

Capital budgeting

- Capital budgeting deals with decisions where
 - Time is an important element of the decision
 - Cash flows of investment can be measured
 - But, there may be some uncertainties

When looking at an investment decision first we must value the investment (project). Once we have this estimate of the project value we can make a decision. But how do we choose between several projects? This area, how to choose a project, is called **Capital Budgeting**. To make a good decision we must consider what will generate value, what is the right timing, what are the cash flow requirements, and what level of uncertainty is associated with the future cash flows.

Classification of decisions

- One project: Accept or reject, simple decision.
- Many projects: decision more complicated, what are the relationships between the projects?
 - Independent:** Accept all profitable projects
 - Mutually exclusive:** Accept the best of a set (ranking)

Independent: Project has no influence over other projects. What type of capital budgeting decision are we making in this case? We consider each project separately and take all projects which meet our acceptance criteria (has a positive NPV for instance). All projects are evaluated this way. In other words, we take all the good projects.

Mutually Exclusive: Involves some type of limited resources. If we take project A we cannot take project B. One project precludes the other. What is the capital decision method in this case? The investment rule is not enough, we need a measure of the quality of the project. We rank all the projects based on some measure and then take only the best projects. (Want to be able to assign each project a number or rank).

So now we are going to be faced with multiple projects and we will need rules and methods to determine which projects to take, this will be our investment criteria. We will examine several methods of selection (beyond NPV which is always the best) but we will see that each has shortcomings.

Begin with the idea that a good investment generates positive cash flow and its benefits exceed its costs.

The NPV Investment Rule

- Financial managers should accept a project when its **perceived benefits exceed its perceived costs**. In general, value is created when benefits exceed costs Investment which increases the value of the firm.
- If the NPV of a project is **positive**, the PV of the benefits is greater than the PV of the costs (and vice versa)
- When firms accept all **positive** NPV investments, they maximize the value of their shareholders
- The value of the firm rises by the NPV of the project

NPV Rule is BEST
bar none. It generates the
optimal decision.

$$NPV = \sum_{t=0}^T \frac{CF_t}{(1+r)^t}$$

← Cash Flow

Independent Projects:

Accept if NPV>0 (meaning positive cash flow)

Mutually Exclusive Projects:

Choose the projects with the highest NPV, as long as the NPV>0
Need to compute NPV of each in order to rank.

The NPV Rule:

- ✓ uses the magnitude of cash flows (scale of the project)
- ✓ uses all the cash flows of the project
- ✓ discounts the cash flows properly

NPV measures gain after we have subtracted the costs. A good project increases the value of the firm, generates positive NPV. Maximize value by choosing only positive NPV projects.

	A	B	C	D	E	
NPV:	120	-30	400	-70	50	Criteria
	✓	✗	✓	✗	✓	Independent
	✓	✗	✓	✗	✗	M.E., only take 2
	✓	✗	✓	✗	✓	M.E. can take 4

Alternative Investment Criteria

- Managers often use criteria other than NPV when evaluating investment projects. This is a simple technique, good for evaluation of manager.
- Although these alternative criteria have intuitive appeal, they are generally ad hoc, and can lead to poor investment decisions

Payback Period Rule

- Measures how long does it take the project to “pay back” its initial investment? This is a very simple measurement.
- Payback period = number of years to recover initial costs; i.e., t^* such that

$$\sum_{t=0}^{t^*} CF_t = 0$$

As soon as sum of cash inflows meets cost of investment we have reached **payback period**.

Independent projects:

Accept all projects for which $t^* < K$ (where K is a cutoff determined by the firm)
But the firm must first decide on a good K value! K is arbitrary.

Mutually exclusive projects:

Choose the projects with the lowest t^* , as long as $t^* < K$
Need to rank the projects. Best project is the one with lowest K . After that the projects must meet the acceptance criteria.

Payback Rule Example:

Will compare payback method for 3 projects with NPV method at 10%. We will calculate NPV and use it's value to evaluate the payback method.

Project \ Yr	0	1	2	3	NPV @ 10% / Rank	Payback / Rank
A	-2,000	2,000	0	0	-\$182: Worst	1: Best
B	-2,000	1,000	1,000	5,000	\$3,492: Second Best	2: Second Best
C	-2,000	1,000	1,000	100,000	\$74,867: Best	2: Second Best

- Project A: payback period = 1 Year

$$NPV_A = -2000 + 2000/1.1 = -\$182$$

- Project B: payback period = 2 Years

$$NPV_B = -2000 + 1000/1.1 + 1000/1.1^2 + 5000/1.1^3 = \$3,492$$

- Project C: payback period = 2 Years

$$NPV_C = -2000 + 1000/1.1 + 1000/1.1^2 + 100000/1.1^3 = \$74,867$$

Result: Payback method says A is best but NPV method says A is worst! This tells us that payback is not evaluating something, specifically, **discounting of the cash flows**. It's OK to cover the cost of a project but we want a return proportional to the discount rate.

According to payback period rule projects B and C are the same. But we can see in the NPV method that this is not true. So the payback method misses something. In this case the missing element is **cash flow after payback!** The \$100,000 you get in year 3, the year after payback analysis ends!

In the analysis of this method we have seen two problems:

1. Cash flow is not discounted.
2. Payments after the payback period analysis ends.

Also, **we cannot decide on a project until we establish the K value, the number of years we require to achieve payback.** But K is an arbitrary number subject to the discretion of management.

Drawbacks of the Payback Period Rule

- Requires an arbitrary acceptance criteria (K value)
- Ignores cash flows occurring after the payback period
- Neglects timing and risk of cash flows

Determining the discount rate is difficult. Payback period does not require a discount rate.

Good Points of Payback Period

- Simple, good for small decisions.
- No Discount Rate
- Good for evaluating managers.

- How long does it take the project to “pay back” its initial investment taking the time value of money into account?

Discounted Payback Period

This discounted payback period attempts to overcome the shortcomings of the straight payback period by including a solved for discount rate. We want to take into account the time value of money. We will accumulate the present value of all the positive payments, not only the amounts we will get but the present value of those amounts. We want to calculate the cost in present terms.

The discounted payback period is the number of years, t^* , such that

$$\sum_{t=0}^{t^*} \frac{CF_t}{(1+r)^t} = 0$$

We only go as far as necessary so that the sum of present values of cash flows equals 0. This amounts to an advanced version of the payback period where we are taking into consideration the time value of money.

(Example below)

Example:

Year	0	1	2	3	4
CF	-2000	1000	1000	350	350

Four year project with initial investment and then positive payments. At discount rate of 10%, what is the discounted payback period?

In this case the straight payback period is 2. We will calculate the cumulative present values starting with 1 year and then add subsequent years and so on until we have included enough years cash flows to cover the payback period (initial investment).

$$PV(CF_0) + PV(CF_1) = -2000 + \frac{1000}{1.1} = -\$1090.91$$

not \$0, add in another year...

$$PV(CF_0) + PV(CF_1) + PV(CF_2) = -2000 + 909.09 + \frac{1000}{1.1^2} = -\$264.46$$

still not enough, add another year...

$$PV(CF_0) + PV(CF_1) + PV(CF_2) + PV(CF_3) = -2000 - 909.09 - 264.46 = -\$1.5$$

This is close enough. The discount payback period is 3. (The real payback period will be “three point something” but this will suffice.) The actual value will be much closer to 3 years than 4.

Now, do we take this project or not? We still have the question of what is our K value, the number of years the firm requires payback in? This problem of having to come up with an arbitrary K value still exist. In this case we know that if K is 2 we do not take the project. This method also ignores the problem of future payments (payments beyond the k^{th} year). The choice of K is arbitrary. Plus, we require a discount rate. Why not just use NPV? Still, this method does overcome the time value of money problem.

Drawbacks of the Discounted Payback Rule

- Requires an arbitrary acceptance criteria (K value)
- Ignores cash flows occurring after the payback period

And also:

- If you have already estimated the appropriate discount rate, why not calculating the NPV?

Profitability Index Rule

The **Profitability Index** (or **Benefit-Cost Ratio**) is the ratio of the Present Value of all the positive cash flows (inflows) to the Present Value of all the negative cash flows (outflows):

(Note: this method does consider the time value of money / discount rate)

$$\text{Profitability Index} = \frac{\sum_{t=1}^T \text{Present Value}(\text{Cash Inflow})_t}{\sum_{t=1}^T \text{Present Value}(\text{Cash Outflow})_t}$$

Independent projects:

Accept all projects with $PI > 1$ (PV(inflows) > PV(outflows), NPV is positive)
Do not take if $PI < 1$ (PV(inflows) < PV(outflows), NPV is negative)

Mutually exclusive projects (rank and then):

Rank all the projects based on Profitability Index

Choose the projects with the highest PI, as long as $PI > 1$

$NPV = PV(\text{Positive CF's}) - PV(\text{negative CF's}) = \text{Benefit} - \text{Cost}$ (in present terms)

PI method uses ratio instead of difference.

$$PI = \frac{\text{Present Value(Positive Cashflows)}}{\text{Present Value(Negative Cashflows)}} > 1 \quad \text{if ratio} > 1, \text{ NPV is POSITIVE}$$

But what is lacking?

PI cannot determine **MAGNITUDE** of **Outflows**.

Example:

Here we use NPV as a measure.

Project \ Yr	0	1	2	NPV @ 10%	PI	Rank
A	-2000	7,000	1,000	5,190	3.595	← BEST NPV
B	-1000	1,500	4,000	3,669	4.67	← BEST PI
C	-1000	2000 -500	4,000	3,669	3.52	

Here we are going to break out the NPV into positive and negative terms.
Add all the positives and add all the negatives.

NOTE THAT WE DO NOT USE THE NEGATIVE SIGN IN THE DENOMINATOR

Project A:

$$PI_A = \frac{PV(\text{Positive Cashflow})}{PV(\text{Negative Cashflow})} = \frac{\frac{7000}{1.1} + \frac{1000}{1.1^2}}{2000} = \frac{7190}{2000} = 3.595$$

EXAM

$$NPV_A = -2000 + \frac{7000}{1.1} + \frac{1000}{1.1^2} = -2000 + 7190 = \$5,190$$

Project B:

$$PI_B = \frac{\frac{1500}{1.1} + \frac{4000}{1.1^2}}{1,000} = 4.67$$

$$NPV_B = -1000 + \frac{1500}{1.1} + \frac{4000}{1.1^2} = -1000 + 4669 = \$3,669$$

Project B has a higher PI than A but we know that project A is a better project because it has a higher NPV. What is the PI method missing? The answer is SCALE, this is another case where the evaluation method does not consider the scale of the project. We are more interest in the MAGNITUDE of the return than the RATE of return.

Project C:

Project C has the same present value as projects B. **Project C is very similar to B, net is same and NPV is the same.** So the question is, will the uneven cash flow in year 1 effect the PI of project C?

$$PI_C = \frac{\frac{2000}{1.1} + \frac{4000}{1.1^2}}{1000 + \frac{500}{1.1}} = 3.52$$

B & C are the same project. This example shows that **this rule is subject to the variations of cash flows within a given period. Here the PI index is greatly reduced by the year 1 cash flow fluctuations.**

Always take the project with the highest NPV (assuming your discount rate is solid).

NPV and PI give different results. PI misses the magnitude of the projects (for example, a project which returns \$1,000,000 as opposed to a project which returns \$100,000).

Project A gives a larger return even though it has a lower ratio.

Example:

Project A: $\begin{array}{c} \text{0} \\ \text{-----} \\ \text{-10 Mil} \quad \text{10.5 Mil} \\ \text{1} \end{array}$ $NPV = -10 + \frac{10.5}{(1+.044776)} = 50,000$

Project B: $\begin{array}{c} \text{0} \\ \text{-----} \\ \text{-1000} \quad \text{\$20,000} \\ \text{1} \end{array}$ $NPV = 18,142.86$

Project B has about a 20x return but project A still returns **more**. Must take project A. Sure, project A ties up your money a while but you've included that in your discount rate. We want the project with the greater return as opposed to the highest return ratio.

Looking at the NPV the question is very simple; does the firm prefer to receive \$50,000 right now or does it prefer to receive \$18,142 right now? It will prefer the \$50,000. This illustrates that the rate of return does not make a lot of difference.

Drawbacks of the Profitability Index Rule

- **Ignores the scale of the project**
- **Sensitive to the definition of periodic benefits and costs (cash flows in periods)**

Internal Rate of Return Rule

- This is the second most popular method (NPV is most popular).
- Answers the question: What is the return we will make on the investment?
- Gives us the average rate of return we will make on the project.
- The internal rate of return (IRR) is the discount rate of return, r^* , that sets the NPV of the project to be equal to zero:

$$\sum_{t=0}^T \frac{CF_t}{(1+r^*)^t} = 0$$

Cash Flows

Set to 0

Independent projects:

Accept all projects with IRR = r^* greater than the discount rate

Mutually exclusive projects:

Rank each of the projects based on it's IRR (highest is best).

Choose the projects with the highest r^* , as long as $r^* >$ discount rate

(IRR must be higher than the discount rate)

For Bonds, the discount rate which makes present value of future payments equal to the bond price is the yield to maturity:

$$B = PV(\text{Future cash flows}), \quad NPV = PV(\text{future cash flows}) - B = 0$$

So IIR is similar to YTM but is more general, can be used to evaluate any asset.

Example:

$$\begin{array}{c} 0 \qquad \qquad \qquad 1 \\ \hline -1000 \qquad \qquad \qquad \$1,200 \end{array} \quad NPV = -1000 + \frac{1200}{1+r} = 0 \quad \text{solve for } r = \frac{1200}{1000} - 1 = 20\%$$

So this project has an IIR of 20%. This shows why **IRR measures AVERAGE RETURN**.

What percentage we will make on the investment = IRR

We are solving for an internal r^* which we compare to the market discount rate.

In the above example if the **market rate** were 10% and our IRR is 20% we obviously take the IRR project (we would have a positive NPV). If the market discount rate were 30% ,greater than the internal IRR, we would refuse the internal project and look to exploit the market discount rate.

Example:

Year	0	1	2
CF	-4,000	2,000	4,000

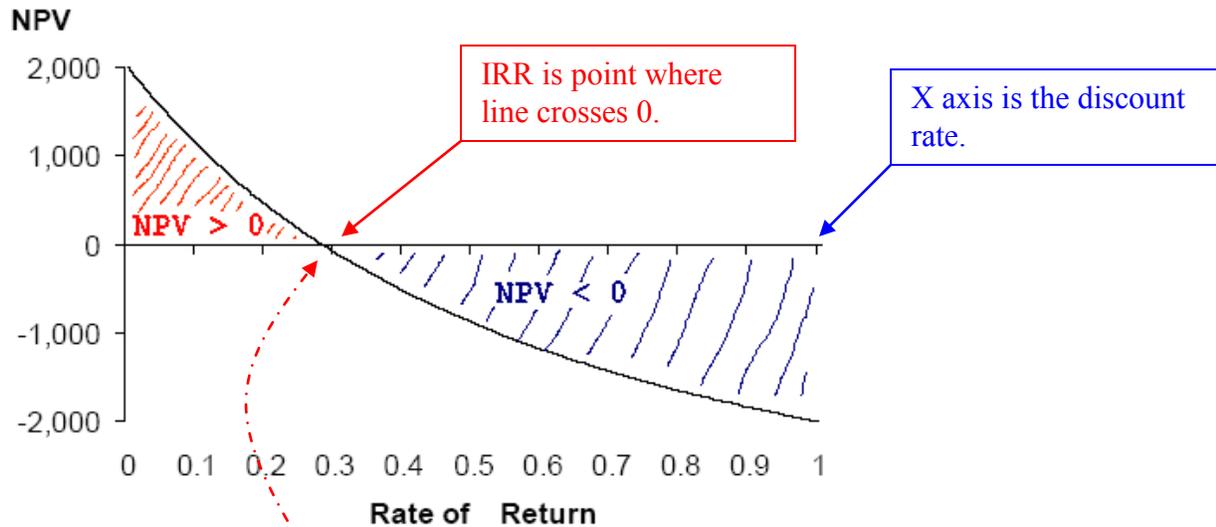
- The IRR is the rate of return, r^* , that solves the following equation

$$NPV = -4,000 + \frac{2,000}{1+r^*} + \frac{4,000}{(1+r^*)^2} = 0 \Rightarrow IRR = 28\%$$

But this is not an easy problem to solve. Use the Excel IRR function.

Year	CF
0	-4000
1	2000
2	4000

IRR = `=IRR(H4:H6,0.0001)`
`IRR(values, [guess])`



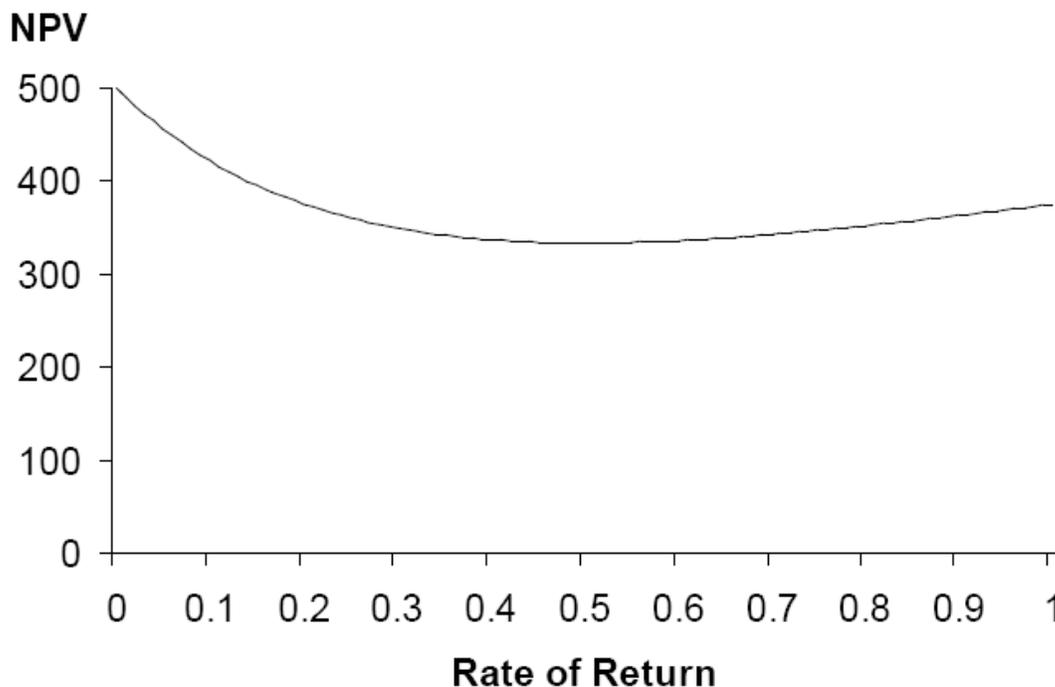
- The IRR for this investment is 28%. The X axis is counting the discount rate, 26, 27, 28, 29, ... Curve intersection with X is the IRR. For discount rates lower than the X axis crossing the project will have a positive NPV. The Y axis is the NPV of the project at a given rate. So the intersection with the X axis is the point where the NPV of the project is 0, as in the IRR definition, and the r of that point is the IRR.

If $r^* = 0$ then $NPV = -4000 + 2000 + 4000 = 0$, this is the intersection of the line with Y axis. As r^* increases the value of NPV decreases until discount rate = IRR = 28% in this case. As we evaluate greater r values beyond the IRR point the NPV of the project becomes negative. We only take a project with positive NPV.

Potential problems with IRR

Year	0	1	2
CF	1,000	-2,000	1,500

Consider this project. First and last years have a payment but the middle year has an expense. There are many types of projects like this.



- The IRR does not always exist

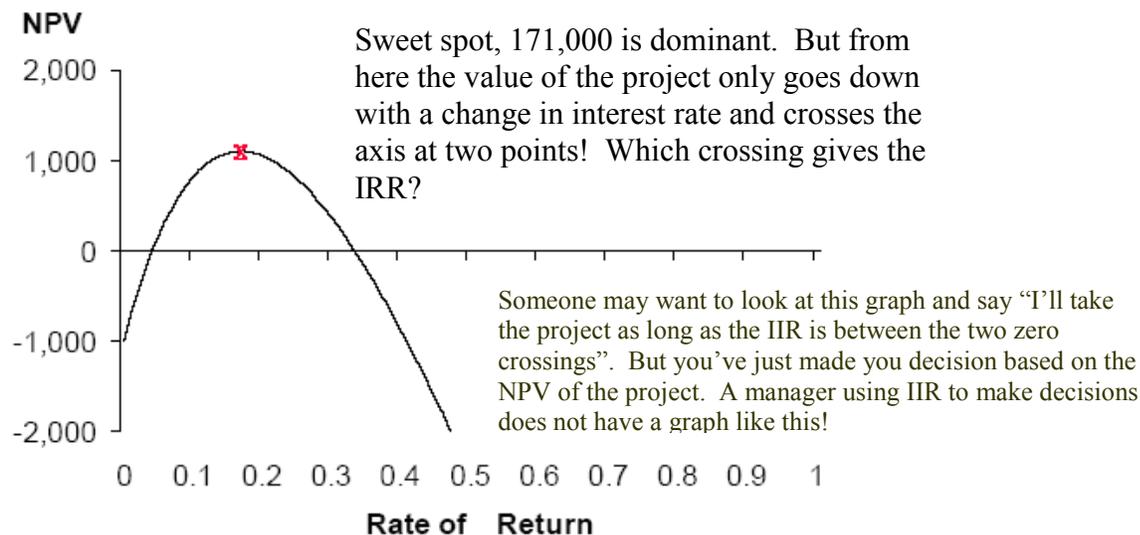
As r becomes large the 1000 becomes the dominant payment (others are becoming smaller). In the above example the IRR does not exist, the line never crosses the X axis (discount rate) and therefore there is no interest rate which will set the NPV of the project equal to 0.

$$NPV = 1000 - \frac{2000}{1+r} + \frac{1500}{(1+r)^2} = 0$$

may have quadratic solution but may be complex. **Managers need the IRR to make the decision so this illustrates that there are cases where the IRR method does not work.** The shape of the curve is the result of the discount rate acting on the other payments.

Potential problems with IRR

Year	0	1	2
CF	-72,000	171,000	-100,000



- The IRR does not always unique

We also see in this example that if r goes to infinity the IRR = 172,000.

In general we will have as many IRR's as there are sign changes in the cash flows (which corresponds to the degree of the polynomial). **But we cannot make a decision based on multiple IRRs, must have a unique IRR to decide.** It is not possible to compare the IRR to the discount rate when you have multiple IRR's!

So why is it the case that the IRR method breaks down when we have multiple sign changes? We like high rates of return when we lend money. When we borrow money we like low rates of return (to the lender). The IRR measures only the rate of the growing of the money. It doesn't take into account if you are a borrower or a lender. It only tells at what rate the money is growing. Over the course of a project the firm's position will change from that of borrower to lender many times. When we are lending we will benefit from high rates but suffer from low rates. When we are borrowing we will suffer from high rates and benefit from low rates. But the IRR method has no way to take this into consideration.

The IRR method falls apart when we have multiple sign changes.

Potential problems with IRR

Project \ Year	0	1	IRR	NPV
A	-1,000	1,200	20%	90.91
B	1000	-1200	20%	-90.91

- What are the NPV of the projects if the appropriate discount rate is 10%?

$$NPV_A = -1000 + \frac{1200}{1.1} = 90.91 \quad NPV_B = 1000 - \frac{1200}{1.1} = -90.91$$

$$IRR_A = -1000 + \frac{1200}{1+r^*} = 0 \Rightarrow r^* = 20\% \quad IIR_B = 1000 - \frac{1200}{1+r^*} = 0 \Rightarrow r^* = 20\%$$

Both projects yield the same IRR but one (B) has a negative cash flow. IIR says take project B but it has a negative NPV! It says the rate of growing is 20% but doesn't tell you it's growing at -20%! In this case we are borrowing.

This illustrates that ...

The IRR does not distinguish between investing (Lending) and Borrowing. Does not tell you if rate of growth is positive or negative!

The IRR can give incorrect answers when evaluating mutually exclusive projects

Example 1

Project \ Year	0	1	IRR	NPV
A	-1000	1200	20%	90.91
B	-8000	9200	15%	363.64

- Which project's NPV is higher if the appropriate discount rate is 10%? Based on IIR project A is the best. Based on NPV project B is the best.

The IRR does not take into account the scale of the project

If the above are independent projects take both. If they are **mutually exclusive** we will have a problem. If we rank these projects based on IRR we will take the low return project and miss the high return project. **The IIR method is not taking into account the scale of the project** (like we saw with the PI method).

Potential problems with IRR

The IRR can give incorrect answers when evaluating Mutually Exclusive projects

Example:

Which bridge to build?

- Concrete bridge: high initial cost, lower maintenance
- Wooden bridge: lower initial cost, higher maintenance

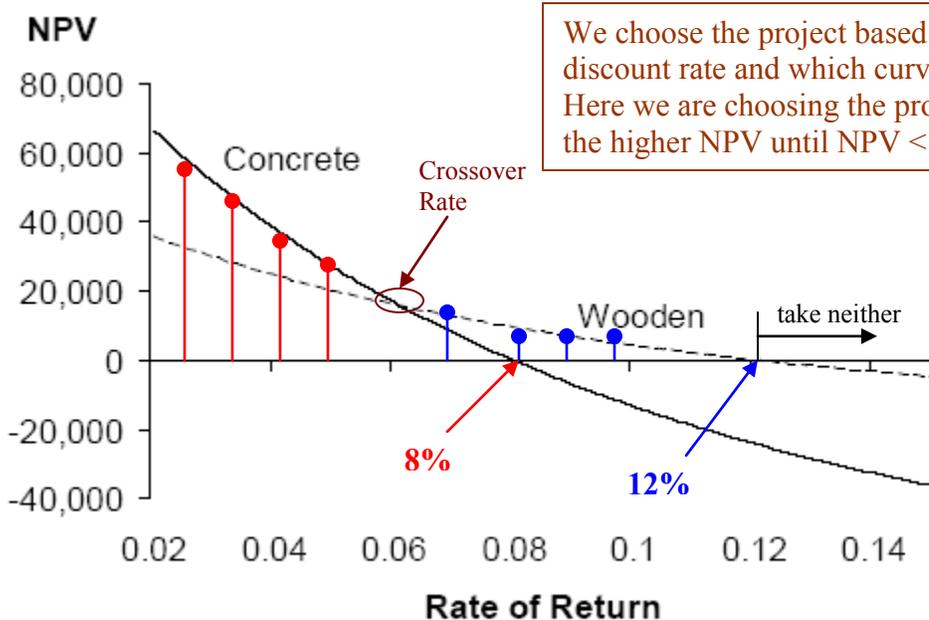
		Concrete	Wooden
Year 0	Investment	-100,000	-30,000
Year 1-20	Maintenance	-9,815	-15,984
	Tolls	20,000	20,000
	Cash Flow	10,185	4,016

IRR

- Concrete bridge IRR = 8%
- Wooden bridge IRR = 12%

IRR rule says build the wooden bridge (as long as our discount rate < 12%)

But is the wooden bridge the better choice?



We choose the project based on discount rate and which curve is higher. Here we are choosing the project with the higher NPV until NPV < 0.

If the discount rate is lower than the crossover rate take the project with the lowest IRR. At this point the project with the lower IRR will have a higher NPV.

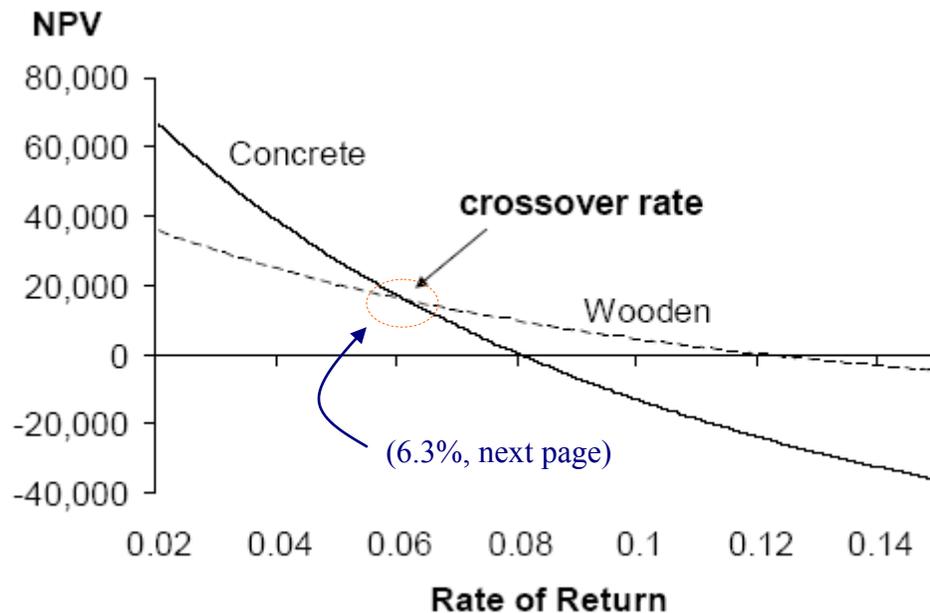
If the discount rate is higher than the crossover rate choose the project with the highest IRR. At this point the project with the higher IRR will have a higher NPV.

But it must always be the case that the discount rate is lower than the IRR.

The IRR does not take into account the TIMING of the project.

Timing of the payments is the reason for the two different curves and the crossover rate above. In this case the projects are of similar scale but one has lower maintenance costs and thus returns it's money more quickly.

Choosing between Mutually Exclusive Projects using the Crossover Rate



If the crossover rate > discount rate, choose the project with the lower IRR (and vice versa), as long as the IRR > discount rate

(Basically, choose the project with the higher NPV curve value.)

- The crossover rate is the rate of return, r^* , under which:
(setting the two NPV's of cash flows equal and solving for r)

$$NPV(A) = NPV(B) \Rightarrow \sum_{t=0}^{\infty} \frac{CF(A)_t}{(1+r^*)^t} = \sum_{t=0}^{\infty} \frac{CF(B)_t}{(1+r^*)^t}$$

$$\Rightarrow \sum_{t=0}^{\infty} \frac{CF(A)_t - CF(B)_t}{(1+r^*)^t} = 0$$

This equation does the same thing.

The NPV of the combined projects is set equal to 0. **THIS IS THE IIR OF THE COMBINED PROJECTS.**

Choosing between Mutually Exclusive Projects using the Crossover Rate

- Find the crossover rate of the two projects

Bridge project, finding the crossover rate

	Concrete	Wooden	(difference) C – W
Year 0	-100,000	-30,000	-70,000
Year 1 – 20	10,185	4,016	6,169
IRR	8%	12%	6.13%

This says that the project with the higher IRR is not always the best. If the discount rate is below the crossover rate choose the project with the lower IRR. (The project with the higher NPV is always the best project. NPV is always the best measure.)

- Therefore, if the discount rate < 6.13%, choose Concrete, and if the discount rate > 6.13%, choose Wooden. (Calculate IRR on difference C – W to find crossover rate which is the IIR of the combined project). Which project is subtracted from which is not important, result will be the same.

Facts:

- **The project with the higher IRR is not always the better one**
- **The project with the higher NPV is always the better one**

When we have two projects which are mutually exclusive solving for the crossover rate will give the right answer. Still have to consider weather the discount rate is higher or lower than the crossover rate.

Popularity of different capital budgeting methods

Method	Percent of CFOs
IRR	75.6
NPV	74.9
Payback period	56.7
Discounted payback period	29.5
Profitability index	11.9

Why is IRR so popular?

- **Very intuitive and easy to communicate**
- **Compares to the firm's "benchmark" return**
- **Can take some pressure off the task of estimating the discount rate. For example, if the IRR is 20%, then the project has a positive NPV for any discount rate < 20%**
- **If cash flows have the traditional pattern (one or several negative cash flows followed by only positive cash flows, conventional), then the NPV is positive whenever the IRR is greater than the discount rate – Thus, the IRR rule usually works (works when there is no scale problem!)**

If any method conflicts with NPV use the NPV rule. Then you can use the other investment rules to get secondary information.

Summary

- The IRR and the other alternative investment criteria are correct only when they give the same answer as the NPV rule
- Use the NPV as the first rule
- The other criteria can provide secondary information

Practice questions

Problem	Done ?
6.1	
6.7	
6.9	
6.13	
6.15	
6.21	

Some Alternative Investment Rules

The purpose of this chapter is to review commonly used investment rules in addition to the net present value rule. Rules such as payback period, discounted payback period, accounting rate of return are inferior to methods using discounted cash flows, such as the internal rate of return or net present value. The internal rate of return criterion provides the correct accept-reject decision in most cases, but it suffers from such problems as multiple rates of return and may be difficult to use with mutually exclusive projects, projects with different scale, or differences in the timing of cash flows. The profitability index is another common decision rule which is particularly useful when capital rationing is present.

Key concepts presented in Chapter 6 are outlined below.

- Why net present value
 - proper use of cash flows
 - shareholders benefit
- Alternate investment rules
 - payback period
 - discounted payback period
 - average accounting return
- Internal rate of return
 - multiple rates of return
 - mutually exclusive projects
 - projects of different scale
 - timing of cash flows
- Profitability index
 - independent projects
 - mutually exclusive projects
 - capital rationing

Chapter Summary

1. In this chapter we cover different investment decision rules. We evaluate the most popular alternatives to the NPV: the payback period, the accounting rate of return, the internal rate of return, and the profitability index. In doing so, we learn more about the NPV.
2. While we find that the alternatives have some redeeming qualities, when all is said and done, they are not the NPV rule; for those of us in finance, that makes them decidedly second-rate.
3. Of the competitors to NPV, IRR must be ranked above either payback or accounting rate of return. In fact, IRR always reaches the same decision as NPV in the normal case where the initial outflows of an independent investment project are only followed by a series of inflows.
4. We classified the flaws of IRR into two types. First, we considered the general case applying to both independent and mutually exclusive projects. There appeared to be two problems here:
 - a) Some projects have cash inflows followed by one or more outflows. The IRR rule is inverted here: One should accept when the IRR is below the discount rate.
 - b) Some projects have a number of changes of sign in their cash flows. Here, there are likely to be multiple internal rates of return. The practitioner must use either NPV or modified internal rate of return here.
5. Next, we considered the specific problems with the NPV for mutually exclusive projects. We showed that, either due to differences in size or in timing, the project with the highest IRR

need not have the highest NPV. Hence, the IRR rule should not be applied. (Of course, NPV can still be applied.) However, we then calculated incremental cash flows. For ease of calculation, we suggested subtracting the cash flows of the smaller project from the cash flows of the larger project. In that way, the incremental initial cash flow is negative. One can always reach a correct decision by accepting the larger project if the incremental IRR is greater than the discount rate.

6. We describe capital rationing as the case where funds are limited to a fixed dollar amount. With capital rationing the profitability index is a useful method of adjusting the NPV.