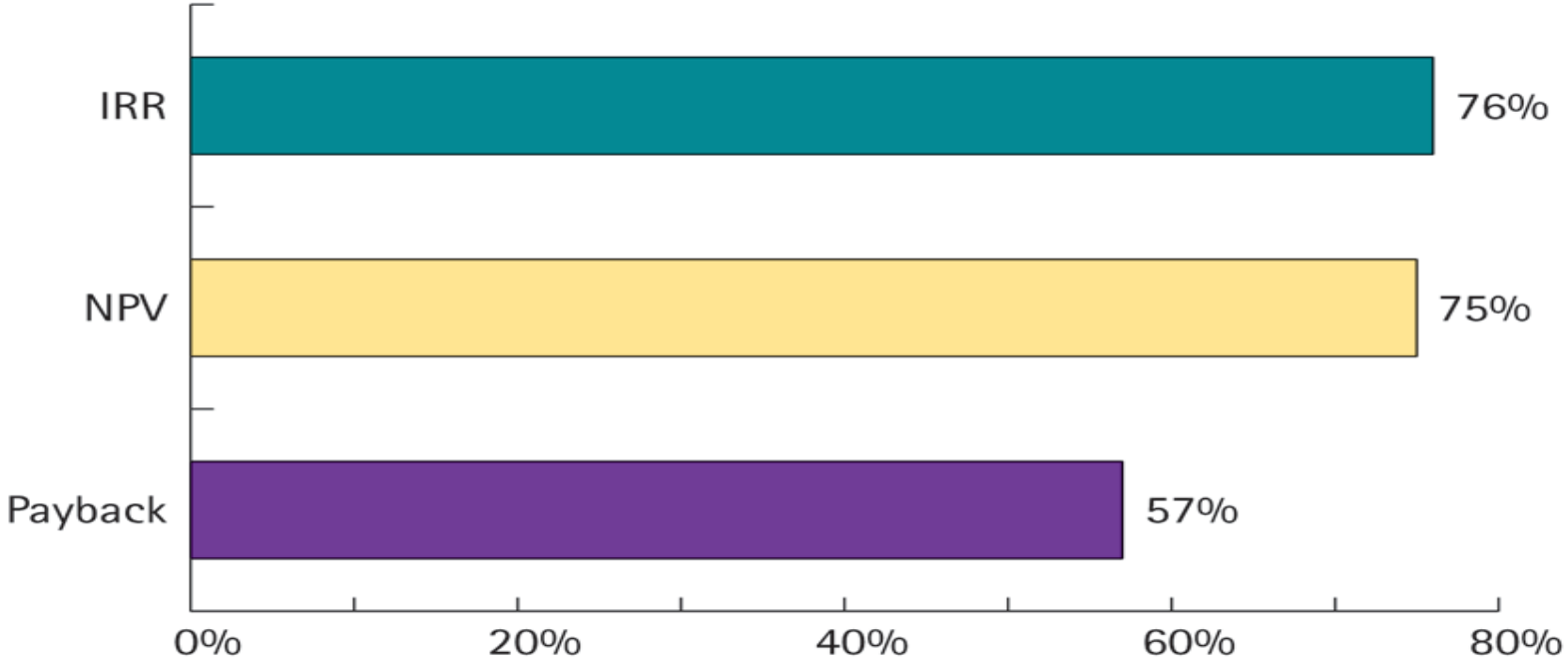
INVESTMENT DECISION RULES: NPV, IRR, AND PAYBACK TIME

Which are the Most Popular Investment Decision Rules Used by CFOs?



The NPV Decision Rule

$$NPV = PV\ (Benefits) - PV\ (Costs)$$

- The NPV rule implies that we should:
  - Accept all projects with NPV>0
  - Reject all projects with NPV<0

Example: Using the NPV Rule

- A fertilizer company is considering developing a new environmentally friendly fertilizer
- Requires building a new factory: Cost $81.6 million
- The estimated profit is $28 million in the first year, and these profits will last four years
- What's the NPV of this project?

- Given a discount rate *r*, the NPV of this project is:

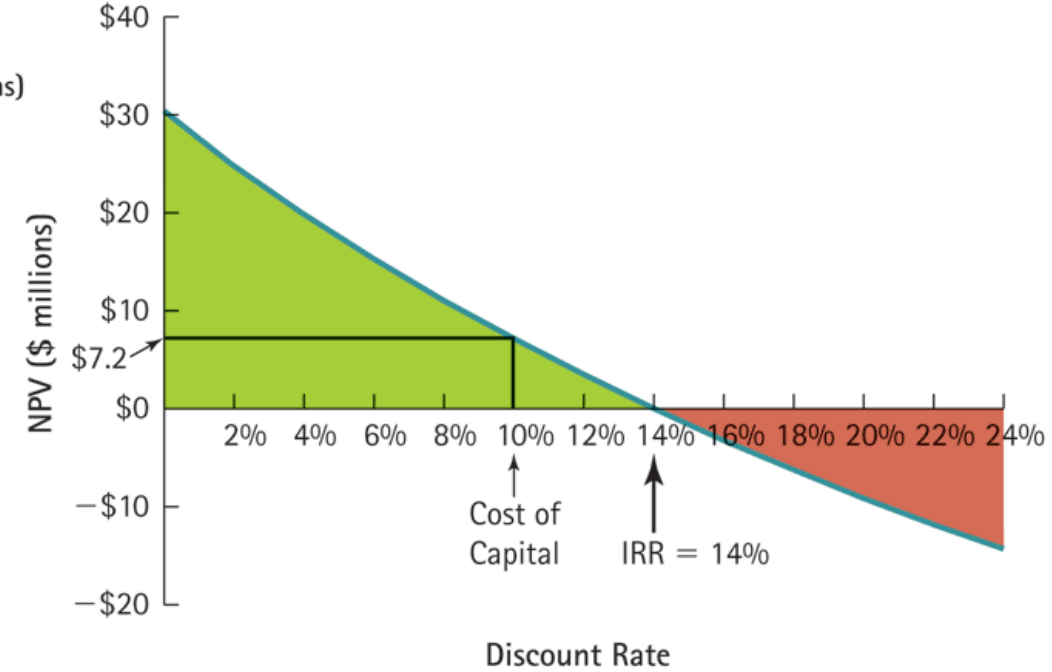
$$NPV = -81.6 + \frac{28}{1+r} + \frac{28}{(1+r)^2} + \frac{28}{(1+r)^3} + \frac{28}{(1+r)^4}$$

What discount rate, *r*?

- Suppose that investing in this project has a similar *systematic* risk profile as that of another company that has an expected return of 10%
  - Then 10% is the *opportunity cost of capital*, and the correct discount rate for this project
- Why search for a company that has similar risk instead of directly calculating the systematic risk and discount rate for the project?

Whether NPV is positive or negative depends on *r*

Discount Rate	NPV ($ millions)
0%	$30.4
2%	$25.0
4%	$20.0
6%	$15.4
8%	$11.1
10%	$7.2
12%	$3.4
14%	$0.0
16%	−$3.3
18%	−$6.3
20%	−$9.1
22%	−$11.8
24%	−$14.3



If the correct discount rate ("cost of capital") is 10%, the NPV is $7.2 million → The company should take the project

The Internal Rate of Return (IRR)

- **IRR:** Discount rate that sets the NPV of cash flows equal to zero
  - Recall, in the previous example we had:

$$NPV = -81.6 + \frac{28}{1+r} + \frac{28}{(1+r)^2} + \frac{28}{(1+r)^3} + \frac{28}{(1+r)^4}$$

    We can solve this for an IRR of 14%
    (i.e., the root of the equation where intersects x-axis)

- **IRR Decision Rule:**
  - *Accept any investment where IRR > Cost of capital*
  - *Reject any investment where IRR < Cost of capital*
- In the previous example, the IRR Decision Rule says:
  - Accept the investment, because the IRR (14%) is greater than the opportunity cost of capital (10%)

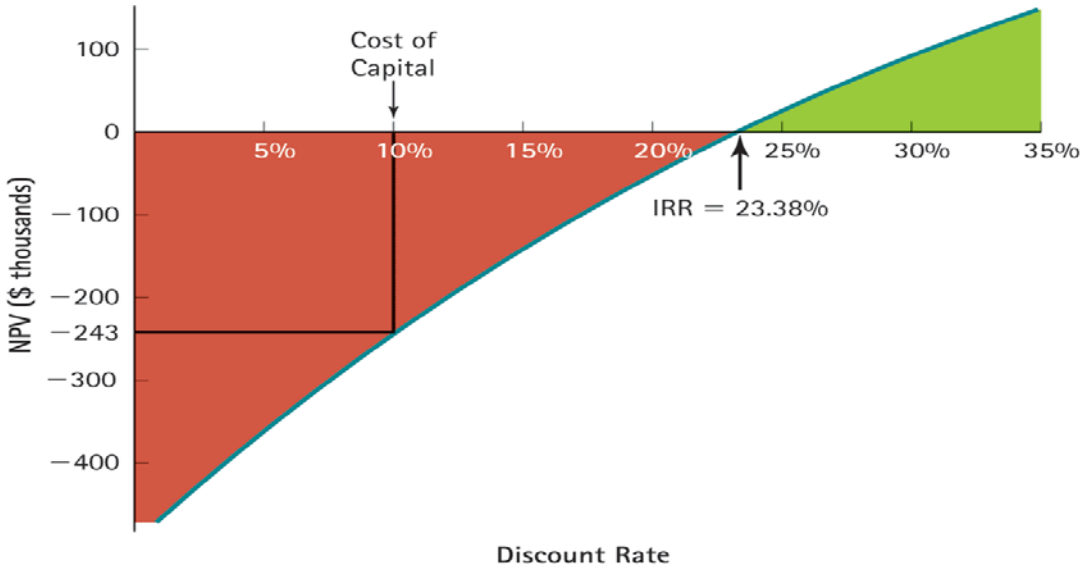
IRR Rule and Differences in **Risk**

- A higher IRR usually better
- But, important not to use the same IRR cutoff to evaluate projects with different risk profiles
  - E.g., an IRR of 20% may be attractive for a safe project (with a low cost of capital), but may not necessarily be attractive for a riskier project (with a high cost of capital)

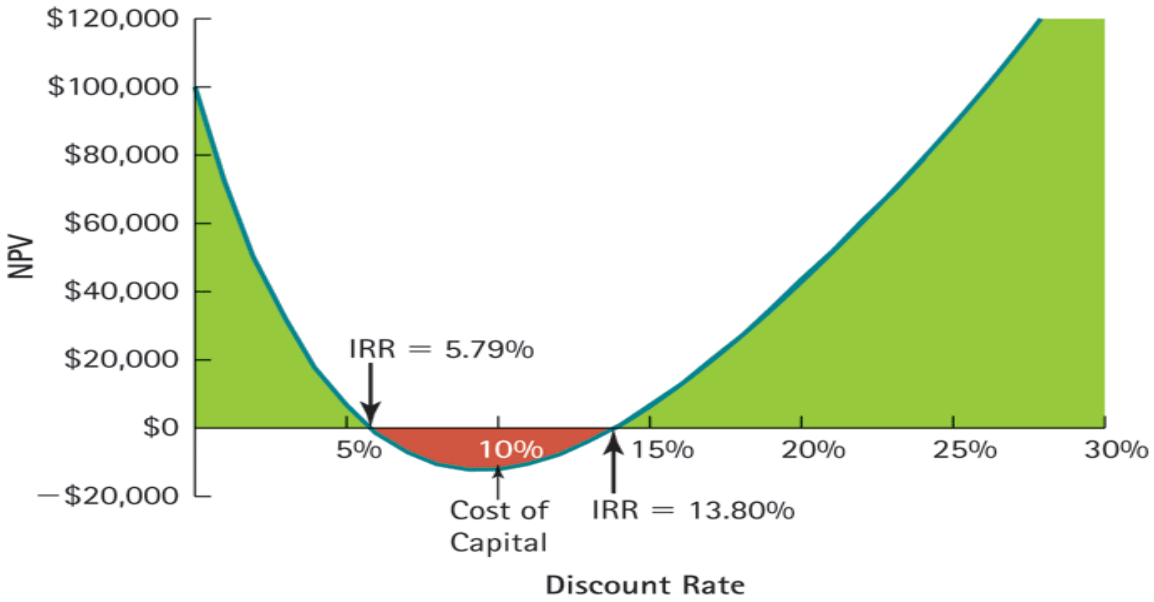
IRR Rule vs. NPV Rule

- The NPV rule and IRR rule often give the same answer
- BUT, the IRR rule sometimes disagrees with the NPV rule, for example:
  - Delayed investment: If negative cash flows follow positive cash flows (then a *higher* discount rate is better)
  - Multiple IRRs or No IRR → Cannot use the IRR Rule
  - Differences in scale
- Which rule should we use when they disagree?

Example: Delayed investment (benefits upfront and costs later)



Example: If multiple IRRs



IRR Rule and Differences in **Scale**

- If a project's size is doubled, its NPV also doubles
  - This is not the case with IRR

➢ IRRs cannot be used to compare the values of projects that have different scales

The Payback Rule

- Based on intuition that the quicker a project pays back its initial investment, the better
- **Payback period:** The amount of time it takes to earn back the initial investment
- **The Payback Rule** implies that we should:
  - *Accept any investment where the payback period is less than a pre-determined required cutoff time*
  - *Reject any investment where the payback period is greater than this cutoff time*

Example: Using the Payback Rule

- Assume the fertilizer company in the previous example requires all projects to have a payback period of two years or less
- Would the firm undertake the project under this rule?

Problems with the Payback Rule

- Payback rule is simple to compute, BUT
  - — Requires us to use an *arbitrary* cutoff period
  - — Ignores cash-flows *after* the payback period
  - — Does *not discount* future cash flows
    - *i.e.,* ignores time value of money and systematic risk
- Can therefore lead to wrong decisions:
  - — Accepting negative-NPV projects or rejecting positive-NPV projects

Choosing Between Projects

- If you can't pick every project with a positive NPV
  - *e.g.,* if two mutually exclusive projects, or, if you only can pick *N* projects, then:
  - Rank and pick the project(s) based on the *Highest NPV*!
  - Ranking based on *Highest IRR* or *Shortest Payback Period* can lead to the wrong answer
- What if we have a limited resource, *e.g.* store shelf space?
  - Simple answer: Pick the "project(s)" with the highest NPV per constrained resource!
  - Complicated answer: If we have multiple limited resources or if projects are discrete, this can become a really hard problem → often solved using "linear programming" methods
    - Linear programming is beyond the scope of this course (unless you really want to do it!)

Example: Choosing Between Projects

NPV and Mutually Exclusive Projects

Problem

A small commercial property is for sale near your university. Given its location, you believe a student-oriented business would be very successful there. You have researched several possibilities and come up with the following cash flow estimates (including the cost of purchasing the property). Which investment should you choose?

Project	Initial Investment	First-Year Cash Flow	Growth Rate	Cost of Capital
Book Store	$300,000	$63,000	3.0%	8%
Coffee Shop	$400,000	$80,000	3.0%	8%
Music Store	$400,000	$104,000	0.0%	8%
Electronics Store	$400,000	$100,000	3.0%	11%

Solution

Assuming each business lasts indefinitely, we can compute the present value of the cash flows from each as a constant growth perpetuity. The NPV of each project is

$$NPV(\text{Book Store}) = -300{,}000 + \frac{63{,}000}{8\% - 3\%} = \$960{,}000$$

$$NPV(\text{Coffee Shop}) = -400{,}000 + \frac{80{,}000}{8\% - 3\%} = \$1{,}200{,}000$$

$$NPV(\text{Music Store}) = -400{,}000 + \frac{104{,}000}{8\%} = \$900{,}000$$

$$NPV(\text{Electronics Store}) = -400{,}000 + \frac{100{,}000}{11\% - 3\%} = \$850{,}000$$

Thus, all of the alternatives have a positive NPV. But because we can only choose one, the coffee shop is the best alternative.

Note: The IRRs are 24%, 23%, 26%, and 28% respectively – ranks the wrong way!

Summary of decision rules

- NPV
  - Definition: Difference between PV of project's benefits and PV of its costs
  - NPV Rule: Take projects that have a positive NPV; reject projects with negative NPV
- IRR
  - Definition: The discount rate that sets NPV of cash flows equal to zero
  - IRR Rule: Take projects where IRR>Cost of capital
  - Often gives the same answer as the NPV Rule, but there are exceptions
- Payback Period
  - Definition: Amount of time to pay back initial investment
  - Payback Rule: Take projects whose payback period is less than a chosen cutoff
  - Is simple to compute but has several disadvantages

HOW TO MEASURE THE VALUE OF A DECISION USING EVENT STUDIES

(NOTE: I HAVE NOT FOUND A DISCUSSION OF THIS IN B&M, SO DON'T LOOK TOO HARD FOR IT…)

Measuring NPV using liabilities

- A decision with an NPV of $*NPV* will change firm value by $*NPV:*

$$V_{after} = V_{before} + NPV \rightarrow NPV = V_{after} - V_{before}$$

- E.g., merger, dividend
- Likewise, an event that changes other firm policies

Event study

- Event studies is a methodology to measure the value implications for a firm from an event or action by observing changes to security prices around the event/action
- Because equity is the residual claimant, almost all positive/negative value of any decision affects equity
- The *return* on a firm's equity around the announcement of an event reflects the NPV *N* of this event:

$$NPV = \Delta E = E_{before} * R_{E(\%)}$$

- For some decisions where debt values also might be significantly affected:

$$NPV = \Delta E + \Delta D = E_{before} * R_{E(\%)} + D_{before} * R_{D(\%)}$$

Example: The AT&T Time Warner merger (1)

- On Oct. 22, AT&T announced it will buy Time Warner Inc. for $85.4 billion
- Was this a positive-NPV decision for AT&T?
- The closing stock price on Oct 21 (Friday): $37.49
- The opening stock price on Oct 24 (Monday): $36.51
- A decline of $0.98 per share or 2.6%
  - AT&T has around 6.14 B shares outstanding
  - This implies a negative-NPV of $0.98*6.14B = $6.02 Billion

Caveat 1: But what if the entire stock market went down by 3% that day?

- *Abnormal return: Event return for firm i minus the return for a "control group"*
  - Market adjusted (subtract market return, e.g. S&P 500)
  - Industry adjusted (subtract industry return)
  - Characteristic adjusted (subtract return of firms with similar size and M/B)
  - "Factor adjusted" (e.g. subtract Rm*beta)

Caveat 2: Dealing with expectations and information leakage

- If everyone already knew that a certain decision is going to be made, then we would expect to see no firm value change around the announcement even a decision has a large NPV (whether positive or negative)…
- Or, imagine people thought it was a 50/50 probability that an announcement would be made… then how should we interpret event returns?
- We see some evidence of this in the AT&T deal… how?
- We often add returns over a few days around an event to deal with leakage before the event (and allow time for the market to “reflect” on the news)