# CHAPTER 8: Investment Criteria

## *LEARNING OBJECTIVES*

After studying this chapter, you should be able to:

- Calculate the net present value of an investment.
- Calculate the internal rate of return of a project and know what to look out for when using the internal rate of return rule
- Explain why payback rule doesn't always make shareholders better off
- Use the net present value rule to analyze three common problems that involve competing projects: (a) When to postpone an investment expenditure, (b) how to choose between projects with unequal lives, and (c) when to replace equipment.
- Calculate the profitability index and use it to choose between projects when funds are limited

The investment decision, also known as capital budgeting, is central to the success of the company. We have already seen that capital investment can sometimes absorb substantial amounts of cash, they also have very long-term consequences. The assets you buy today may determine the business you are in many years hence.

Sometimes the firm may be forced to make choices because it does not have enough money to take on every project that it would like. We will explain how to maximize shareholder wealth when capital is rationed. It turns out that the solution is to pick the projects that have the highest net present value per dollar invested

This measure known as the profitability index.

## 8.1 Net Present Value

- pportunity Cost of Capital is expected rate of return given up by investing in a project.
- Net Present Value ( NPV) is the difference between the present value of cash inflows and the present value of cash outflows over a period of time. In other words, Net Present Value is present value of cash flows minus initial investment.

  NPV= PV – required investment

  Or

  NPV=C0+C11+r1+C21+r2+…+Ct1+rt

**Terminology**

C0: The initial cash outflow

Ct: The net cash flow generated

t = time period of the investment

r = opportunity cost of capital

- The Cash Flow could be positive or negative at any time period.
- The Net Present Value Rule states that managers increase shareholder's wealth by accepting all projects that are worth more than they cost. Therefore, they should accept all projects with a positive net present value.

**1. A Comment on Risk and Present Value**

Net Present Value (NPV) and the Risk have a strong relationship with each other. With inappropriate assessment of risk, one cannot arrive at correct or near correct net present value. Net present value of any asset or investment is the present worth of that asset or investment based on analysis of future returns using appropriate discounting rate. A risk is an uncertainty attached to the future cash flows.

The concept of net present value is based on the basic principle of finance which is quoted everywhere. *A dollar today is worth more than a dollar one year later*. It is simple to understand, a person can instantly invest his dollar in government security today and increase the future value of its dollar one year later by earning interest on that. Conversely, the present value of a dollar one year later is definitely less than one dollar. Moreover, the relevance of the relationship between net present value with risk is explained by another basic principle of finance. *A safe dollar is worth more than a risky one*. For examples, Suppose there are two options for an investor to invest his money. One, in real estate with 6% rate of return and

another in government security with the same rate of return of 6%. Every rational investor will invest in government security simply because their hard earned money is safe in government security in comparison to the real estate investment.

In the calculation of net present value, we utilize present cash outflow or initial investment, future cash inflows and a discounting rate. Risk has relevance with 2 out of 3 components of net present value. Normally, initial investment or cash outlay is known with certainty but future cash inflow is an estimation based on certain assumptions which may or may not turn true. Therefore, a risk is associated with future cash flows. If in actual, the future cash flows turn lesser than estimated, the viability of the whole project may go for a toss and it may turn out to be a loss making an investment.

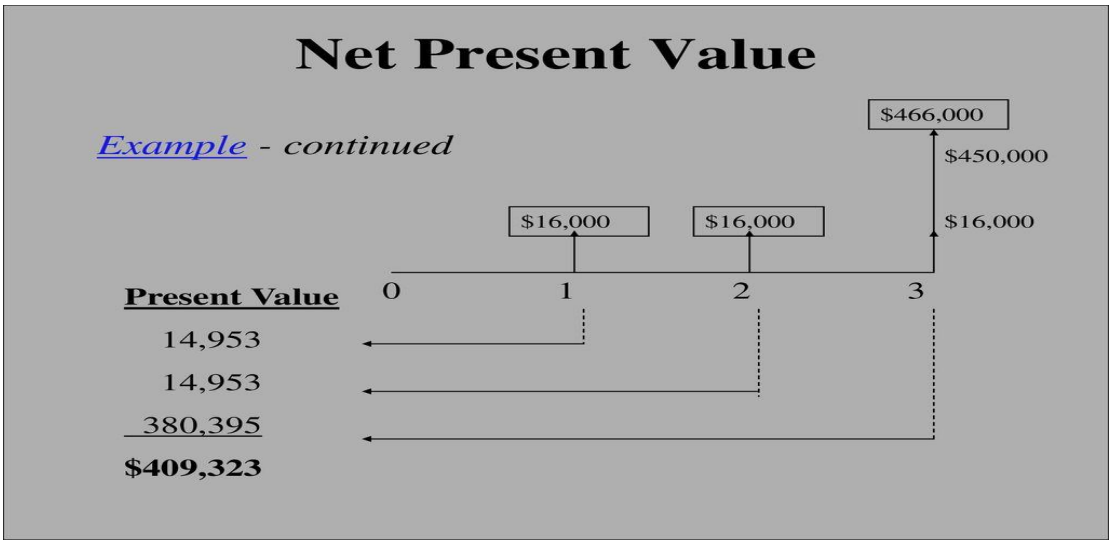
Secondly, a decision regarding discounting rate is very critical. It is because this rate is applied to all the future expected cash flows to convert them into their present values and a slight difference of even decimals may change the whole game. A discounting rate of say 9.25% may give positive net present value and a slight change to 9.45% may make it negative. Discounting rate of return is also known as an opportunity cost of capital or hurdle rate.

It is the rate of return which could be earned from the next best alternative investment opportunity having a similar risk profile. Considering the same investment options discussed above, the rate of return on government security cannot be used for evaluating or finding NPV for real estate investment. Simply because the risk profile of the two investments is totally different. One is highly risky and the other is highly safe.

## 2. Valuing Long – Lived Projects

**For example 1:**

To give an example of simple NPV, Suppose that you have the opportunity to purchase an office building with cost $350,000. You have a tenant lined up that will generate $16,000 per year in cash flows for three years. At the end of three years you anticipate selling the building for $450,000. How much would you be willing to pay for the building if the opportunity cost of capital is 7%?




A picture shows a time line of the cash flows. To find the present value of the project, we discount these cash flows at the 7% opportunity cost of capital:

PV=C1(1+r)+C21+r2 +C31+r3 = \$16,0001.07+\$16,0001.072 +\$466,0001.073 = \$409,323

The net present value: NPV = PV - required investment

= \$409,323 - \$350,000 = \$59,323

*However*, you can calculate NPV directly:

NPV = C0+C11+r+C21+r2 +C31+r3

= -\$350,000 + \$16,0001.07+\$16,0001.072 +\$466,0001.073 = \$59,323

**For example 2:**

Consider company Shoes For You' s who is determining whether they should invest in a new project. Shoes For You 's will expect to invest \$500,000 for the development of their new product. The company estimates that the first year cash flow will be \$200,000, the second year cash flow will be \$300,000, and the third year cash flow to be \$200,000. The expected return of 10% is used as the discount rate.

The following table provides each year's cash flow and the present value of each cash flow.

| Year | Cash Flow | Present Value |
|---|---|---|
| 0 | -\$500,000 | -\$500,000 |

| | | |
|---|---|---|
| 1 | $200,000 | $181,818.18 |
| 2 | $300,000 | $247,933.88 |
| 3 | $200,000 | $150,262.96 |

Net Present Value = $80,015.02

**3. Using the NPV Rule to Choose among Projects**

The simple projects we have considered so far involve take-it-or-leave-it decisions. But almost all real-world decisions are either-or choice. Therefore, when you need to choose among mutually exclusive projects, the decision rule is simple: Calculate the NPV of each alternative, and choose the highest positive NPV project.

It is clearly to say that, in the alternative, management may simply adopt a minimum required threshold rate of return that must be exceeded before an investment will be undertaken.

If a prospective investment has a positive net present value (the present value of cash inflows exceeds the present value of cash outflows), then it clears the minimum cost of capital and is deemed to be a suitable undertaking, NPV>0(accept the project). On the other hand, if an investment has a negative net present value (the present value of cash inflows is less than the present value of cash outflows), the investment opportunity should be rejected, NPV<0(reject the project). Therefore, a positive NPV suggests that the project is expected to add value to the firm, and the project should improve shareholders' wealth. Besides that, the goal of financial management is to increase shareholders' wealth, NPV is a good measure of how well this project will meet this goal.

There is one practical example, which is come from " Choosing between Two Project" page 242 , It has been several years since your office last upgraded its office networking software. Two competing systems have been proposed. Both have an expected useful life of 3 years, at which point it will be time for another upgrade. One proposal is for an expensive, cutting-edge system, which will cost $800,000 and increase firm cash flows by $350,000 a year through increased productivity. The other proposal is for a cheaper, somewhat slower system. This system would cost only $700,000 but would increase cash flows by only $300,000 a year. If the cost of capital is 7%, which is the better option?

The following table summarizes the cash flows and the NPVs of the two proposals:

| Cash Flows ( thousands of dollars) | | | | | |
|---|---|---|---|---|---|
| System | C0 | C1 | C2 | C3 | NPV at 7% |
| Faster | -800 | +350 | +350 | +350 | +118.5 |
| Slower | -700 | +300 | +300 | +300 | +87.3 |

In both cases, the software systems are worth more than they cost, but the faster system would make the greater contribution to value and therefore should be your preferred choice.

## 8.2 Other Investment Criteria

1.The Payback Rule:

Payback Period:

• How long does it take to get the initial cost back in a nominal sense?

• Computation :

– Estimate the cash flows.

– Subtract the future cash flows from the initial cost until the initial investment has been recovered.

• Decision Rule – Accept if the payback period is less than some preset limit

2.Computing Payback for the Project

• Assume we will accept the project if it pays back within two years.

– Year 1: 165,000 – 63,120 = 101,880 still to recover

– Year 2: 101,880 – 70,800 = 31,080 still to recover

– Year 3: 31,080 – 91,080 = -60,000 project pays back in year 3

• Do we accept or reject the project?

The payback period is year 3 if you assume that the cash flows occur at the end of the year, as we do with all of the other decision rules.

If we assume that the cash flows occur evenly throughout the year, then the project pays back in 2.34 years.

Either way, the payback rule would say to reject the project.

3.Decision Criteria Test – Payback

• Does the payback rule account for the time value of money?

• Does the payback rule account for the risk of the cash flows?

• Does the payback rule provide an indication about the increase in value?

• Should we consider the payback rule for our primary decision rule?

The answer to all of these questions is no.

Lecture Tip: The payback period can be interpreted as a naïve form of discounting if we consider the class of investments with level cash flows over arbitrarily long lives. Since the present value of a perpetuity is the payment divided by the discount rate, a payback period cutoff can be seen to imply a certain discount rate. That is:

cost/annual cash flow = payback period cutoff

cost = annual cash flow times payback period cutoff

The PV of a perpetuity is: PV = annual cash flow / R. This illustrates the inverse relationship between the payback period cutoff and the discount rate.

4.Advantages and Disadvantages of Payback:

• Advantages :

– Easy to understand.

– Adjusts for uncertainty of later cash flows.

– Biased toward liquidity.

• Disadvantages :

– Ignores the time value of money.

– Requires an arbitrary cutoff point.

– Ignores cash flows beyond the cutoff date.

– Biased against long-term projects, such as research and development, and new projects.

5.The Discounted Payback:

Discounted Payback Period:

• Compute the present value of each cash flow and then determine how long it takes to pay back on a discounted basis.

• Compare to a specified required period.

• Decision Rule - Accept the project if it pays back on a discounted basis within the specified time

6.Computing Discounted Payback for the Project:

• Assume we will accept the project if it pays back on a discounted basis in 2 years.

• Compute the PV for each cash flow and determine the payback

period using discounted cash flows

– Year 1: 165,000 – 63,120/1.12 1 = 108,643

– Year 2: 108,643 – 70,800/1.12 2 = 52,202

– Year 3: 52,202 – 91,080/1.12 3 = -12,627 project pays back in year 3

• Do we accept or reject the project?

No – it doesn't pay back on a discounted basis within the required 2-year period.

7.Decision Criteria Test – Discounted Payback:

• Does the discounted payback rule account for the time value of money?

• Does the discounted payback rule account for the risk of the cash flows?

• Does the discounted payback rule provide an indication about the increase in value?

• Should we consider the discounted payback rule for our primary decision rule?

 The answer to the first two questions is yes.

 The answer to the third question is no because of the arbitrary cut-off date.

Since the rule does not indicate whether or not we are creating value for the firm, it should not be the primary decision rule.

8. Advantages and Disadvantages of Discounted Payback:

• Advantages :

– Includes time value of money.

– Easy to understand.

– Does not accept negative estimated NPV investments when all future cash flows are positive.

– Biased towards liquidity.

• Disadvantages :

– May reject positive NPV investments.

– Requires an arbitrary cutoff point.

– Ignores cash flows beyond the cutoff point.

– Biased against long-term projects, such as R&D and new products.

9.The Average Accounting Return:

Average Accounting Return:

• There are many different definitions for average accounting return.

• The one used in the book is:

– Average net income / average book value.

– Note that the average book value depends on how the asset is depreciated.

• Need to have a target cutoff rate.

• Decision Rule: Accept the project if the AAR is greater than a preset rate.

10.Computing AAR for the Project:

• Assume we require an average accounting return of 25%.

• Average Net Income:

– (13,620 + 3,300 + 29,100) / 3 = 15,340

• AAR = 15,340 / 72,000 = .213 = 21.3%

 Decision Criteria Test – AAR:

• Does the AAR rule account for the time value of money?

• Does the AAR rule account for the risk of the cash flows?

• Does the AAR rule provide an indication about the increase in value?

• Should we consider the AAR rule for our primary decision rule?

 The answer to all of these questions is no. In fact, this rule is even worse than the payback rule in that it doesn't even use cash flows for the analysis. It uses net income and book value. Thus, it is not surprising that most surveys indicate that few large firms employ the payback and/or AAR methods exclusively.

 Advantages and Disadvantages of AAR:

• Advantages :

– Easy to calculate.

– Needed information will usually be available.

• Disadvantages :

– Not a true rate of return; time value of money is ignored.

– Uses an arbitrary benchmark cutoff rate.

– Based on accounting net income and book values, not cash flows and market values.

11.The Internal Rate of Return

Internal Rate of Return:

• This is the most important alternative to NPV.

• It is often used in practice and is intuitively appealing.

• It is based entirely on the estimated cash flows and is independent of interest rates found elsewhere.

12. IRR – Definition and Decision Rule:

• Definition: IRR is the return that makes the NPV = 0

• Decision Rule: Accept the project if the IRR is greater than the required return.

 Computing IRR for the Project:

• If you do not have a financial calculator, then this becomes a trial and error process

• Calculator:

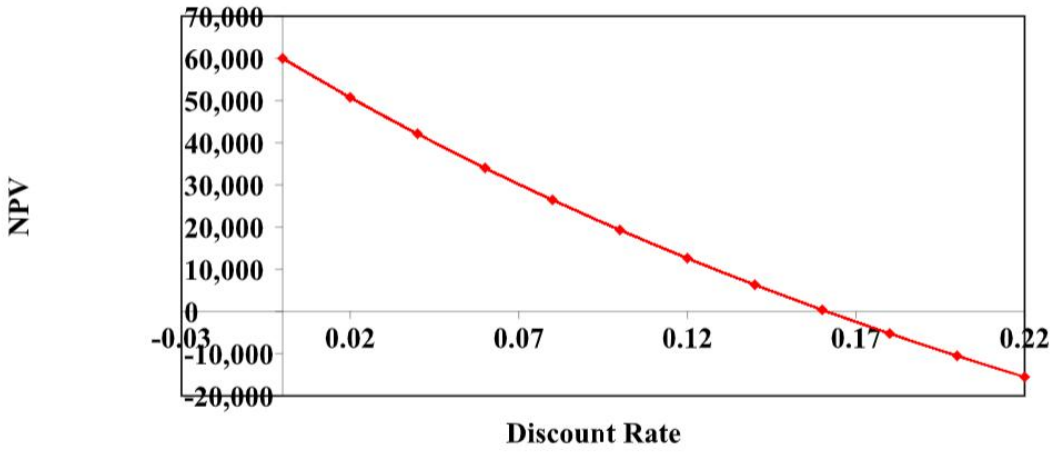
– Enter the cash flows as you did with NPV.

– Press IRR and then CPT.

– IRR = 16.13% > 12% required return.

13. NPV Profile for the Project:

➢ **NPV Profile for the Project:**




 Decision Criteria Test – IRR:

• Does the IRR rule account for the time value of money?

• Does the IRR rule account for the risk of the cash flows?

• Does the IRR rule provide an indication about the increase in value?

• Should we consider the IRR rule for our primary decision criteria?

 The answer to all of these questions is yes, although it is not always as obvious.

 The IRR rule accounts for time value because it is finding the rate of return that equates all of the cash flows on a time value basis.

 The IRR rule accounts for the risk of the cash flows because you compare it to the required return, which is determined by the risk of the project.

 The IRR rule provides an indication of value because we will always increase value if we can earn a return greater than our required return.

We should consider the IRR rule as our primary decision criteria, but as we will see, it has some problems that the NPV does not have. That is why we end up choosing the NPV as our ultimate decision rule.

● Advantages of IRR:

• Knowing a return is intuitively appealing.
• It is a simple way to communicate the value of a project to someone who doesn't know all the estimation details.
• If the IRR is high enough, you may not need to estimate a required return, which is often a difficult task.

● NPV and IRR:

• NPV and IRR will generally give us the same decision.
• Exceptions :
– Nonconventional cash flows – cash flow signs change more than once.
– Mutually exclusive projects :
• Initial investments are substantially different (issue of scale).
• Timing of cash flows is substantially different.
14. Summary of Decision Rules:
• The NPV is positive at a required return of 15%, so you should Accept
• If you use the financial calculator, you would get an IRR of 10.11% which would tell you to Reject

• You need to recognize that there are non-conventional cash flows and look at the NPV profile.

● IRR and Mutually Exclusive Projects:

• Mutually exclusive projects

– If you choose one, you can't choose the other.

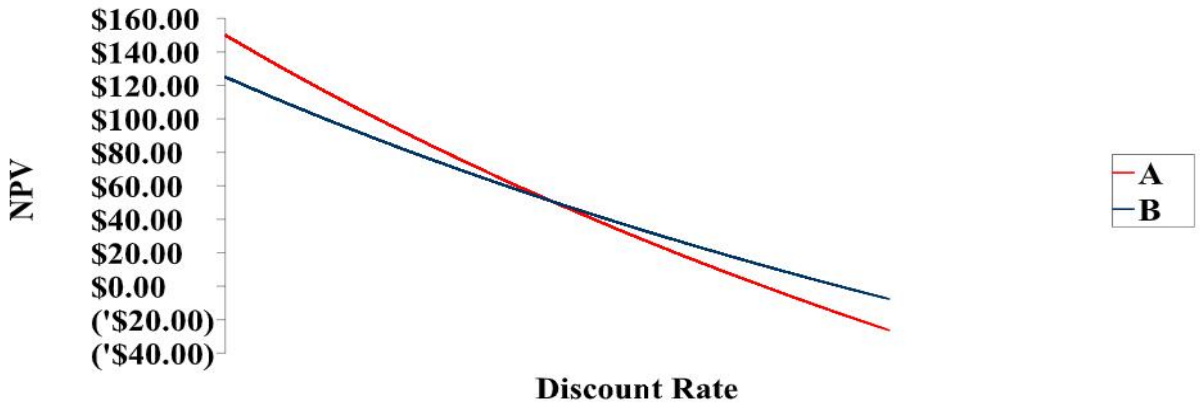
– Example: You can choose to attend graduate school at either Harvard or Stanford, but not both.

• Intuitively, you would use the following decision rules:

– NPV – choose the project with the higher NPV

● NPV Profiles:

➢ **NPV Profiles:**




● If the required return is less than the crossover point of 11.8%, then you should choose A

● If the required return is greater than the crossover point of 11.8%, then you should choose B

● Conflicts Between NPV and IRR:

• NPV directly measures the increase in value to the firm

• Whenever there is a conflict between NPV and another decision

rule, you should always use NPV

• IRR is unreliable in the following situations

– Nonconventional cash flows

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– Mutually exclusive projects

Modified IRR:

- Calculate the net present value of all cash outflows using the
- borrowing rate.
- Calculate the net future value of all cash inflows using the
- Investing rate.
- Find the rate of return that equates these values.
- Benefits: single answer and specific rates for borrowing and
- reinvestment

# 8.3 More Examples of Mutually Exclusive Projects.

The equivalent annual annuity (EAA) method is used in capital budgeting to rank mutually exclusive projects with unequal life spans.

EAA essentially smoothes out all cash flows and generates a single average cash flow for all periods that (when discounted) equal the project's NPV. EAA is calculated using the following formula:

Equivalent annual annuity = Present value of costsannuity factor =NPV× r1-1+r-t

*Where:*

*NPV: net present value*

*t: number of periods*

*r: rate per period*

Example1: Considering two projects: one has a seven-year term and an NPV of $100,000. The other has a nine-year term and an NPV of $120,000. Both projects are discounted at a 6 percent rate. The EAA of each project is:

EAA Project one = (0.06 x $100,000) / (1 - (1 + 0.06)$^{-7}$ ) = $17,914

EAA Project two = (0.06 x $120,000) / (1 - (1 + 0.06)$^{-9}$ ) = $17,643

So The project one is the better option.

Example2: Company C is considering two mutually exclusive projects with the same initial investment of $20,000,000. The life span of Project A is 5 years, and the life span of Project B is 4 years. The cost of capital is 12%.

| | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Project A | -$20,000 | $5,000 | $5,500 | $7,500 | $6,000 | $5,500 |
| Project B | -$20,000 | $6,250 | $7,000 | $7,500 | $7,250 | |

*Project A:
NPV = C0 + C11+r1+ C21+r2+…+ Ct1+rt
→NPV= -$20,000 + $5,0001+12%1+ $5,500(1+12%)2+ $6,000(1+12%)3+ $5,500(1+12%)4= $1,121.16
EAA = NPV× r1-1+r-t = $1,121.16 × 12%1-1+12%-5=$311.02
*Project B:
NPV = C0 + C1(1+r)1+ C2(1+r)2+…+ Ct(1+r)t
→NPV=-$20,000+$6,2501+12%1+ $7,0001+12%2+ $7,5001+12%3+$7,2501+12%4=$1,106.57
EAA = NPV× r1-1+r-t = $1,664.61 × 12%1-1+12%-4=$364.32
EAA of project A < EAA of project B, so B is the better project.

# 8.4 Capital rationing

Soft rationing or"internal" rationing is caused due to internal policies of co. The company may voluntarily have certain restrictions that limit the amount of funds available for investments in projects.

Hard rationing or "external" rationing occurs when the company faces problems in raising funds in the external equity markets. This can lead to the shortage of capital to finance the new projects in the company.

Let us illustrate. Suppose that the opportunity cost of capital is 10% that the company has total resource of $20 million, and that it is presented with the following project proposals

| Cash Flows ( thousands of dollars) | | | | | |
|---|---|---|---|---|---|
| **Project** | C0 | C1 | C2 | **PV at 10%** | **NPV** |
| J | -3 | 2.2 | 2.42 | 4 | 1 |
| K | -5 | 2.2 | 4.84 | 6 | 1 |
| L | -7 | 6.6 | 4.84 | 10 | 3 |
| M | -6 | 3.3 | 6.05 | 8 | 2 |
| N | -4 | 1.1 | 4.84 | 5 | 1 |

All five projects have a positivie NPV

For our five projects the profitability index is calculated as follows:

| **Project** | **PV** | **Investment** | **NPV** | **Profitability Index** |
|---|---|---|---|---|
| J | 4 | 3 | 1 | 1/3=0.33 |
| K | 6 | 5 | 1 | 1/5 |
| L | 10 | 7 | 3 | 3/7 |
| M | 8 | 6 | 2 | 2/6 |
| N | 5 | 4 | 1 | 1/4 |

There four projects exactly use up the $20 millon budget. Between them they offer shareholders the highest attainable gain in wealth.

# A LAST LOOK

An overview and summary of these decision rules

*A comparison of invesment of decision rules*

| Criterion | Definition | Invesment rule | Comments |
|---|---|---|---|
| Net present value (NPV) | Present value of cash inflows minus present value of cash outflows | Accept project if NPV is positive. For mutual exclusive project, choose the one with the highest (positive) NPV | The "gold standard" of invesment criteria. Only criterion necessarily consistent with maximizing the value of the firm. Provides proper rule for choosing among mutually exclusive invesments. Only pitfall involves capital rationing, when one cannot accept all positive-NPV projects |
| Internal rate of return (IRR) | The discount rate at which project NPV equals zero | Accept project if IRR is greater than oppoturnity cost of capital | If used properly, results in same accept-reject decision as NPV in the absence of project interactions. However, beware of following pitfalls: IRR cannot rank mutually exclusive projects-the project with higher IRR lower NPV. The simple IRR rule cannot be used in cases of multiple IRRs or an upward-sloping NPV profile |
| Payback period | Time until the sum of project cash flows equals the intial invesment | Accept project if payback period is less than some specified number of years | A quick and dirty rule of thumb, with several critical pitfalls. Ignores cash flows beyond the acceptable payback period. Ignores discounting. Tend to improperly reject long-lived projects |

| | | | |
|---|---|---|---|
| Profitability index | Ratio of NPV to intial invesment | Accept project if profitability index is greater than 0. In case of capital rationing, accept projects with highest profitability index. | Results in same accept-reject decision as NPV in the absence of project interactions. Useful for ranking projects in case of capital rationing, but misleading tin the presence of interactions. Cannot rank mutually exclusive projects. |

For the mangers in the field, dicounted cash-flow analysis is in face the dominant tool for project evaluation.

*Capital budgeting techniques used in practice*

| **Invesment criterion** | **Percentage of firms that always or almost always use criterion** | **Average score on 0-4 scale (0 = never use; 4= always use)** | | |
|---|---|---|---|---|
| | | **All firms** | **Small firms** | **Large firms** |
| Internal rate of return | 76 | 3.1 | 2.9 | 3.4 |
| Net present value | 75 | 3.1 | 2.8 | 3.4 |
| Payback period | 57 | 2.5 | 2.7 | 2.3 |
| Profitability | 12 | 0.8 | 0.9 | 0.8 |

To some extent, these rules present rough reality checks on the projects. Managers might want to consider some simple ways to describe project profitability, even if they prsent obvious pitfalls.