

Introduction to Financing

Prepared by Dr. Sara Ahmed

Lecture 4





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Net Present Value and other Investments Criteria

Lecture 4

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Topic
04

OUTLINE

- 1 Net Present Value
- 2 The Payback Rule
- 3 The Average Accounting Return
- 4 The Internal Rate of Return
- 5 The Profitability Index
- 6 The Practice of Capital Budgeting

Topic
04

Key Concepts and Skills

- Understand:
 - The payback rule and its shortcomings
 - Accounting rates of return and their problems
 - The internal rate of return and its strengths and weaknesses
 - The net present value rule and why it is the best decision criteria
 - The modified internal rate of return
 - The profitability index and its relation to NPV

Good Decision Criteria

- All cash flows considered?
- TVM considered?
- Risk-adjusted?
- Ability to rank projects?
- Indicates added value to the firm?

Net Present Value

How much value is created from undertaking an investment?

Step 1: Estimate the expected future cash flows.

Step 2: Estimate the required return for projects of this risk level.

Step 3: Find the present value of the cash flows and subtract the initial investment to arrive at the Net Present Value.

Net Present Value

Sum of the PVs of all cash flows

$$\text{NPV} = \sum_{t=0}^n \frac{\text{CF}_t}{(1+R)^t}$$

NOTE: t=0

Initial cost often is CF_0 and is an outflow.

$$\text{NPV} = \sum_{t=1}^n \frac{\text{CF}_t}{(1+R)^t} - \text{CF}_0$$

NPV – Decision Rule

- ***If NPV is positive, accept the project***
- NPV > 0 means:
 - Project is expected to add value to the firm
 - Will increase the wealth of the owners
- NPV is a direct measure of how well this project will meet the goal of increasing shareholder wealth.

Sample Project Data

- You are looking at a new project and have estimated the following cash flows, net income and book value data:
 - Year 0: CF = -165,000
 - Year 1: CF = 63,120 NI = 13,620
 - Year 2: CF = 70,800 NI = 3,300
 - Year 3: CF = 91,080 NI = 29,100
 - Average book value = \$72,000
- Your required return for assets of this risk is 12%.
- This project will be the example for all problem exhibits in this chapter.

Computing NPV for the Project

- Using the formula:
$$NPV = \sum_{t=0}^n \frac{CF_t}{(1+R)^t}$$

$$NPV = -165,000/(1.12)^0 + 63,120/(1.12)^1 + 70,800/(1.12)^2 + 91,080/(1.12)^3 = 12,627.41$$

Capital Budgeting Project

			NPV
Required Return =			12%
Year	CF	Formula	Disc CFs
0	(165,000.00)	$=(-165000)/(1.12)^0 =$	(165,000.00)
1	63,120.00	$=(63120)/(1.12)^1 =$	56,357.14
2	70,800.00	$=(70800)/(1.12)^2 =$	56,441.33
3	91,080.00	$=(91080)/(1.12)^3 =$	64,828.94
			12,627.41

Computing NPV for the Project

Using the TI BAII+ CF Worksheet

Cash Flows:

CF0 = -165000

CF1 = 63120

CF2 = 70800

CF3 = 91080

Display

You Enter

‘1

C00

165000 S!#

C01

63120 !#

F01

1 !#

C02

70800 !#

F02

1 !#

C03

91080 !#

F03

1 !#(

I

12 !#

NPV

%

12,627.41

Calculating NPVs with Excel

- NPV function: =NPV(rate,CF01:CFnn)
 - First parameter = required return entered as a decimal (5% = .05)
 - Second parameter = range of cash flows ***beginning with year 1***
- After computing NPV, subtract the initial investment (CF0)

	A	B	C	D
2			Required Return =	12%
3	Year	CF	Formula	Disc CFs
4	0	(165,000.00)	=(-165000)/(1.12)^0 =	(165,000.00)
5	1	63,120.00	=(63120)/(1.12)^1 =	56,357.14
6	2	70,800.00	=(70800)/(1.12)^2 =	56,441.33
7	3	91,080.00	=(91080)/(1.12)^3 =	64,828.94
8				12,627.41
9				
10		EXCEL	=NPV(D2,B5:B7)	177,627.41
11			NPV + CF0	12,627.41

Net Present Value

Sum of the PVs of all cash flows.

$$\text{NPV} = \sum_{t=0}^n \frac{\text{CF}_t}{(1+R)^t} \quad \ll \text{CALCULATOR}$$

$$\text{NPV} = \sum_{t=1}^n \frac{\text{CF}_t}{(1+R)^t} - \text{CF}_0 \quad \ll \text{EXCEL}$$

Rationale for the NPV Method

- $NPV = PV \text{ inflows} - \text{Cost}$

$NPV=0 \rightarrow$ Project's inflows are “exactly sufficient to repay the invested capital and provide the required rate of return”

- $NPV = \text{net gain in shareholder wealth}$
- **Rule: Accept project if $NPV > 0$**

NPV Method

- Meets all desirable criteria
 - Considers all CFs
 - Considers TVM
 - Adjusts for risk
 - Can rank mutually exclusive projects
- Directly related to increase in V_F
- Dominant method; always prevails

Payback Period

- How long does it take to recover the initial cost of a project?
- Computation
 - Estimate the cash flows
 - Subtract the future cash flows from the initial cost until initial investment is recovered
 - A “break-even” type measure
- Decision Rule – ***Accept if the payback period is less than some preset limit***

Computing Payback for the Project

Capital Budgeting Project

Year	CF	Cum. CFs
0	\$ (165,000)	\$ (165,000)
1	\$ 63,120	\$ (101,880)
2	\$ 70,800	\$ (31,080)
3	\$ 91,080	\$ 60,000



$$\text{Payback} = \text{year 2} + \frac{31,080}{91,080}$$

$$\text{Payback} = 2.34 \text{ years}$$

- *Do we accept or reject the project?*

Decision Criteria Test

Payback

- Does the payback rule:
 - Account for the time value of money?
 - Account for the risk of the cash flows?
 - Provide an indication about the increase in value?
 - Permit project ranking?
- Should we consider the payback rule for our primary decision rule?

Advantages and Disadvantages of Payback

- Advantages

- Easy to understand
- Adjusts for uncertainty of later cash flows
- Biased towards liquidity

ASKS THE WRONG QUESTION!

- 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

Average Accounting Return

- Many different definitions for average accounting return (AAR)
- In this book:
$$\text{AAR} = \frac{\text{Average Net Income}}{\text{Average Book Value}}$$
 - Note: Average book value depends on how the asset is depreciated.
- Requires a target cutoff rate
- Decision Rule: ***Accept the project if the AAR is greater than target rate.***

Computing AAR for the Project

- Sample Project Data:
 - Year 0: CF = -165,000
 - Year 1: CF = 63,120 NI = 13,620
 - Year 2: CF = 70,800 NI = 3,300
 - Year 3: CF = 91,080 NI = 29,100
 - Average book value = \$72,000
- Required average accounting return = 25%
- Average Net Income:
 - $(\$13,620 + 3,300 + 29,100) / 3 = \$15,340$
- $\text{AAR} = \$15,340 / 72,000 = .213 = 21.3\%$
- ***Do we accept or reject the project?***

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 criteria?

Advantages and Disadvantages of AAR

- Advantages

- Easy to calculate
- Needed information usually available

- Disadvantages

- Not a true rate of return
- Time value of money ignored
- Uses an arbitrary benchmark cutoff rate
- Based on accounting net income and book values, not cash flows and market values

Internal Rate of Return

- Most important alternative to NPV
- Widely used in practice
- Intuitively appealing
- Based entirely on the estimated cash flows
- Independent of interest rates

IRR

Definition and Decision Rule

- Definition:
 - **IRR = discount rate that makes the NPV = 0**
- Decision Rule:
 - ***Accept the project if the IRR is greater than the required return***

NPV vs. IRR

NPV: Enter r , solve for NPV

$$\sum_{t=0}^n \frac{CF_t}{(1 \square R)^t} \square \text{NPV}$$

IRR: Enter NPV = 0, solve for IRR.

$$\sum_{t=0}^n \frac{CF_t}{(1 \square \text{IRR})^t} \square 0$$

Computing IRR For The Project

- Without a financial calculator or Excel, this becomes a trial-and-error process
- Calculator
 - Enter the cash flows as for NPV
 - Press IRR and then CPT
 - $IRR = 16.13\% > 12\%$ required return
- ***Do we accept or reject the project?***

Computing IRR for the Project

Using the TI BAII+ CF Worksheet

Cash Flows:

CF0 = -165000

CF1 = 63120

CF2 = 70800

CF3 = 91080

Display

You Enter

“

C00

165000 S!#

C01

63120 !#

F01

1 !#

C02

70800 !#

F02

1 !#

C03

91080 !#

F03

1 !#)

IRR

%

16.1322

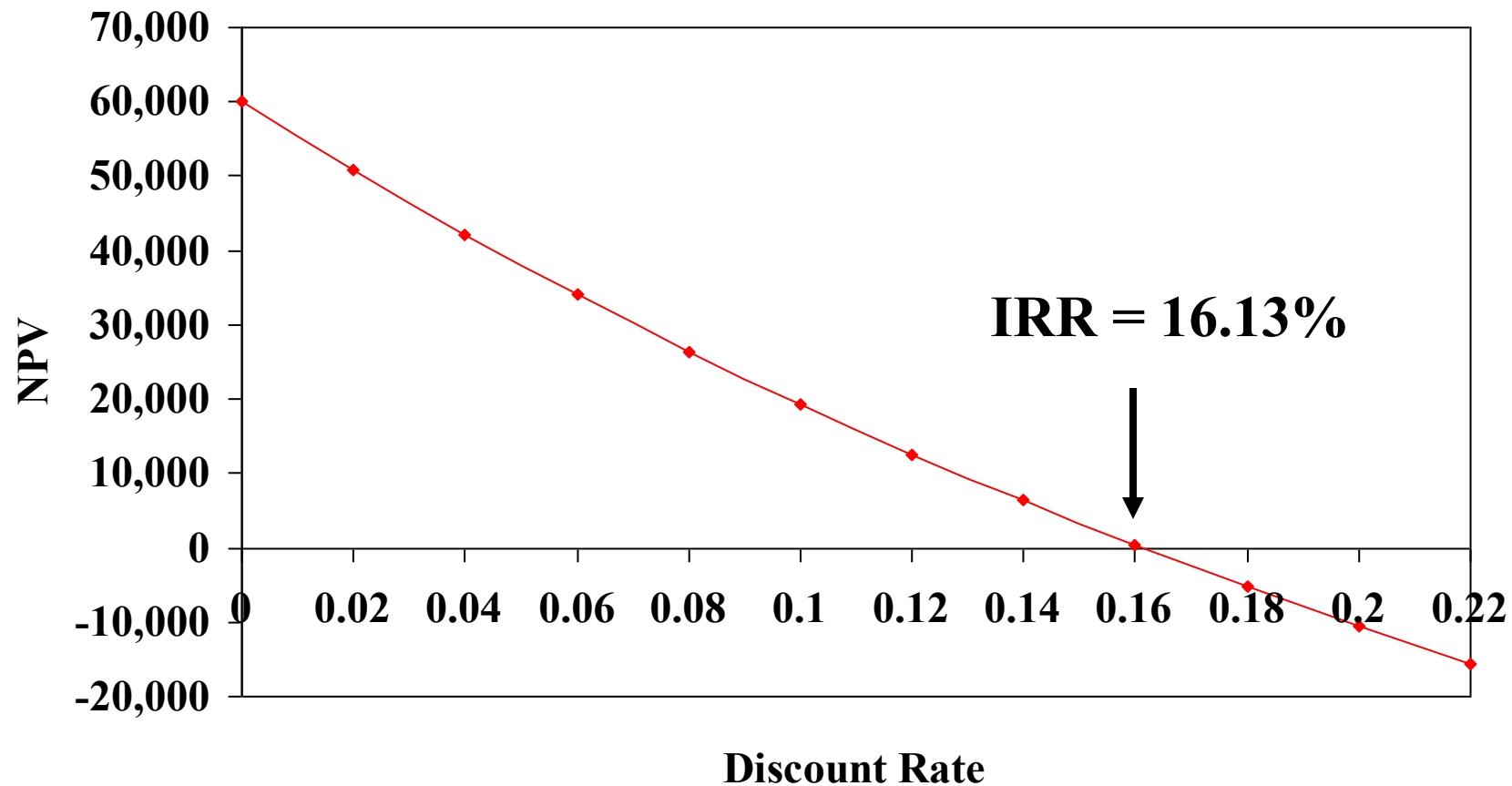
Calculating IRR with Excel

- Start with the cash flows as you did to solve for NPV
- Use the IRR function
 - Enter the range of cash flows, beginning with the initial cash flow (Cash flow 0)
 - You can enter a guess, but it is not necessary
 - The default format is a whole percent

Calculating IRR with Excel

	A	B	C
1	IRR		
2	Year	CF	
3	0	(165,000.00)	
4	1	63,120.00	
5	2	70,800.00	
6	3	91,080.00	
7			
8	EXCEL	=IRR(B3:B6)	16.13%

NPV Profile For The Project



Decision Criteria Test

IRR

- Does the IRR rule:
 - Account for the time value of money?
 - Account for the risk of the cash flows?
 - Provide an indication about the increase in value?
 - Permit project ranking?
- Should we consider the IRR rule for our primary decision criteria?

IRR - Advantages

- Preferred by executives
 - Intuitively appealing
 - Easy to communicate the value of a project
- If the IRR is high enough, may not need to estimate a required return
- Considers all cash flows
- Considers time value of money
- Provides indication of risk

IRR - Disadvantages

- Can produce multiple answers
- Cannot rank mutually exclusive projects
- Reinvestment assumption flawed

Summary of Decisions for the Project

Summary	
Net Present Value	<i>Accept</i>
Payback Period	<i>???</i>
Average Accounting Return	<i>???</i>
Internal Rate of Return	<i>Accept</i>

NPV vs. IRR

- NPV and IRR will generally give the same decision
- Exceptions
 - **Non-conventional cash flows**
 - Cash flow sign changes more than once
 - **Mutually exclusive projects**
 - Initial investments are substantially different
 - Timing of cash flows is substantially different
 - Will not reliably rank projects

IRR & Non-Conventional Cash Flows

- “Non-conventional”
 - Cash flows change sign more than once
 - Most common:
 - Initial cost (negative CF)
 - A stream of positive CFs
 - Negative cash flow to close project.
 - For example, nuclear power plant or strip mine.
 - More than one IRR
 - Which one do you use to make your decision?

Multiple IRRs

- Descartes Rule of Signs

$$\sum_{t=0}^n \frac{CF_t}{(1 - IRR)^t} = 0$$

- Polynomial of degree $n \rightarrow n$ roots
 - When you solve for IRR you are solving for the root of an equation
 - 1 real root per sign change
 - Rest = imaginary ($i^2 = -1$)

Non-Conventional Cash Flows

- Suppose an investment will cost \$90,000 initially and will generate the following cash flows:
 - Year 1: 132,000
 - Year 2: 100,000
 - Year 3: -150,000
- The required return is 15%.
- Should we accept or reject the project?

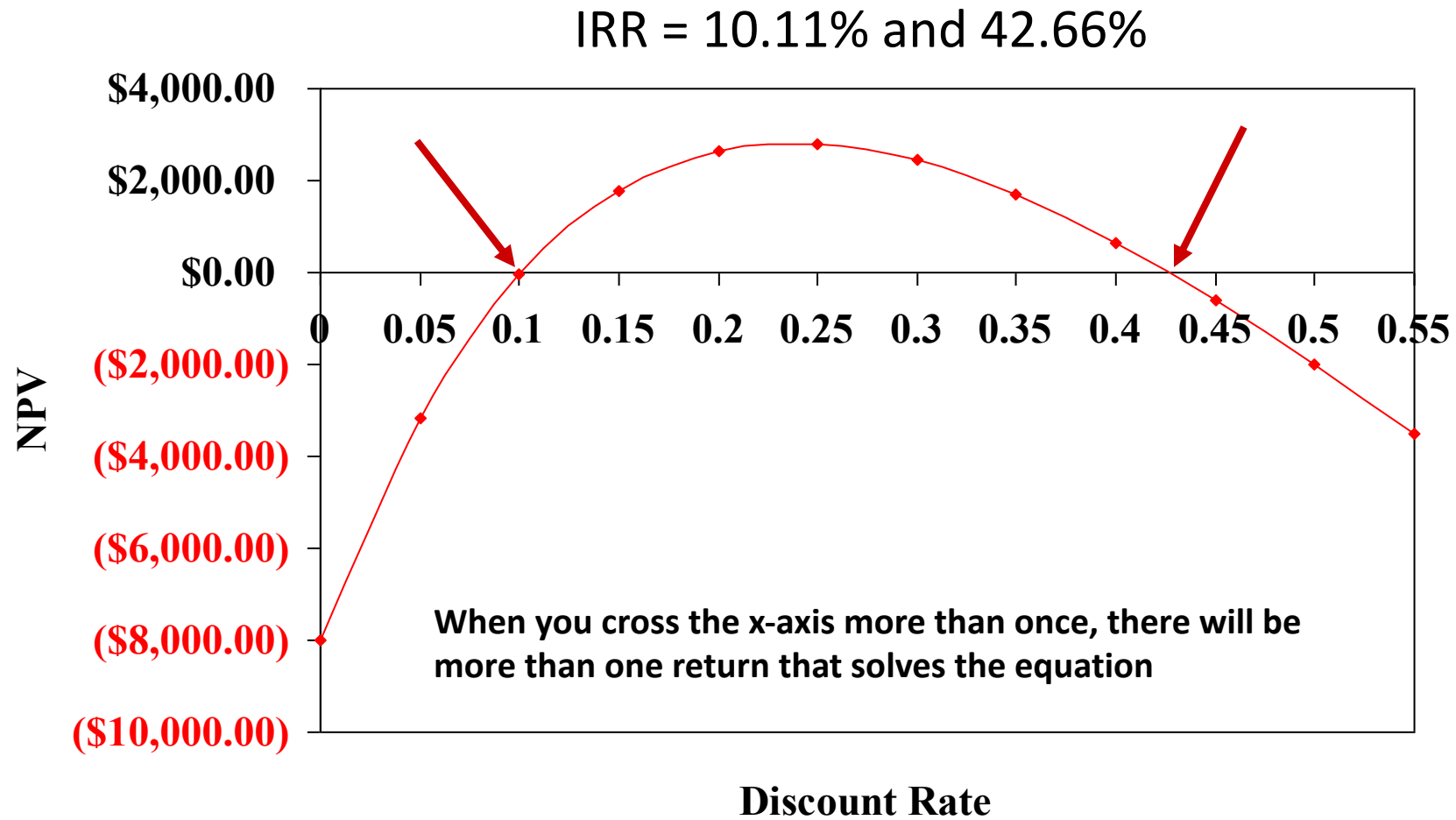
Non-Conventional Cash Flows

Summary of Decision Rules

- NPV > 0 at 15% required return, so you should **Accept**
- IRR = 10.11% (using a financial calculator), which would tell you to **Reject**
- Recognize the non-conventional cash flows and look at the NPV profile

I =	15%	
YR	CF	
0	-\$90,000	
1	\$132,000	
2	\$100,000	
3	-\$150,000	
NPV	\$1,769.54	> 0
IRR-1	10.11%	< 15%
IRR-2	42.66%	> 15%

NPV Profile



Independent versus Mutually Exclusive Projects

- Independent
 - The cash flows of one project are unaffected by the acceptance of the other.
- Mutually Exclusive
 - The acceptance of one project precludes accepting the other.

Reinvestment Rate Assumption

- IRR assumes reinvestment at IRR
- NPV assumes reinvestment at the firm's weighted average cost of capital (opportunity cost of capital)
 - More realistic
 - NPV method is best
- NPV should be used to choose between mutually exclusive projects

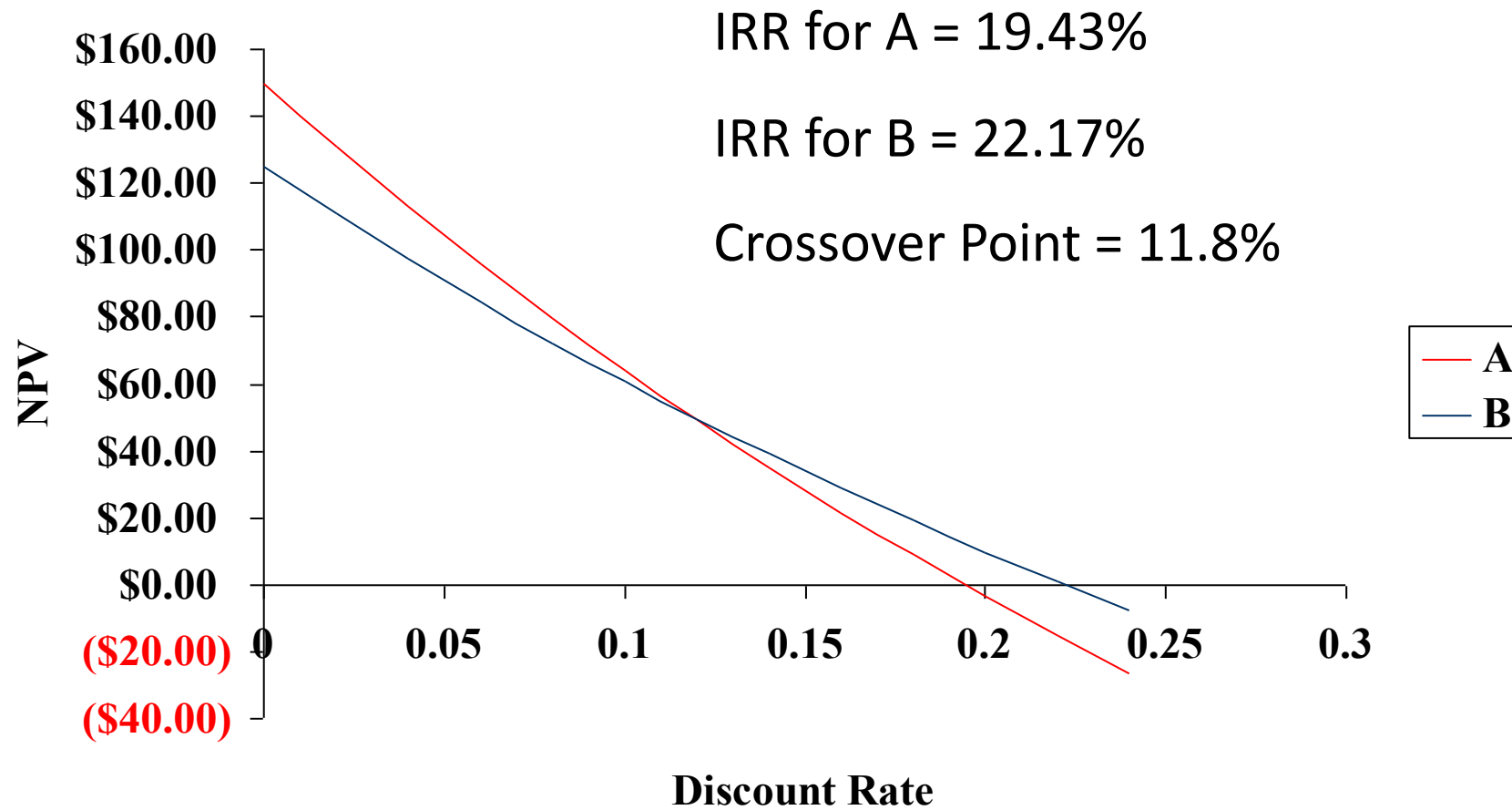
Example of Mutually Exclusive Projects

Period	Project A	Project B
0	-500	-400
1	325	325
2	325	200
IRR	19.43%	22.17%
NPV	64.05	60.74

The required return for both projects is 10%.

Which project should you accept and why?

NPV Profiles



Two Reasons NPV Profiles Cross

- Size (scale) differences.
 - Smaller project frees up funds sooner for investment.
 - The higher the opportunity cost, the more valuable these funds, so high discount rate favors small projects.
- Timing differences.
 - Project with faster payback provides more CF in early years for reinvestment.
 - If discount rate is high, early CF especially good

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, ***always*** use NPV
- IRR is unreliable in the following situations:
 - Non-conventional cash flows
 - Mutually exclusive projects

Modified Internal Rate of Return (MIRR)

- Controls for some problems with IRR
- Three Methods:
 1. Discounting Approach = Discount future outflows to present and add to CF_0
 2. Reinvestment Approach = Compound all CFs except the first one forward to end
 3. Combination Approach – Discount outflows to present; compound inflows to end
- MIRR will be unique number for each method
- Discount (finance) /compound (reinvestment) rate externally supplied

MIRR Method 1

Discounting Approach

Step 1: Discount future outflows (negative cash flows) to present and add to CF0

Step 2: Zero out negative cash flows which have been added to CF0.

Step 3: Compute IRR normally

Method 1: Discounting Approach			
R =	20%		
Yr	CF	ADJ	MCF
0	-60	-69.444	-129.44444
1	155		155
2	-100		0
		IRR=	19.74%

MIRR Method 2

Reinvestment Approach

Step 1: Compound ALL cash flows (except CF0) to end of project's life

Step 2: Zero out all cash flows which have been added to the last year of the project's life.

Step 3: Compute IRR normally

Method 2: Reinvestment Approach

R =	20%		
Yr	CF	ADJ	MCF
0	-60		-60
1	155		0
2	-100	186	86
		IRR=	19.72%

MIRR Method 3

Combination Approach

Step 1: Discount all outflows (except CF0) to present and add to CF0.

Step 2: Compound all cash inflows to end of project's life

Step 3: Compute IRR normally

Method 3: Combination Approach			
R =	20%		
Yr	CF	ADJ	MCF
0	-60	-69.444	-129.44444
1	155		0
2	-100	186	186
		IRR=	19.87%

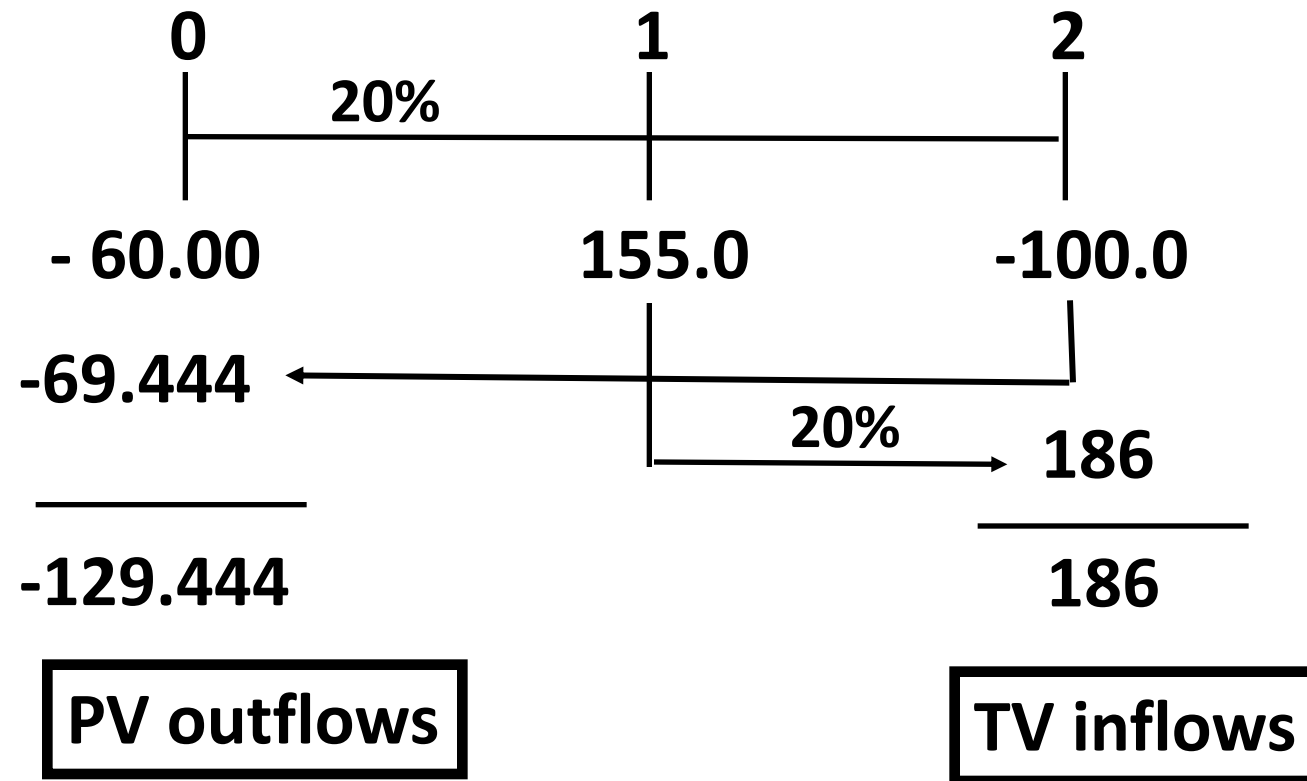
MIRR in Excel

- Excel = Method 3
- MIRR = discount rate which causes the PV of a project's terminal value (TV) to equal the PV of costs (outflows)
- ➡ MIRR assumes CFs reinvested at WACC
- Function: =MIRR(Range, FR, RR)
 - FR = Finance rate (discount)
 - RR = Reinvestment rate (compound)

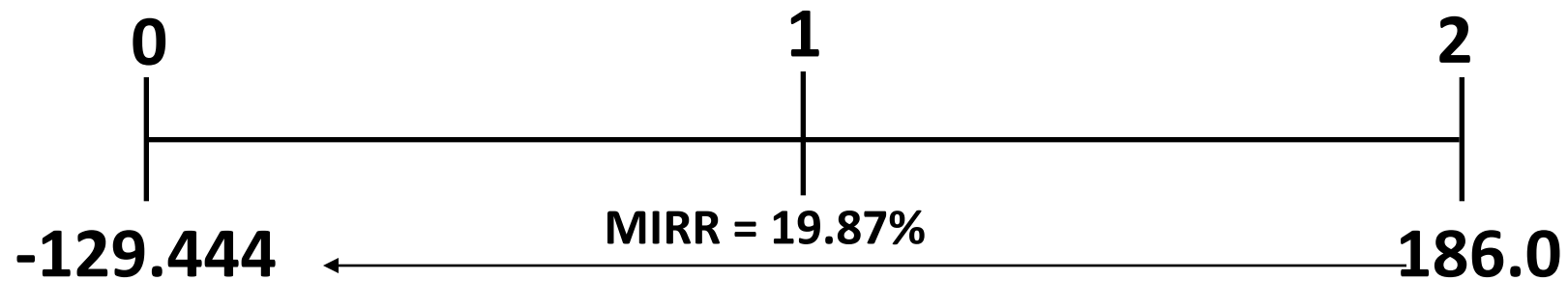
MIRR

First, find PV and TV

(FR = RR = 20%)



Second: Find discount rate that equates PV and TV



PV outflows

TV inflows

$$\$129.444 = \frac{\$186.0}{(1+\text{MIRR})^2}$$

MIRR = 19.87%

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Second: Find discount rate that equates PV and TV

- Formula:

$$R = (186 / 129.444)^{1/2} - 1 = .1987 = 19.87\%$$

- Calculator – the sign convention matters!!!

2
129.444 ,
0 S.
 /
186 0
% - = 19.87%

- Excel: =RATE(2,0,-129.444,186) = 0.1987
=MIRR(Range, FR, RR) 19.87%

MIRR versus IRR

- MIRR correctly assumes reinvestment at opportunity cost = WACC
- MIRR avoids the multiple IRR problem
- Managers like rate of return comparisons, and MIRR is better for this than IRR

Profitability Index

- Measures the benefit per unit cost, based on the time value of money
 - A profitability index of 1.1 implies that for every \$1 of investment, we create an additional \$0.10 in value
- Can be very useful in situations of capital rationing
- ***Decision Rule: If $PI > 1.0 \rightarrow \text{Accept}$***

Profitability Index

- For conventional CF Projects:

$$PI = \frac{\sum_{t=1}^n \frac{CF_t}{(1+r)^t}}{|CF_0|}$$

PV(Cash Inflows)

Absolute Value of Initial Investment

Advantages and Disadvantages of Profitability Index

- Advantages

- Closely related to NPV, generally leading to identical decisions
 - Considers all CFs
 - Considers TVM
- Easy to understand and communicate
- Useful in capital rationing

- Disadvantages

- May lead to incorrect decisions in comparisons of mutually exclusive investments (can conflict with NPV)

Profitability Index

Example of Conflict with NPV

	A	B
CF(0)	(10,000.00)	(100,000.00)
PV(CIF)	15,000.00	125,000.00
PI	1.50	1.25
NPV	5,000.00	25,000.00

Capital Budgeting In Practice

- Consider all investment criteria when making decisions
- NPV and IRR are the most commonly used primary investment criteria
- Payback is a commonly used secondary investment criteria
- All provide valuable information

Summary

Calculate ALL -- each has value

<u>Method</u>	<u>What it measures Metric</u>
NPV	→ \$ increase in VF \$\$
Payback	→ Liquidity Years
AAR	→ Acct return (ROA) %
IRR	→ E(R), risk %
PI	→ If rationed Ratio

NPV Summary

Net present value =

- Difference between market value (PV of inflows) and cost
- Accept if $NPV > 0$
- No serious flaws
- Preferred decision criterion

IRR Summary

Internal rate of return =

- Discount rate that makes $NPV = 0$
- Accept if $IRR > \text{required return}$
- Same decision as NPV with conventional cash flows
- Unreliable with:
 - Non-conventional cash flows
 - Mutually exclusive projects
- MIRR = better alternative

Payback Summary

Payback period =

- Length of time until initial investment is recovered
- Accept if payback < some specified target
- Doesn't account for time value of money
- Ignores cash flows after payback
- Arbitrary cutoff period
- Asks the wrong question

AAR Summary

Average Accounting Return=

- Average net income/Average book value
- Accept if AAR > Some specified target
- Needed data usually readily available
- Not a true rate of return
- Time value of money ignored
- Arbitrary benchmark
- Based on accounting data not cash flows

Profitability Index Summary

Profitability Index =

- Benefit-cost ratio
- Accept investment if $PI > 1$
- Cannot be used to rank mutually exclusive projects
- May be used to rank projects in the presence of capital rationing

Quick Quiz

- Consider an investment that costs \$100,000 and has a cash inflow of \$25,000 every year for 5 years. The required return is 9% and required payback is 4 years.
 - What is the payback period?
 - What is the NPV?
 - What is the IRR?
 - Should we accept the project?
- What decision rule should be the primary decision method?
- When is the IRR rule unreliable?

Quick Quiz Solution

Quick Quiz

Chapter 8

r =
Req. PB =

9%
4 yrs

t	CF	Cumulative CFs	DCF	Cumulative DCFs
0	(100,000.00)	(100,000.00)	(100,000.00)	(100,000.00)
1	25,000.00	(75,000.00)	22,935.78	(77,064.22)
2	25,000.00	(50,000.00)	21,042.00	(56,022.22)
3	25,000.00	(25,000.00)	19,304.59	(36,717.63)
4	25,000.00	0.00	17,710.63	(19,007.00)
5	25,000.00	25,000.00	16,248.28	(2,758.72)
			(2,758.72)	

Payback =

4 years

NPV = (\$2,758.72) =NPV(E3,C9:C13)+C8
IRR = 7.93% =IRR(C8:C13)



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Thank You

