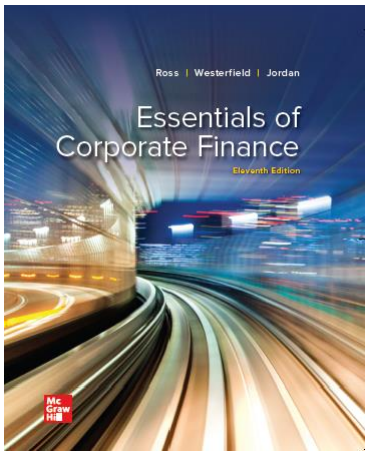
Because learning changes everything.®

Chapter 08

Net Present Value and Other Investment Criteria



Key Concepts and Skills

After studying this chapter, you should be able to:

- Summarize the payback rule and some of its shortcomings.
- Discuss accounting rates of return and their problems.
- Explain the internal rate of return criterion and its strengths and weaknesses.
- Evaluate proposed investments by using the net present value criterion.
- Apply the modified internal rate of return.
- Calculate the profitability index and understand its relation to net present value.

Chapter Outline

8.1 Net Present Value.

8.2 The Payback Rule.

8.3 The Average Accounting Return.

8.4 The Internal Rate of Return.

8.5 The Profitability Index.

8.6 The Practice of Capital Budgeting.

Capital Budgeting

Analysis of potential projects.

Long-term decisions.

Large expenditures.

Difficult/impossible to reverse.

Determines firm's strategic direction.

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 [1]

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

NOTE: $t = 0$

Initial cost often is CF_0 and is an outflow.

$$\text{NPV} = \sum_{t=1}^{n} \frac{CF_t}{(1+R)^t} - CF_0$$

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 percent.

This project will be the example for all problem exhibits in this chapter.

Computing NPV for the Project

Using the formula:

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

$$\text{NPV} = -\$165,000/1.12^0 + \$63,120/1.12^1 + \$70,800/1.12^2 + \$91,080/1.12^3 = \$12,627.41$$

Capital Budgeting Project

			NPV
		Required Return =	12%
Year	CF	Formula	Disc CFs
0	−$165,000.00	= −165,000/1.12^0 =	−$165,000.00
1	$63,120.00	= 63,120/1.12^1 =	$56,357.14
2	$70,800.00	= 70,800/1.12^2 =	$56,441.33
3	$91,080.00	= 91,080/1.12^3 =	$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***	
	CF, 2nd,CLR WORK	
C00	−165000	*Enter, Down*
C01	63120	*Enter, Down*
F01	*1*	*Enter, Down*
C02	70800	*Enter, Down*
F02	*1*	*Enter, Down*
C03	91080	*Enter, Down*
F03	*1*	*Enter, NPV*
I	*12*	*Enter, Down*
NPV	*CPT*	
$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	= $-165{,}000/1.12^0$ =	−165,000.00
5	1	63,120.00	= $63{,}120/1.12^1$ =	56,357.14
6	2	70,800.00	= $70{,}800/1.12^2$ =	56,441.33
7	3	91,080.00	= $91{,}080/1.12^3$ =	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 [2]

$$\text{NPV} = \sum_{t=0}^{n} \frac{CF_t}{(1+R)^t}$$ **<< CALCULATOR**

$$\text{NPV} = \sum_{t=0}^{n} \frac{CF_t}{(1+R)^t} - CF_0$$ **<< EXCEL**

Rationale for the NPV Method

NPV = PV inflows − Cost.

NPV = 0 → Project's inflows are "exactly sufficient to repay the invested capital and provide the required rate of return."

NPV = 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

$$\text{Payback} = \text{Year } 2 + (\$31{,}080/\$91{,}080).$$

Payback = 2.34 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: $\text{AAR} = \dfrac{\text{Average Net Income}}{\text{Average Book Value}}$

- 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 the 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:

- $(\$13{,}620 + 3{,}300 + 29{,}100) / 3 = \$15{,}340.$

$$\text{AAR} = \$15{,}340 / \$72{,}000 = .2131, \text{ or } 21.31\%.$$

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 versus IRR [1]

NPV: Enter *r*, solve for NPV

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

IRR: Enter NPV = 0, solve for IRR.

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

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***	
	CF, 2nd,CLR WORK	
C00	165000	*Enter, Down*
C01	63120	*Enter, Down*
F01	*1*	*Enter, Down*
C02	70800	*Enter, Down*
F02	*1*	*Enter, Down*
C03	91080	*Enter, Down*
F03	*1*	*Enter, IRR*
IRR	*CPT*	
16.13%		

Calculating IRR with Excel 1

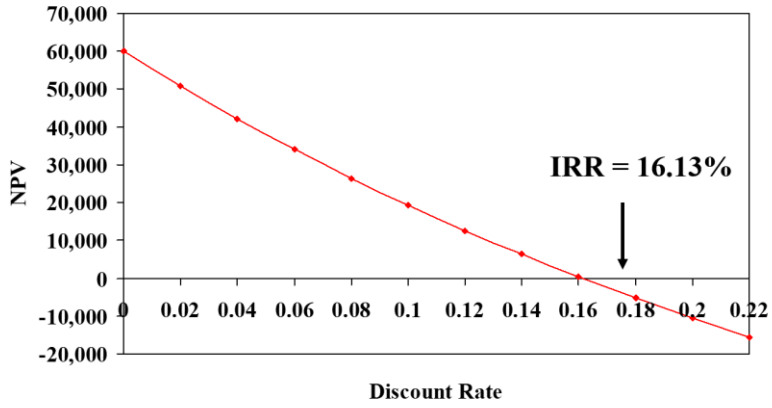
Start with the cash flows as you did to solve for NPV.

- 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 2

	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



Access the text alternative for slide images.

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	***Accept***
Payback Period	***???***
Average Accounting Return	***???***
Internal Rate of Return	***Accept***

NPV versus IRR 2

NPV and IRR will generally give the same decision.

Exceptions.

Nonconventional 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 & Nonconventional Cash Flows

Nonconventional".

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.

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

Polynomial of degree n→n roots.

- When you solve for IRR, you are solving for the root of an equation.
- One real root per sign change; rest are imaginary $(i^2 = -1)$.

Nonconventional 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 percent.

Should we accept or reject the project?

Nonconventional Cash Flows Summary of Decision Rules

NPV > 0 at 15 percent required return, so you should ***accept.***

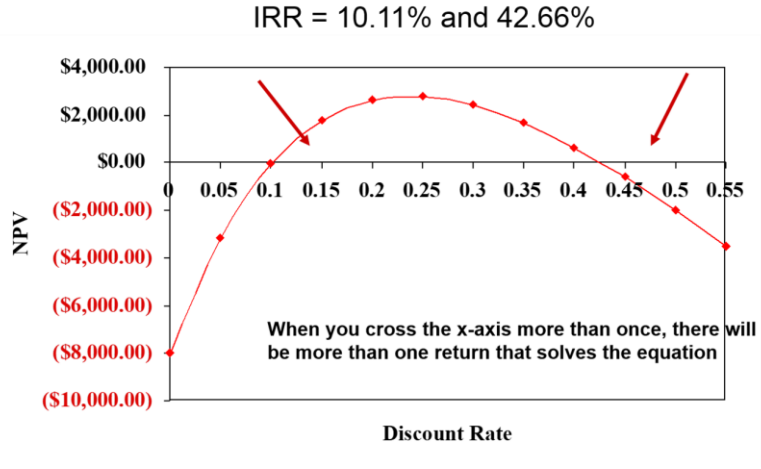
IRR = 10.11 percent (using a financial calculator), which would tell you to ***reject.***

Recognize the nonconventional 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 [1]



Access the text alternative for slide images.

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.

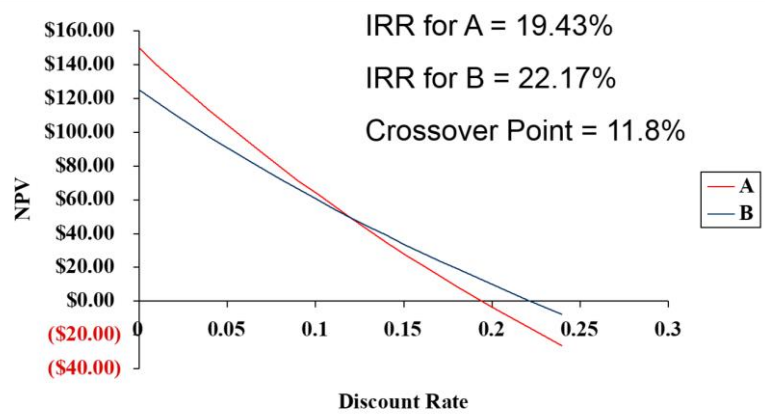
Example of Mutually Exclusive Projects

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 percent.

Which project should you accept and why?

NPV Profile 2



Access the text alternative for slide images.

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:

- Nonconventional 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 CF_0.

Step 2: Zero out negative cash flows which have been added to CF_0.

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 CF_0) 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 CF_0) to present and add to CF_0.

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

Step 3: Compute IRR normally.

Method 3: Combination Approach

R =	20%		
Yr	CF	ADJ	MCF
0	−60	−69.444	−12.44444
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).

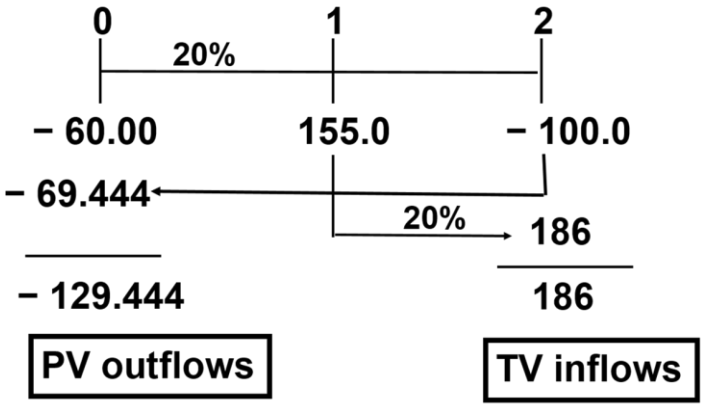
➡MIRR assumes CFs reinvested at WACC.

Function: =MIRR(Range,FR,RR).

FR = Finance rate (discount).

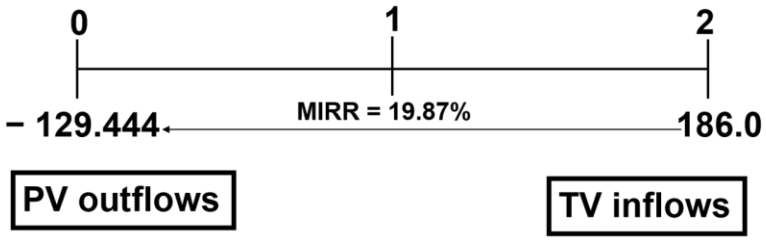
RR = Reinvestment rate (compound).

MIRR First: Find PV and TV (FR = RR = 20%)



Access the text alternative for slide images.

Second: Find discount rate that equates PV and TV [1]



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

$$\text{MIRR} = 19.87\%$$

Second: Find discount rate that equates PV and TV 2

Formula:

$$R = \left(\$186 / \$129.444\right)^{1/2} - 1 = .1987, \text{ or } 19.87\%.$$

Calculator – the sign convention matters!!!

2	N
−129.444	PV
0	PMT
186 FV	
CPT I/Y	=19.87%

Excel: =RATE(2,0,−129.444,186) = .1987.

=MIRR(Range, FR, RR) = .1987, or 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 1

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 $.10 in value.

Can be very useful in situations of capital rationing.

Decision Rule: If PI > 1.0 → Accept.

Profitability Index 2

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
CF0	−10,000	−100,000
PV(CIF)	15,000	125,000
PI	1.50	1.25
NPV	5,000	25,000

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.

Method	What it measures	Metric
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 > required return.

Same decision as NPV with conventional cash flows.

Unreliable with:

- Non-conventional cash flows.
- Mutually exclusive projects.

MIRR is a better alternative.

Payback Summary

Payback period =

- Length of time until initial investment is recovered.
- Accept if payback < some specified target.
- Does not 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 percent 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

***r* =**	**9%**
Required payback =	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	

Pay back =	4 years	
NPV =	−$2,758.72	= NPV(E3,C9:C13)+C8
IRR =	7.93%	= IRR(C8:C13)

Because learning changes everything.®

www.mheducation.com

Accessibility Content: Text Alternatives for Images

NPV Profile for the Project −Text Alternative

Return to parent-slide containing images.

The horizontal axis displays the discount rate and is scaled from 0 to 0.22. The vertical axis displays the net present value and is scaled from negative 20,000 to 70,000. The function is decreasing and is nearly perfectly linear. At a discount rate of 0, the net present value is 60,000. The internal rate of return of 16.13%, which is where the function crosses the horizontal axis.

Return to parent-slide containing images.

NPV Profile 1 − Text Alternative

Return to parent-slide containing images.

The horizontal axis displays the discount rate and is scaled from 0 to 0.55. The vertical axis displays the net present value and is scaled from negative 10,000 to 4,000. The function is nonlinear, increasing to a peak NPV at a discount rate of about 0.25, then decreasing again. The function crosses the horizontal axis at 10.11% and 42.66%.

Return to parent-slide containing images.

NPV Profile 2 − Text Alternative

Return to parent-slide containing images.

The horizontal axis is scaled from 0 to 0.3 and the vertical axis is scaled from negative 40 to $160. Both functions are nonlinear and decreasing. Project A begins with a greater NPV, but ends with a lesser NPV. The crossover point is 11.8%.

Return to parent-slide containing images.

MIRR First: Find PV and TV (FR = RR = 20%) − Text Alternative

Return to parent-slide containing images.

The cash flows are negative 60, 155, and negative 100, for time 0, 1, and 2 respectively. The PV outflows is negative 129.444 and the TV inflows is 186.

Return to parent-slide containing images.