Investment Decision Analysis

The investment decision process:
- Generate cash flow forecasts for the projects,
- Determine the appropriate opportunity cost of capital,
- Use the cash flows and the cost of capital to compute the relevant investment criteria.

Issues:
- Why use cash flows and not accounting earnings?
    - *can we "spend" earnings?*
- Which cash flows do we use?
    - *total vs. incremental cash flows,*
    - *how to treat sunk costs.*
- Which investment criterion do we use, and why?
    - *Net Present Value (NPV),*
    - *Payback / Discounted payback period*
    - *Average Accounting Return*
    - *Internal Rate of Return (IRR)*
    - *Profitability Index*
- Mutually exclusive vs. independent projects.
- Sensitivity analysis.
    - *How sensitive are the criterion to changes in key assumptions.*

Earnings vs. Cash Flows

- *You cannot spend earnings!* Need cash to build a plant, not earnings.
- Earnings can be manipulated by *creative* accounting.

Classic Example: The movie *Forrest Gump* (Paramount Pictures, 1994)

- Winston Groom, the author of the book on which the movie is based, was promised 2% of the *net income* on the movie.
- The movie grossed over $650 million worldwide.
- However, Groom got *nothing*!
- Paramount reported a $62 million loss on the movie, because of a 32% commission the studio charged the movie to cover costs on future films that might fail!!
- *Do you think they didn't make a cash profit on the movie?*

So earnings can be what you want them to be, while cash flows are what you receive in your bank account, and are hence much more real and transparent.

Net Present Value (NPV)

The net present value of a project is the sum of the present values of the expected cash flows on the project (discounted at the cost of capital / hurdle rate for the projects), net of the initial investment.

The decision rule:
    Accept, if   NPV > 0
    Reject,   if   NPV < 0
Accepting positive NPV projects enhances stockholders' wealth.

Example: Suppose $ cash flows are:
               (-1000, 300, 400, 500, 600)
               discount rate is 12%.
Then, NPV = $324.

Advantages:
- Cash flow based.
- Additivity: The NPVs of individual projects can be added to arrive at the cumulative NPV for the business or division as a whole (*NPV(A+B)=NPV(A)+NPV(B)*).
- NPV uses *all* cash flows for the project, not just some cash flows upto a particular date.
- Accounts for the time value of money, as all cash flows are discounted at the appropriate rate.
- Allows for expected term structure and interest rate shifts: NPV can be computed using time-varying discount rates.
- Linked to the objective of value maximization: Provides a criterion based on an absolute number that represents the increase (or decrease!) in the value of the firm if the project is accepted.

Biases, limitations, and caveats:
- An *absolute* criterion, so does not factor in the scale of the project.
- Does not control for the life of the project, so when comparing mutually exclusive projects with unequal lives, the NPV rule is biased towards accepting longer-term projects.

Payback Period

The payback period for a project is the length of time it will take for nominal cash flows from the project to cover the initial investment.

Example: Suppose $ cash flows are:
             (-1000, 300, 400, 500, 600)
             discount rate is 12% (*don't need it here*!)

Then, payback period is between 2 and 3 years, and can be approximated to be 2.6 years assuming uniform cash flows.

Usually, a maximum acceptable payback period is set – projects that payback their initial investment sooner than the maximum are accepted, whereas projects that do not are rejected.

Advantage:
- Simple and easy to compute, so a useful criterion for very frequent, low value decisions (e.g., do I spend $500 to get a higher efficiency motor that saves me $20 a month, or just use the existing one?)

Biases, limitations, and caveats:
- Ignores what happens after the initial investment is recouped. This can lead to absurdities – consider two projects: A   (-1,000, 300, 400, 300, 10,000) -   3 yrs
  B   (-1,000, 500, 500, 100, 100)   -   2 yrs
  would you pick B?
- The payback rule breaks down if the investment is spread over time, not in one shot upfront.
- Does not consider the time value of money – no discounting of cash flows – counts cash flows in earlier years the same as cash flows in the later years.
- The choice of a standard for payback period is arbitrary, unlike the NPV approach, where the firm can go to the capital markets to get the discount rate.

Discounted Payback Period

It is the number of periods at the end of which the discounted cash flows cumulate to cover the initial investment.

Example: Suppose $ cash flows are:
                      (-1000, 300, 400, 500, 600)
                      discount rate is 12%
The discounted payback period is 3.15 yrs.

Advantages:
- Cash flows are discounted, so accounts for the time value of money.

Biases, limitations, and caveats:
- Has all the other disadvantages of the Payback Period rule.
- Since cash flows have to be discounted, the advantage of simplicity is also lost!

A poor compromise between Payback period method and NPV.

Average Accounting Return (AAR)

It is the average project earnings (after taxes and depreciation), divided by the average book value of the investment during its life.

Example:

Advantages:

- *Not too many!* Just that it uses accounting numbers that are readily available.

Disadvantages:

- Uses the wrong numbers – earnings instead of cash flows, and book value of investment instead of market value (which is more realistic).
- No discounting – does not account for time value of money.
- Targeted rate of return is arbitrary.

Internal Rate of Return (IRR)

The IRR of a project measures the rate of return earned by the project based upon cash flows, allowing for the time value of money.

- IRR is the discount rate that makes the NPV zero.
- Discounted cash flow analog to the accounting rates of return.

Example: Suppose $ cash flows are:
             (-1000, 300, 400, 500, 600)
The IRR of this project is 24.89%.

The decision rule:
      Accept, if   IRR > cost of capital
      Reject,   if   IRR < cost of capital

Linkage between NPV and IRR: The NPV profile

Measures the sensitivity of the net present value to changes in the discount rate.

IRR is the point where the NPV profile crosses the x-axis.

Advantages:
- A single number that summarizes the merits of a project, without making assumptions about the discount rate (*but we do need the discount rate while using the IRR rule – why?*).
- The IRR rule coincides exactly with the NPV rule (except for *some* cases), so it is (*usually*) consistent with the objective of value maximization.
- Provides a *percentage* return, which is often easier to interpret and communicate.

Biases, limitations, and caveats:
- Ignores the issue of scale: tends to bias decision makers towards smaller projects, which are more likely to yield high percentage returns, over larger ones (*which one would you pick - $2 after 10 minutes in return for $1 now (100% IRR), or $13 after 10 minutes in return for $10 now (30% IRR)?*).
- Lending or borrowing?

Project	C_0	C_1	IRR(%)	NPV at 10%
A	-1,000	1,500	50	364
B	1,000	-1,500	50	-364

  The decision rule has to be clarified, depending on the kind of project – whether it is lending (Accept if IRR>hurdle rate) or borrowing (Reject if IRR>hurdle rate).

- Multiple Rates of Return:
  Consider the project (-1,000, 800, 1,000, 1,300, -2,200)
  Has two IRRs : 6.60% and 36.55%
     If the hurdle rate falls between these two IRRs, the decision on whether or not to take the project will change depending on which IRR is used. Hence, need to look at the NPV profile to make the right decision.

Multiple IRRs:
- The IRR is mathematically the root to the polynomial present value equation for cash flows.
- Number of IRRs is equal to the number of sign changes in the project cash flows.
- The general solution to this problem is to use NPV instead!

Profitability Index (PI)

It is the NPV of a project divided by the initial investment in the project – so its is a *scaled* version of NPV.

Example: Suppose $ cash flows are:
            (-1000, 300, 400, 500, 600)
            discount rate is 12%.
Then, NPV = $324, PI = 324/1000 = 32.4%

The decision rule:
    Accept, if   PI > cost of capital
    Reject,   if   PI < cost of capital

- In most cases, PI and IRR yield similar results (differences are due to different reinvestment rate assumptions).
- Ignores scale issue, as it is a ratio.

A solution to the scale issue: Incremental Cash Flows

- Consider two *mutually exclusive* projects:
  - A: (-1000, 300, 400, 500, 600)
  - B: (-3000, 700, 900, 1400, 1700)
- Then,   *NPV (@12%)*   *IRR*

	NPV (@12%)	*IRR*
A	$324	24.9%
B	$419	17.5%

- Which one do you accept?

Compute incremental cash flows (B-A):
- The incremental project is
  (-2000, 400, 500, 900, 1100)
- For this incremental project,
  NPV = $95, IRR = 13.9%
- Since both projects are acceptable on a stand-alone basis, we want to know if it is beneficial to invest an *additional* 2000 in project B, instead of just project A (remember, they are mutually exclusive).
- The incremental NPV is positive, the incremental IRR > 12% (the hurdle rate), hence the incremental investment is justified, therefore choose project B.
- Here, using just the IRR would lead to the wrong decision!

NPV vs. IRR – Which one to use?

High IRR $\Rightarrow$ "bigger bang for the buck" and more
                              margin for error

High NPV $\Rightarrow$ creates more "dollar value"

Under a scenario where capital is limited, and there is uncertainty (which is usually the case!):

- If a business has limited access to capital, has a stream of surplus value projects and faces more uncertainty in its project cash flows, it is much more likely to use IRR as its decision rule

   Small, high-growth companies and private businesses are much more likely to use IRR.

- If a business has substantial funds on hand, access to capital, limited surplus value projects, and more certainty on its project cash flows, it is much more likely to use NPV as its decision rule.

   As firms go public and grow, they are much more likely to gain from using NPV.

The reason for these differences

- The NPV rule assumes that intermediate cash flows on the project get reinvested at the hurdle rate (which is based upon what projects of comparable risk should earn).
- The IRR rule assumes that intermediate cash flows on the project get reinvested at the IRR. Implicit is the assumption that the firm has an infinite stream of projects yielding similar IRRs.
- Conclusion: When the IRR is high (the project is creating significant surplus value) and the project life is long, the IRR will overstate the true return on the project.

The solution?
- Compute a modified internal rate of return (MIRR), explicitly incorporating the desired reinvestment rate assumption.

What do firms actually use?

A survey of some of the largest companies in the US has shown:

Decision Rule	*% of firms using as primary decision rule*	
	1976	***1986***
IRR	53.6%	49.0%
Accounting Return	25.0%	8.0%
NPV	9.8%	21.0%
Payback Period	8.9%	19.0%
Profitability Index	2.7%	3.0%

What does this show?
- Decision makers seem to prefer a scaled measure of investment performance (IRR), even if it has problems.
- Surprisingly large number of firms use the payback period, even with all its limitations.
- The use of NPV has increased, while the popularity of accounting measures is on the decline.
- Most firms used more than one investment criterion to decide on projects.

Summary: *No one technique is perfect. Firms should use one primary technique in decision making, but should supplement it with other techniques, depending on the project and business conditions.*