among the projects under consideration, or in other situations.

However, there are some cases where using the Profitability Index to select projects to invest in will result in a less than optimal total net present value. For example, a company may be ranking its potential projects on the basis of PI. When it gets close to its maximum amount of capital funding available, the next best project may be too large because it would put the company over the limit. As a result, some of the capital budget goes unused.

When this happens, it may be better to search for another combination of projects that will use up more of the capital budget, while at the same time optimizing the net present value of all the projects selected. **NPV is the best way to select the group** of projects that will maximize shareholder wealth, because NPV results in an absolute amount of increased discounted cash flow. When more than one project can be selected but not all of them can be selected, the group of projects that comes closest to using all of the funds available **and** does so with the highest total NPV will maximize shareholder wealth.

Note: When capital is limited, the decision as to which project should receive money first should be made using the **Profitability Indices** of the different proposed projects, within limits as discussed above.

Note: Profitability Index, IRR and NPV may all be used to rank projects according to their expected return. In addition, the coefficient of variation of the probability distribution of project outcomes can be used to compare the riskiness of projects. When evaluating two projects with the same expected returns, the one with the lesser risk is the more desirable.

## Internal Capital Markets as an Alternative Solution to Capital Funding Limitations

Ideally, in order to maximize shareholder wealth over the long run, a company should invest in all proposals that will yield more than the required rate of return. A capital budget ceiling prevents a company from taking advantage of all the profitable investment opportunities that may be available to it. Therefore, capital rationing usually results in a less-than-optimal investment policy.

An alternative that may be available to large conglomerates is the use of what is called **internal capital markets**.

Conglomerates are large companies that have grown by acquiring a lot of companies in unrelated industries. Advantages that have been claimed for conglomerates are

1) They are diversified across several industries. This should stabilize earnings and reduce risk.

2) Good managers can manage any business. Modern management techniques will work as well in manufacturing airplanes as they will in managing a large retail chain. Through the use of good management, conglomerates can force dramatic improvements in mature and poorly managed businesses that they acquire.

3) The wide diversification of conglomerates permits their top managements to operate **internal capital markets**. Different businesses in different stages of growth through maturity have different cash flow characteristics. Mature businesses generate a lot of cash, while newer, growing businesses need cash. Thus, cash flow generated by divisions in mature industries can supply cash to other divisions that have profitable growth opportunities. Therefore, the faster-growing divisions within a conglomerate do not need to raise capital from outside sources, because it can be provided internally from within the consolidated corporate structure.

There are some advantages to using internal capital markets to fund capital expansion programs:

- A company's senior management probably knows more about the investment opportunities in the various divisions than do outside investors.
- Transaction costs of issuing securities on the external capital markets can be avoided.

However, the evidence has indicated that attempts by conglomerates to allocate their capital across multiple, unrelated industries are more likely to destroy shareholder value than to add to it. This is because in the real world, capital does not get allocated from industries with high cash availability to industries that need it, for the following reasons:

- Internal capital markets are not markets at all but are simply the result of centralized planning by top management combined with **intracompany bargaining**. Divisional capital budgets are as much a result of internal politics as they are a reflection of economics.
- Large, mature and profitable divisions with plenty of free cash flow generally have more bargaining power than they have growth opportunities, and they may therefore receive generous capital budgets that they can't use profitably.
- On the other hand, smaller divisions with less bargaining power but with good opportunities don't receive the capital funding they need because of their lack of bargaining power.
- If cash flow in one industry within the conglomerate is restricted because of cyclicality or because of falling output, management may make "across-the-board" cuts to the capital budgets of all divisions, even though only the one division is affected. This, again, will result in a lack of capital for the industries that are growing and that need the funds to continue their expansion.

The result of this is that shareholders recognize the misallocation of investment that may be taking place, and they mark down the value of the conglomerates' shares because of their concern that management will make negative NPV investments in mature divisions while foregoing positive NPV projects in other divisions. The market value of the average conglomerate is 12 to 15 percent lower than the sum of the values of its parts.

Another problem with conglomerates is that there is no way to calculate a "market value" for each individual division. Therefore, it is difficult to set incentives for the division managers. And for a high-risk startup division within a conglomerate, senior management might not be as patient as investors in the market might be, so they might not appropriately evaluate the startup's management during the startup phase.

Question 56: Flex Corporation is studying a capital acquisition proposal in which newly acquired assets will be depreciated using the straight-line method. Which one of the following statements about the proposal would be incorrect if a switch is made to the Modified Accelerated Cost Recovery System (MACRS)?

a) The net present value will increase.

b) The internal rate-of-return will increase.

c) The payback period will be shortened.

d) The profitability index will decrease.

(CMA Adapted)

**The following information is for the next three Questions:** The Moore Corporation is considering the acquisition of a new machine. The machine can be purchased for $90,000; it will cost $6,000 to transport to Moore's plant and $9,000 to install. It is estimated that the machine will last 10 years, and it is expected to have an estimated salvage value of $5,000. Over its 10-year life, the machine is expected to produce 2,000 units per year with a selling price of $500 and combined material and labor costs of $450 per unit. Federal tax regulations permit machines of this type to be depreciated using the straight-line method over 5 years with no estimated salvage value. Moore has a marginal tax rate of 40%.

Question 57: What is the net cash outflow at the beginning of the first year that Moore Corporation should use in a capital budgeting analysis?

a) $(85,000)

b) $(90,000)

c) $(96,000)

d) $(105,000)

Question 58: What is the net cash flow for the third year that Moore Corporation should use in a capital budgeting analysis?

a) $68,400

b) $68,000

c) $64,200

d) $79,000

Question 59: What is the net cash flow for the tenth year of the project that Moore Corporation should use in a capital budgeting analysis?

a) $100,000

b) $81,000

c) $68,400

d) $63,000

(CMA Adapted)

**The following information is for the next four Questions:** Yipann Corporation is reviewing an investment proposal. The initial cost as well as other relevant data for each year are presented in the schedule below. All cash flows are assumed to take place at the end of the year. The salvage value of the investment at the end of each year is equal to its net book value, and there will be no salvage value at the end of the investment's life.

| Year | Initial Cost and Book Value | Annual Net After-Tax Cash Flows | Annual Net Income |
|---|---|---|---|
| 0 | $105,000 | $ 0 | $ 0 |
| 1 | 70,000 | 50,000 | 15,000 |
| 2 | 42,000 | 45,000 | 17,000 |
| 3 | 21,000 | 40,000 | 19,000 |
| 4 | 7,000 | 35,000 | 21,000 |
| 5 | 0 | 30,000 | 23,000 |

Yipann uses a 24% after-tax target rate-of-return for new investment proposals. The discount figures for a 24% rate-of-return are given.

| Year | Present Value of $1.00 Received at the End of Period | Present Value of an Annuity of $1.00 Received at the End of Each Period |
|---|---|---|
| 1 | .81 | .81 |
| 2 | .65 | 1.46 |
| 3 | .52 | 1.98 |
| 4 | .42 | 2.40 |
| 5 | .34 | 2.74 |
| 6 | .28 | 3.02 |
| 7 | .22 | 3.24 |

Question 60: The average annual cash inflow at which Yipann would be indifferent to the investment (rounded to the nearest dollar) is:

a) $21,000

b) $40,000

c) $38,321

d) $46,667

Question 61: The accounting rate-of-return for the investment proposal over its life using the initial value of the investment is:

a) 36.2%

b) 18.1%

c) 28.1%

d) 38.1%

Question 62: The traditional payback period for the investment proposal is:

a) .875 years

b) 1.933 years

c) 2.250 years

d) Over 5 years

Question 63: The net present value of the investment proposal is:

a) $4,600

b) $10,450

c) $(55,280)

d) $115,450

(CMA Adapted)

**The following information is for the next two Questions:** Capital Invest Inc. uses a 12% hurdle rate for all capital expenditures and has done the following analysis for 4 projects for the upcoming year.

| | Project 1 | Project 2 | Project 3 | Project 4 |
|---|---|---|---|---|
| Initial capital outlay | $200,000 | $298,000 | $248,000 | $272,000 |
| Annual net cash inflows | | | | |
| Year 1 | $ 65,000 | $100,000 | $ 80,000 | $ 95,000 |
| Year 2 | 70,000 | 135,000 | 95,000 | 125,000 |
| Year 3 | 80,000 | 90,000 | 90,000 | 90,000 |
| Year 4 | 40,000 | 65,000 | 80,000 | 60,000 |
| Net present value | (3,798) | 4,276 | 14,064 | 14,662 |
| Profitability Index | 98% | 101% | 106% | 105% |
| Internal rate-of-return | 11% | 13% | 14% | 15% |

Question 64: Which project(s) should Capital Invest Inc. undertake during the upcoming year assuming it has no budget restrictions?

a) All of the projects

b) Projects 1, 2 and 3

c) Projects 2, 3 and 4

d) Projects 1, 3 and 4

Question 65: Which project(s) should Capital Invest Inc. undertake during the upcoming year if it has only $600,000 of funds available?

a) Projects 1 and 3

b) Projects 2, 3 and 4

c) Projects 2 and 3

d) Projects 3 and 4

(CMA Adapted)

**The following information is for the next four Questions:** The following selected data pertain to a 4-year project being considered by Metro Industries:

- A depreciable asset that costs $1,200,000 will be acquired on January 1. The asset, which is expected to have a $200,000 salvage value at the end of 4 years, qualifies as 3-year property under the Modified Accelerated Cost Recovery System (MACRS).
- The new asset will replace an existing asset that has a tax basis of $150,000 and can be sold on the same January 1 for $180,000.
- The project is expected to provide added annual sales of 30,000 units at $20. Additional cash operating costs are: variable, $12 per unit and fixed, $90,000 per year.
- A $50,000 working capital investment, fully recoverable at the end of the fourth year, is required at the beginning of the project.

Metro is subject to a 40% income tax rate and rounds all computations to the nearest dollar. Assume that any gain or loss affects the taxes paid at the end of the year in which it occurred. The company uses the net present value method to analyze investments and will employ the following factors and rates.

| Period | PV of $1 at 12% | PV of $1 Annuity at 12% | MACRS |
|---|---|---|---|
| 1 | 0.89 | 0.89 | 33% |
| 2 | 0.80 | 1.69 | 45% |
| 3 | 0.71 | 2.40 | 15% |
| 4 | 0.64 | 3.04 | 7% |

Question 66: The discounted cash flow for the fourth year MACRS depreciation on the new asset is:

a) $0

b) $17,920

c) $21,504

d) $26,880

Question 67: The discounted, net-of-tax amount that relates to disposal of the existing asset is:

a) $168,000

b) $169,320

c) $180,000

d) $190,680

Question 68: The expected incremental sales will provide a discounted, net-of-tax contribution margin over 4 years of:

a) $57,600

b) $92,160

c) $273,600

d) $437,760

Question 69: The overall discounted-cash-flow impact of the working capital investment on Metro's project is:

a) $(2,800)

b) $(18,000)

c) $(50,000)

d) $(59,200)

(CMA Adapted)

# Capital Budgeting and Inflation

Thus far, we have mentioned inflation, but we have not included any consideration of it in our capital budgeting examples. When we are evaluating a project that will extend many years into the future, inflation is a very real consideration, because it results in a decline in general purchasing power. If inflation is 10% a year, then what you could buy with $100 at the beginning of the year will cost you $110 by year end. This is important in capital budgeting analysis because a decline in purchasing power can inflate future expected cash flows above what they would have been without any inflation. The inflated expected cash flows can cause the project to look better than it is.

Inflation can be incorporated into capital budgeting to address this anomaly. To do this, we need to consider **real expected cash flow** versus **nominal expected cash flow;** and **real rate-of-return** versus **nominal rate-of-return**.

***Real* expected cash flows assume no inflation.** If we are considering an investment and we expect to sell 1,000 units of the resulting product each year for four years, we might expect a net cash inflow of $10 per unit **with no inflation**. Thus with no inflation, we would expect a net cash inflow of $10,000 per year for the life of the project.

However, if we are expecting inflation of 10% per year during that period, we need to recognize that we should instead expect cash inflows of $11,000 in Year 1 ($10,000 × 1.10), $12,100 ($10,000 × $1.10^2$) in Year 2, and so forth. The net expected cash inflows of $11,000 and $12,100 are ***nominal* expected cash flows**, because they **include inflation**. It is the **nominal** expected cash flows that will be recorded in the accounting system. The net expected cash inflows of $10,000 per year are the **real** expected cash flows, which are not recorded in the accounting system. Often, the **real** expected cash flows will need to be converted to **nominal** expected cash flows for capital budgeting purposes.

Example of **Real Expected Cash Flows** converted to **Nominal Expected Cash Flows** for capital budgeting:

We will assume that cash inflows expected in **real** dollars are $10,000 per year for four years, and inflation of 10% is expected:

| Year | Before-Tax Expected Cash Inflows Real $ | Cumulative Inflation Factor | Before-Tax Expected Cash Inflows Nominal $ |
|---|---|---|---|
| 1 | $10,000 | $(1.10)^1 = 1.1000$ | $11,000 |
| 2 | 10,000 | $(1.10)^2 = 1.2100$ | 12,100 |
| 3 | 10,000 | $(1.10)^3 = 1.3310$ | 13,310 |
| 4 | 10,000 | $(1.10)^4 = 1.4641$ | 14,641 |

In our capital budgeting analyses, then, we will use the **nominal expected cash flows** that we have calculated for Years 1 through 4. The amount of the initial investment will not be adjusted, because it is assumed to take place before the impact of the future inflation is felt.

Not only do the future expected cash flows need to be adjusted for inflation, but also the required rate-of-return needs to be adjusted for inflation. **If we adjust one, we must adjust the other.**

**Real required rate-of-return** is the rate-of-return that is required to cover the **risk** inherent in an investment. Like real cash flow, it assumes **no inflation**. The real rate-of-return includes two components:

1) A **risk-free rate-of-return** when there is no expected inflation, which is approximated by the rate for long-term government bonds; and

2) A **risk premium**, which is required to compensate for the business risk foreseen.

**Nominal required rate-of-return** consists of **three** elements, because it also includes a component for inflation. Nominal rate-of-return includes:

1) The risk-free rate-of-return as above;
2) The risk premium as above; and
3) An inflation element, which is a premium above the real rate that is required to offset the expected decline in purchasing power due to inflation.

Rates of return quoted for financial markets are nominal rates, because investors demand compensation for both the investment risk that they assume and for the expected decline in purchasing power.

The nominal rate of inflation will be slightly **higher** than simply the real rate plus the inflation component, because inflation also decreases the purchasing power of the real rate-of-return earned each year. The nominal rate-of-return is calculated as follows:

$$\textbf{Nominal Rate} = (1 + \textbf{Real Rate}) \times (1 + \textbf{Inflation Rate}) - 1$$

So to convert a real rate-of-return of 10% to a nominal rate-of-return, if inflation is expected to be 5% per year, the calculation is:

$$\begin{aligned} \text{Nominal Rate} &= (1 + .10) \times (1 + .05) - 1 \\ &= (1.10 \times 1.05) - 1 \\ &= 1.15 - 1 \\ &= .155 \text{ or } 15.5\% \end{aligned}$$

When incorporating inflation into a capital budgeting analysis, **we adjust both expected real cash flow and real required rate-of-return to nominal values**. The nominal required rate-of-return as calculated above is used to determine the present value of each of the annual nominal expected cash flows. This same nominal rate-of-return will be used to discount the expected cash flow for every year of the project; it is not adjusted upward annually.

Note: If the required rate-of-return used to discount the cash flows of a project includes a premium for inflation, then to be internally consistent, **expected cash flows used in the analysis must also be adjusted for inflation.**

Example of the calculation of Net Present Value using adjustments for inflation:

- The inflation rate is 10%;
- Real Cash Flows are $10,000 per year and are adjusted to Nominal Cash Flows as calculated above;
- The Real Required Rate-of-Return is 10% and is adjusted to a Nominal Required Rate-of-Return of 21% as calculated above;
- The net initial investment, which is unadjusted, is $25,000;
- Depreciation for book and tax purposes is straight-line depreciation with no salvage value;
- The tax rate is 40%.

| | Year 0 | Year 1 | Year 2 | Year 3 | Year 4 |
|---|---|---|---|---|---|
| Real Expected Cash Flow (after-tax) | (25,000) | 10,000 | 10,000 | 10,000 | 10,000 |
| Inflation factor (see Note 1) | | 1.10 | 1.21 | 1.331 | 1.4641 |
| Nominal Expected Cash Flow (after-tax) | (25,000) | 11,000 | 12,100 | 13,310 | 14,641 |
| PV of $1 factor for Nominal Rate of 21%, 4 yrs (see Note 2) | | .82645 | .68301 | .56447 | .46651 |
| PV of Nominal Cash Flow | (25,000) | 9,091 | 8,264 | 7,513 | 6,830 |
| Depreciation | | 6,250 | 6,250 | 6,250 | 6,250 |
| Tax Depr Shield | | 2,500 | 2,500 | 2,500 | 2,500 |
| PV of Tax Depr Shield (see Note 3) | | 2,066 | 1,708 | 1,411 | 1,166 |
| PV Tot Nom CF | (25,000) | 11,157 | 9,972 | 8,924 | 7,996 |

NPV = (25,000) + 11,157 + 9,972 + 8,924 + 7,996 = 13,049

Note 1: The inflation factor is calculated as $(1 + \text{inflation rate})^n$, where $n$ is the number of years from Year 0.

Note 2: The Nominal Required Rate-of-Return is calculated as (1 + Real Rate-of-Return) × (1 + Inflation Rate) − 1.

Note 3: The depreciation is not adjusted for inflation because the IRS allows assets to be depreciated only on the original cost of the asset. The original cost of the asset is not increased each year for inflation, so the depreciation amount is not increased, either. The depreciation tax shield is the depreciation expense multiplied by the tax rate. Therefore, the depreciation tax shield will not increase because of inflation. The depreciation tax shield is already the nominal amount. So we discount it at the nominal rate of return.

If you are given **nominal** expected cash flow and need to convert it to **real** expected cash flow, you will **divide** by the inflation factor, which is $(1 + \text{Inflation Rate})^n$, where $n$ is the number of years **from Year 0.**

$$\textbf{Real Expected Cash Flow} = \frac{\textbf{Nominal Cash Flow}}{(1 + \textbf{Inflation Rate})^n}$$

For example, \$11,000 nominal expected cash flow to be received one year from now when inflation is expected to be 10% annually is equivalent to real cash flow received in one year of:

$$\text{Real Expected Cash Flow} = \frac{\$11{,}000}{(1.10)^1} = \$10{,}000$$

If that same \$11,000 nominal expected cash flow were to be received **two** years from now instead of one year from now, with expected inflation of 10% annually, real expected cash flow received in two years would be:

$$\text{Real Expected Cash Flow} = \frac{\$11{,}000}{(1.10)^2} = \$9{,}091$$

In the same manner, a **nominal rate-of-return** can be converted to a **real rate-of-return** as follows:

$$\text{Real Rate} = \frac{1 + \text{Nominal Rate}}{1 + \text{Inflation Rate}} - 1$$

So, if you have a **nominal rate-of-return** of 15.5% and an inflation rate of 5%, you would convert the nominal rate of return to a **real rate-of-return** as follows:

$$\text{Real Rate} = \frac{1 + .155}{1 + .05} - 1 = 10\%$$

Note:

- **Real expected cash flow** is cash flow assuming **no inflation.**
- **Nominal cash flow** includes an increase to reflect inflation.
- In an inflationary environment, **nominal** cash flow will be **higher** than **real** cash flow.
- The **real rate-of-return** is the return assuming **no inflation.**
- The **nominal rate-of-return** includes an inflation component.
- In an inflationary environment, **nominal** returns will be **higher** than **real** returns.

## Summary and Review of Relevant Cash Flows

Basic characteristics of relevant project expected cash flows:

- Use expected **cash flows**, not accounting income.
- Use **operating,** not financing cash flows.
- Expected cash flows must be determined on an **after-tax** basis.
- Expected cash flows should be **incremental**; we analyze only the **difference** between expected cash flows with the project and those without the project.
- Calculation of the depreciation tax shield is always based on the type of depreciation used for **tax purposes**; and **100% of the asset's cost is always depreciated**, regardless of what type of depreciation (i.e., straight line) is being used for tax purposes.

**Basic principles for estimating after-tax incremental operating cash flows:**

- **Sunk costs** are ignored.
- **Opportunity costs** should be included.
- Requirements for **increased net working capital** (project-driven increases in current assets minus project-driven increases in current liabilities) should be considered as part of the initial investment. At the end of the project's life, the working capital investment is returned in the form of a cash inflow.
- An additional increase in net working capital may be required midway through the project. If so, that is a cash outflow in the year it takes place, and both the initial increase and the additional increase in working capital are recovered at the end of the project.
- If the required rate-of-return includes a **premium for inflation**; then expected cash flows must also be adjusted for inflation.

**Determining initial (Year 0) cash flow:**

| | |
|---|---|
| | Cost of new asset(s) |
| + | Capitalized expenditures such as shipping and installation costs* |
| +(−) | Increased (decreased) level of **net** working capital (change in current assets net of change in current liabilities) |
| − | Net proceeds from sale of old asset(s) if the project represents replacement of assets |
| +(−) | Taxes (tax savings) from gain/loss on sale of replaced old assets |
| = | Initial cash outflow |

* The asset's cost plus any other capitalized expenditures necessary to prepare it for its intended use form the **tax basis** of the asset for depreciation for tax purposes. Note that under depreciation for tax purposes, the depreciable basis is not reduced by any estimate of salvage value.

## Summary and Review of Relevant Cash Flows

**Determining incremental net cash flows per period during the project's life:**

| | |
|---|---|
| | Net increase (decrease) in operating revenue |
| +(−) | Net **decrease** (increase) in operating expenses, **excluding** depreciation |
| −(+) | Net increase (decrease) in depreciation expense **for tax purposes** |
| = | Net change in income **before taxes** |
| −(+) | Net increase (decrease) in income taxes |
| = | Net change in income **after taxes** |
| +(−) | Net increase (decrease) in depreciation expense **for tax purposes** |
| = | Incremental net cash flow for the period |

**Determining incremental net cash flow in final year of the project:**

| | |
|---|---|
| | Incremental net cash flow for the period as above, not including project termination considerations |
| +(−) | Proceeds from sale or (costs of disposal) of asset(s) |
| −(+) | Taxes or (tax savings) on gain or loss from disposal of asset(s) |
| +(−) | Recovered net working capital or (increased) net working capital |
| = | Final year's incremental net cash flow |

## Risk in Capital Budgeting

Up to this point, we have referred to expected cash flow as if it will occur for certain. But, unfortunately, this is something that in reality we cannot be sure of because there are many events that can affect a project's net cash flows. This introduces into capital budgeting the element of **risk** – which is the recognition that the future is uncertain – and the question of how a project's risk can be factored into the capital budgeting process.

We can look at risk individually for each investment opportunity and we can also look at the risk of our entire investment portfolio. Usually, by diversifying our portfolio we are able to lower the overall risk of our investments because while one investment may have a lower than expected return, this will be offset by another investment that has a higher than expected return.

Every project has numerous possible future cash flows. A project has a **range** of estimated cash flows that reflect different possibilities as foreseen by management. To determine what the various possible cash flows should be, management must:

1) Determine what influences have affected the net cash flows of similar projects in the past, such as economic, labor or international conditions, and then
2) Make assumptions about each of those events. For instance, if a recession is expected, management would assume that demand for the project's product will be below normal.

Once these specific assumptions have been formulated, the financial manager then estimates the impact that each assumption could have on the net cash flow in each year of the project's life. Basing adjustments on these assumptions, estimated cash flows may be raised or lowered.

### Types of Risk

There are two major types of risk involved in capital budgeting: market risk (also called nondiversifiable risk) and nonmarket risk (also called diversifiable or stand-alone risk).

**Market risk, or systematic risk,** is the risk that a company experiences from the results of change in its marketplace. These changes will also affect other firms, and it is very difficult, if not impossible, for a firm to influence this risk. It cannot be diversified away. A firm can prepare for market risk and attempt to manage it, but a firm will not be able to influence market risk. Furthermore, market risk is also difficult to measure.

Examples of market risks that can affect the cash flows of a project:

- **Interest-rate risk** is the risk that the return on the investment will fluctuate due to a change in the interest rate over the life of the investment. This means that the longer the term of the investment, the higher the interest rate risk will be.
- **Purchasing-power risk** is the risk that in the future, we will be able to buy less with the same amount of money due to a general increase in price levels. This is essentially the risk of inflation and, as discussed above, in our longer-term models, we will need to take this into account.
- **Exchange-rate risk** is the risk a company faces as the result of changing foreign currency exchange rates.

Market risk must be considered in any capital budgeting analysis of expected cash flows, but not much can be done to change it.

**Nonmarket risk,** also called **company-specific risk** or **stand-alone risk**, is the risk of a project as a separate entity. Stand-alone, or company-specific risk can be influenced by a company's actions. It can be diminished by diversification, and for that reason it is also called **diversifiable,** or **unsystematic risk**.

Nonmarket risk can be measured by statistical measurements using the standard deviation and the coefficient of variation of the probability distribution of the possible outcomes of the project. The coefficient of variation is generally used to compare the riskiness of several projects. Project outcomes can be determined by means of tools such as **Decision Trees**, **Sensitivity Analysis**, **Simulation Analysis**, **Scenario Analysis** and **Breakeven Analysis**.

Examples of nonmarket risk are:

- A company's **portfolio risk** is the risk of its entire portfolio of investments. By proper diversification in the management of the portfolio, the company is able to reduce this risk.
- The **liquidity risk** of a capital asset is the risk that the asset cannot be sold quickly enough for its market value. If an asset needs to be sold at a high discount in order to sell it quickly, that asset has a high liquidity risk.
- The financing it pursues for a project, which can cause its debt-to-equity ratio to either increase or decrease, could change a company's **financial risk**. Additionally, this either increases or decreases risk to its shareholders.
- The **business risk** for a firm is the risk of changes in earnings before interest or taxes when it has **no debt**. Business risk depends on a variety of factors, including the variability of demand, sales price, and the price of inputs as well as the amount of the company's operating leverage. The more stable all of these variables, the less business risk a company will experience.

## Analysis of Risk

Since risk is of such a concern to most decision-makers, it is essential that we know how to attempt to analyze and calculate risk. Unfortunately, we are not always able to do this with specific, or highly accurate and predictable numbers, because we are dealing with the future and perhaps many unknown future events. Therefore, the analysis of risk sometimes comes down to business intuition, or gut-feelings.

There are, however, a number of techniques that we can use in the process of analyzing risk.

### Decision Trees

A **decision tree** is a means of determining the best course of action when there are several possible decision choices under a condition of risk. Decision trees are used with probabilities to determine the expected value of the payoff of a project that may involve making several decisions. A decision tree depicts the natural or logical progression of events. Depending on the decision made at each decision point, the probabilities of the potential payoffs of that decision can be calculated in order to develop an overall expected value for the whole project. The decision tree is helpful for solving complex problems because it breaks them down into a series of smaller problems.

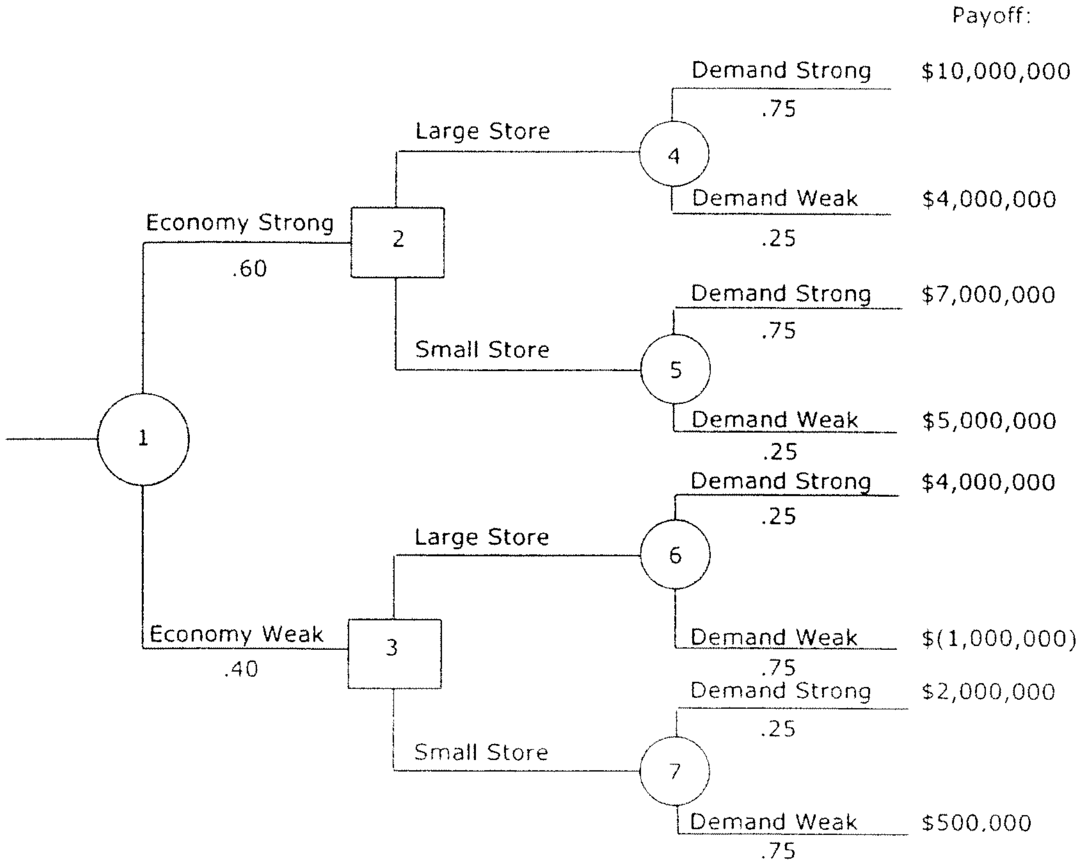
In capital budgeting, decision trees can be used effectively for allocating limited money between various projects. The aim is to provide a structured way to think about decisions and to develop and support subjective judgments that are critical for good decisions.

In a decision tree, a circle represents a **probability node** (also called a chance node), a state of nature over which we have no control, and a box represents a **decision node**, where a decision is to be made.

At a probability node, the branch of the tree that is taken is a matter of probability or chance. These are **conditional probabilities** because they are dependent upon events that may or may not precede them. At a **decision node**, the branch of the tree that is taken depends on the decision made.

For example, suppose we are considering opening a retail store in a new market. We have census data and market data that we have used to develop probabilities of success. However, the future state of the economy will influence the results of the investment, and we cannot control that. Our economists tell us there is a 60% chance the economy will be strong and a 40% chance the economy will be weak. Since the state of the economy is not something that we can control or influence ourselves, the outcome of the economy is a probability node. However, the next factor, whether to open a large or small store, is a decision that we can control, so it is a decision node. The decision tree for opening a store (not yet determined if it will be a small or large store) in an uncertain economy is below.

Here is the decision tree:




Looking at the decision tree, we can see that if the economy is strong and we build a large store, we have a 75% probability that demand will be strong and a 25% probability that demand will be weak. If the economy is strong and we build a small store, we have the same probabilities that demand will be strong or weak.

And if the economy is weak, our chances are just the opposite: a 25% probability that demand will be strong and a 75% probability that it will be weak, whether we build a large store or a small store.

We can use this to determine our best course of action, because we have also made forecasts of what the net present value of each investment will be under the different scenarios. Those net present values appear above at the right side of the decision tree, at the end of each of the nodes, as the payoffs. Our decision strategy is determined by means of a backward pass through the decision tree, using the following guidelines:

1) At a **probability node**, we will calculate the expected value by multiplying the payoff at the end of each of the branches by its probability.

2) At a **decision node**, we select the decision branch that will result in the greatest expected value.

Probability Node No. 1 represents the state of the economy. Decision Nodes 2 and 3 represent the choices between a large or small store, given a strong or weak economy. To determine the expected values of each of these decisions, we multiply the probabilities by the payoffs and, in each case, sum them to calculate an expected value.