# NPV & Capital Budgeting Practice 1

*READ NPV & CAPITAL BUDEGETING*

# Guided Example

Pharmco needs to decide if they should buy the right to a new drug created by another company that would generate cash flows shown in the table at a cost of $1 billion. The risk-free rate is 4%. The opportunity cost of fund (discount rate) for this project is found to be 8%. Should Pharmco invest?

Projected Cash Flows for Pharmaco's Proposed Investment ($ in Millions)

| Time | t = 0 | 1 | 2 | 3 | 4 | 5 |
|------|-------|-----|-----|-----|-----|-----|
| Net inflows | | $150.0 | $180.0 | $216.0 | $259.2 | $311.0 |
| Terminal value | | | | | | $500.0 |

(1) Determine the expected cash flows ($E(Cf_t)$) for this project:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
|   |   |   |   |   |

# Guided Example (con't)

(2) What is the risk-adjusted discount rate (k)? Why?

ANS:

(3) What is the risk premium for this investment?

ANS:

(4) Find PV for investment.

ANS:

(5) Should you invest / reject?

ANS:

# Examples

(1) Can an adjusted risk-free rate be lower than the risk-free rate? Why?

ANS:

(2) Today is January 1, 2010. A project requires initial investment of $1,260 made today and expected cash inflows are on January 1 in the years 2011, 2012, 2013, 2014, 2015. The first of these will be $250, and each one thereafter will be $20 higher than the preceding one. The risk-free rate is 4% and risk premium is 6.6%. Would you invest in this project?

ANS:

# Examples

(3) Calculate the NPV of an investment project with an initial cost of $5 million and positive cash flow of $1.6 million  at the end of Year 1, $2.4 million of round 2 investment at the end of year 2, and another positive cash flow of $7.8 million at the end of year 3. The risk-adjusted discount rate is 12%.

ANS:


(4) Consider projects A and B. Both projects require the same initial investment of $100 today. While project A has a guaranteed cash flow of $200 in one year, project B's cash flow in one year is normally distributed around $200. What is the expected cashflow for each project and which project would you invest in? Why?

*In class:  Assume the risk adjusted discount rate for project A is 8%.  The discount rate for project B is 16%.  The projects are mutually exclusive.*

ANS:

# Guided Example (Revisited)

Pharmco needs to decide if they should buy the right to a new drug created by another company that would generate cash flows shown in the table at a cost of $1 billion. The current risk-free rate is 4% and the hurdle rate for this project is found to be 8%. Help Pharmco decide if they should invest.

Projected Cash Flows for Pharmaco's Proposed Investment ($ in Millions)

| Time | t = 0 | 1 | 2 | 3 | 4 | 5 |
|------|-------|-------|-------|-------|-------|-------|
| Net inflows | | $150.0 | $180.0 | $216.0 | $259.2 | $311.0 |
| Terminal value | | | | | | $500.0 |

(1) What is the IRR of the project? What is the NPV?
ANS:

(2) Should you accept the project based on IRR? Based on NPV?
ANS:

# Problems associated with IRR

- **More than one IRR (or none):**
  - Future cash flows involve more than one "change of sign"
  - There is no cash outflow (i.e. no cost for investment)
  - Example: Consider the following set of follows with k = 8%

| 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| -170 | 160 | 160 | 160 | 160 | -520 |

  - Find NPV with discount rate  = 6.77% and 65.36% respectively
  - NPV @ 6.77% = $0
  - NPV @ 65.36% = $0                            **IRR RULE does not work here**

  *In class:  To determine if this project creates or destroys value, run the NPV at 8%.*
  ANS:

# Reinterpret the IRR Rule if outlays are reversed

- **IRR decision rule needs to be reversed when outflows follow inflows:**
  - Early cash inflow(s) followed by later cash outflows
  - Occurs even with only one change of signs
  - Example: Consider the following set of cash flows with k = 8%

| 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1000 | -150 | -150 | -150 | -150 | -150 |

  - IRR = -8.9%
  - What does a negative IRR mean in this example, and should the project be accepted?
  - **In class: First, practice this one and run the IRR to confirm it is -8.9%.**
  - **In class, suppose the discount rate is 5%.  Run the NPV. Accept or reject?**
  - ANS:
  - **If CFs are reversed (positive outlay followed by payments), then the IRR rule is reversed.**

# Payback Period and Problems Associated with the Payback

- **Ignores risk and time value:**
  - ◦ $100 five years from now is worth the same as $100 one year from now according to the payback period method
  - ◦ You don't need to account for the difference in riskiness amongst the projects
  - ◦ Over-simplified the problem
  - ◦ Consider the Pharmaco example again:

| | $Cf_0$ | $E(Cf_1)$ | $E(Cf_2)$ | $E(Cf_3)$ | $E(Cf_4)$ | $E(Cf_5)$ | Terminal Value |
|---|---|---|---|---|---|---|---|
| **Payback Period:** | | | | | | | |
| Outlay | ($1,000) | | | | | | |
| Inflows | $0 | $150 | $180 | $216 | $259 | $311 | $500 |
| Net cash flow | ($1,000) | $150 | $180 | $216 | $259 | $311 | |
| **Cumulative CF** | **-1000** | _____ | _____ | _____ | _____ | _____ | |

  - ◦ The pay back period is ____years. Recall that Pharmaco's project creates value with a positive NPV and IRR > RR. If the company had just decided they wanted to be paid back in 3 years, the executives would _____.

# Examples to Check understanding of IRR , NPV, and Payback

(1) Does the IRR rule always lead to the same decision as the NPV rule? Why?

ANS:

(2) Given the following cash flows, should you invest/ not invest based on IRR?

| Year 0 | Year 1 | Year 2 | Year 3 |
|--------|--------|--------|--------|
| ($2,340) | $200 | $440 | $770 |

ANS:

First run the IRR:

Then run the NPV at a required return of 8% to confirm the NPV is negative:

# Examples

(3) Suppose the signs of cash flows changed for Q2.  The company is being paid to accept a project in which it owes in the future.  Should the company accept this project?

| Year 0 | Year 1 | Year 2 | Year 3 |
|--------|--------|--------|--------|
| $2,340 | ($200) | ($440) | ($770) |

ANS:

(4) Given the following cash flows, risk-free rate = 4% and risk premium = 2.9%, should you invest/ not invest based on IRR?

| Year 0 | Year 1 | Year 2 | Year 3 |
|--------|--------|--------|--------|
| ($1,550) | $610 | $390 | $790 |

ANS:

# Examples

(5) Given the following cashflows of a project and a target payback period of 4 years, based on payback rule should you accept/ reject the project?

| Year 0 | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 |
|--------|--------|--------|--------|--------|--------|
| ($4,460) | $1,200 | $1,430 | $550 | $860 | $3,500 |

ANS:

(6) Assume same cashflows from Q5 and assume 10% required return, should you accept/ reject the project based on IRR rule?  Also calculate the NPV.

ANS:

# Investment Projects Plotted According to Expected Return and Risk

• Here is a plot of return vs hurdle rate for projects.

• For some companies, all projects have similar risk.

• For other companies, project vary in risk-- some are low, some are medium, some are high.

• The black line -- The higher the risk of the project, the higher is the hurdle rate.

• The black line-- also the zero-NPV line.

• You would accept/reject projects above the zero-NPV line and accept/reject projects below the zero-NPV line
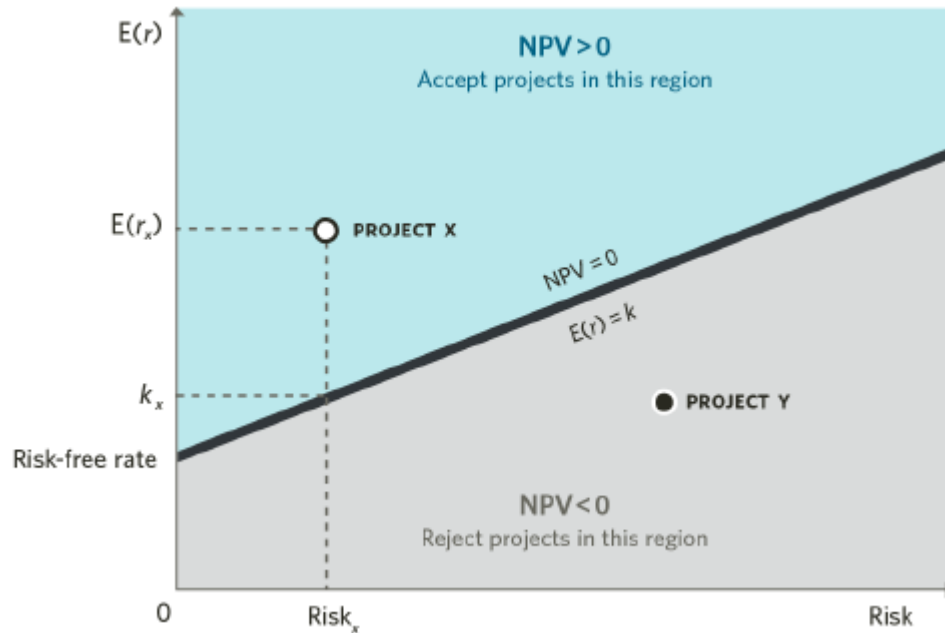
# What if a Company uses a Single Discount rate when it should use Multiple Discount rates?

- What are the consequences of using a single hurdle rate in evaluating all projects?

- Suppose a single hurdle rate K* is used for all projects when projects have differing risk levels

- **Type I errors: wrongly accepted projects** that would destroy value since required expected return is lower than discount rate

- **Type II errors: wrongly rejected projects** that would actually create value since required expected return is higher than discount rate
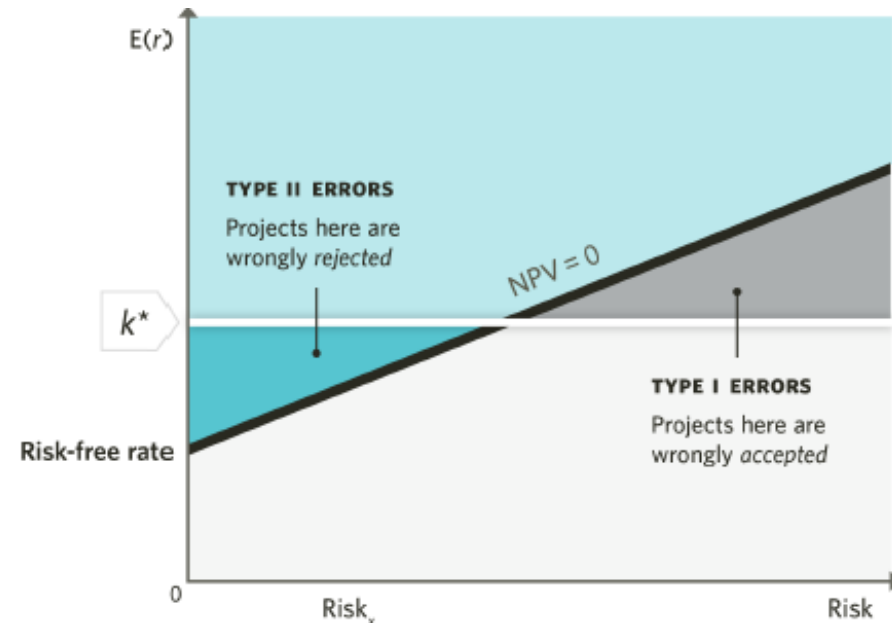
# Extra Example – Different Projects may have different DR

Suppose your company SNC is considering doing business with a high risk customer. The customer has a 50% chance of bankruptcy in which case some Accounts Receivable will never be collected. Your company *average* discount rate is 12%. The hurdle rate for low, middle, and high risk projects = 6%, 12% and 18%.

Your analyst runs the IRR and finds it is 14% so tells you to accept this project since it is above the average company discount rate of 12%.

You, as owner, remind the analyst that this is a _____ risk project and the hurdle rate for this project is _____. You say _____ this project because it actually destroys value.

# Examples

(1) What is the relationship between a project's expected return and required return (discount rate) supposing the NPV of the project is negative? Assume conventional cash flows.

ANS:

(2) Consider two mutually exclusive projects: project A has an NPV = -150 and project B has

an NPV = -200, which project would you accept?

ANS:

(3) There are two mutually exclusive projects, which of the two would you accept?

| Project | Outlay | Cashflow @ t=1 | IRR | NPV @ 12% |
|---------|--------|----------------|--------|-----------|
| A | -3000 | 5000 | 66.67% | 1464.29 |
| B | -10000 | 15000 | 50.00% | 3392.86 |

ANS:

# A Simple Fixed Budget Constraint

- **Fixed Budget Constraint:** There are multiple projects with positive NPVs but you don't have enough money to invest in all of them. Consider the available projects below:

| Project | Discount Rate ($k$) | Year 0 | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | NPV | NPV Ranking | IRR | IRR Ranking |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 4.0% | ($1,000) | $200 | $250 | $280 | $300 | $320 | $191.8 | 4 | 10.1% | 5 |
| B | 4.0% | ($300) | $60 | $75 | $84 | $90 | $96 | $57.5 | 6 | 10.1% | 5 |
| C | 7.0% | ($1,000) | $0 | $0 | $0 | $0 | $2,000 | $426.0 | 1 | 14.9% | 4 |
| D | 7.0% | ($400) | $100 | $150 | $175 | $180 | $200 | $247.2 | 3 | 25.5% | 1 |
| E | 10.0% | ($1,000) | $500 | $700 | ($700) | $550 | $600 | $255.3 | 2 | 20.2% | 3 |
| F | 10.0% | ($500) | $620 | $0 | $0 | $0 | $0 | $63.6 | 5 | 24.0% | 2 |

- Suppose you only have a **budget of $2,000.**
- Determine the projects you would invest in based on NPV rule. How many projects would you invest in and what is the value created by investing in these projects?

ANS:

# Profitability Index: Can we get a higher total NPV if constrained?

○ Profitability Index: measures relative efficiency of value creation among projects

○ It helps us arrive at a useful ranking of the various projects

○ $\text{Profitability Index} = \dfrac{\text{NPV}}{\text{Investment}}$

○ Profitability index tells us the NPV per dollar of investment; In other words, PI demonstrates investment efficiency—how much value we create per dollar invested at a project

○ Rank projects A-F based on the Profitability Index:

| Project | Year 0 | NPV | NPV Ranking | PI | PI Ranking |
|---------|--------|-----|-------------|-----|------------|
| A | ($1,000) | $191.8 | 4 | | |
| B | ($300) | $57.5 | 6 | | |
| C | ($1,000) | $426.0 | 1 | | |
| D | ($400) | $247.2 | 3 | | |
| E | ($1,000) | $255.3 | 2 | | |
| F | ($500) | $63.6 | 5 | | |

# Next Determine Which Projects to Pick

Based on the table you created, what projects would you invest in using PI?

1. First pick projects C and D. Then take the budget constraint and subtract the Costs of Projects C and D to see what you have left.

2. 2000 budget - _____ - _____ = _____

3. Do you have enough left over for Project E with the PI rank of 3? _____

4. Do you have enough left over for Project A with the PI rank of 4. _____

5. Next look at project B with a PI rank of 4 like A and also consider project F with a PI of rank of 6.  (We skipped 5 since two of them tied.)

6. At this point, switch back from PI or efficiency of dollar outlay, and make sure that the PI does not conflict with the most important decision of NPV.

7. The NPV of B is _____ while the NPV of F is _____

8. So while PI helped us at the beginning when faced with a budget constraint, now we should pick project _____.

# Examples

(1) You are given two mutually exclusive projects X and Y with the same risk.  Which project would you invest in?

| Project | Outlay | Year 1 | NPV | IRR |
|---------|--------|--------|-----|-----|
| X | ($34,000) | $40,000 | $426 | 14.9% |
| Y | ($18,000) | $21,500 | $255.3 | 20.2% |

ANS:

(2) Find the profitability index for a project with the following cashflows and a discount rate of 10.5%

| Outlay | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 |
|--------|--------|--------|--------|--------|--------|
| ($2,040) | $760 | $220 | $400 | $680 | $280 |

ANS: