FINC311: Principles of Finance

Chapter 8

Net Present Value and Other Investment Criteria

Chapter Objectives

- Overview of capital budgeting
- Learn various investment criteria
  - Net present value
  - Payback rule
  - Profitability index
  - Internal rate of return
- Understand the benefits and shortcomings of these criteria

Overview of Capital Budgeting

Capital Budgeting Defined

- Capital budgeting is the process by which a business evaluates whether potential projects are worth funding with available capital
  - Large expenditures
  - Long-term decisions
  - Difficult/impossible to reverse

Capital Budgeting Examples

Capital Budget Examples

- Purchase a fixed asset
- Launch a new product
- Enter a new market
- Acquire a company

These decisions determine the strategic direction of the firm

The capital budgeting question is one of the most important issue in corporate finance

Question

Joe buys a run-down house for $25,000 and spends another $25,000 to fix it up and then sells it for $60,000. Was this a good investment?

A. Yes

B. No

C. Maybe

Joe's House Project

- Was this a good investment?
- How do we know?

	Q1	Q2	Q3	Q4
2016	Joe spends $25k to buy a rundown house		Joe pays $25k to workers to fix up the house	Joe sells house for $60k
2017				
2018				

Joe's House Project

- Was this a good investment?
- How do we know?

	Q1	Q2	Q3	Q4
2016	Joe spends $25k to buy a rundown house		Joe pays $25k to workers to fix up the house	
2017				
2018		Joe sells house for $60k		

Corporate Finance Overview

- The role of the financial manager is to answer these questions:

Financial Decision Making

What investments do you make?

- Simple rule: Invest if benefits > cost
- Sounds easy…but it is difficult to measure benefits and costs
- Benefits have more uncertainty than costs

Evaluation Methods

- We will learn the following four methods for evaluating investments

Net Present Value (NPV)

Payback Rule

Profitability Index

Internal Rate of Return (IRR)

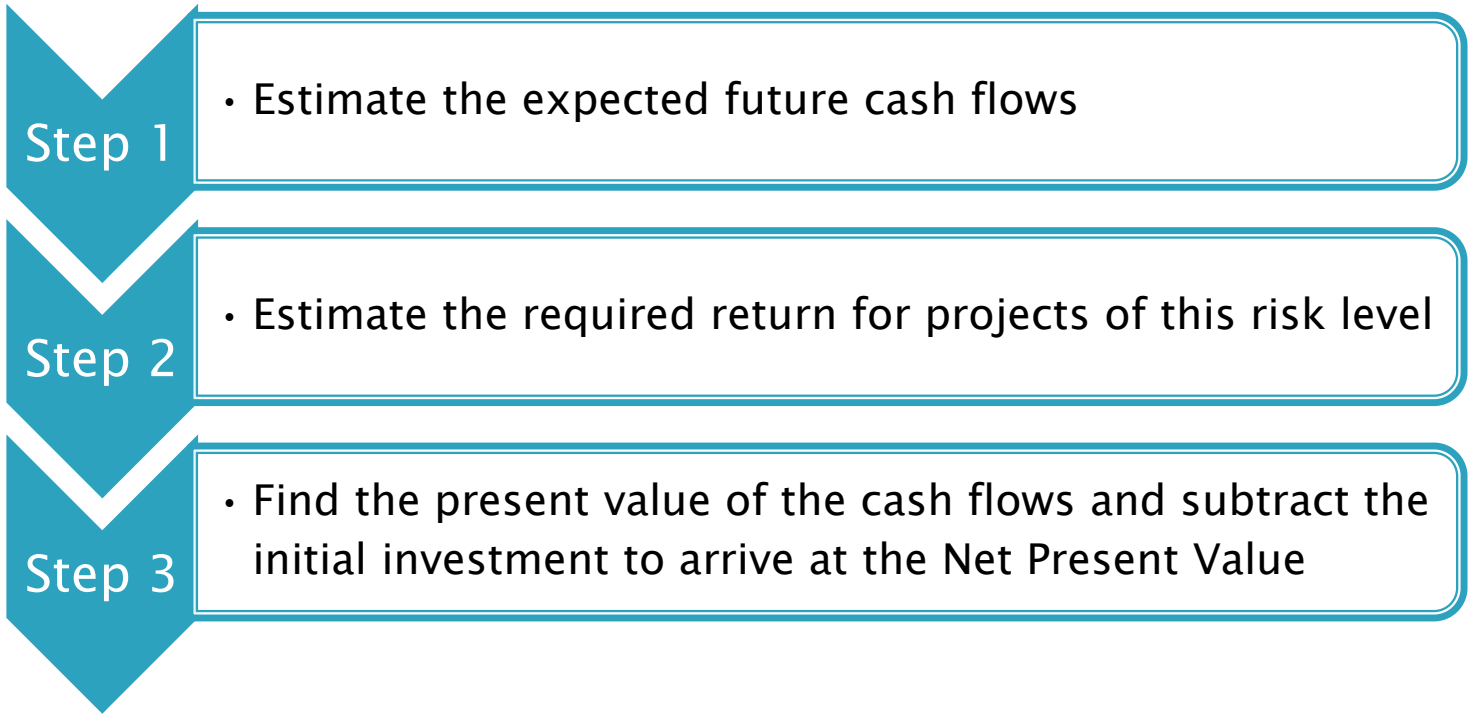
Good Decision Criteria

- Each evaluation method will be assessed against the following decision criteria
  - Are all cash flows considered?
  - Is time value of money considered?
  - Does the criteria adjust for risk?
  - Can project be ranked?
  - Does the project add value to the firm?

Net Present Value (NPV)

Net Present Value

- How much value is created from undertaking an investment?



Net Present Value (NPV)

- NPV is the difference between the present value of cash inflows and the present value of cash outflows

Net Present Value of an Investment

NPV = PV of future cash flows – Initial cost of investment

~ or ~

NPV = – Cost + PV

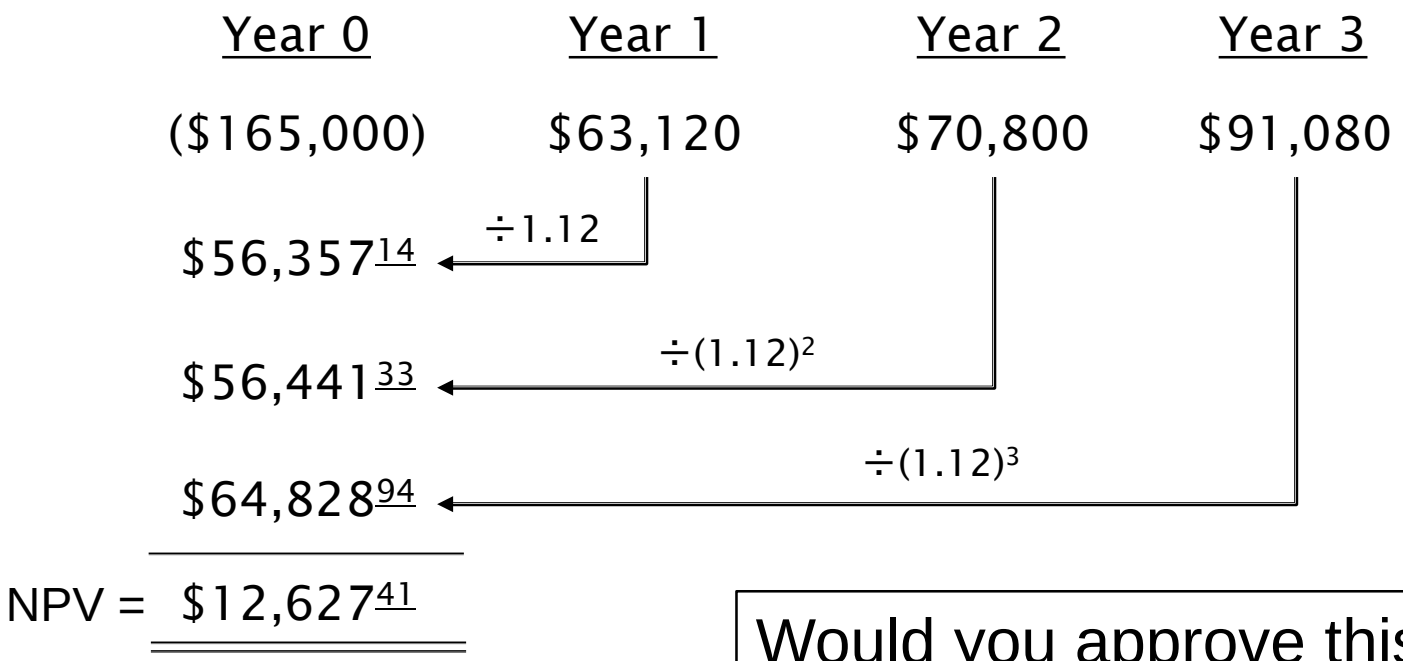
Sample Project Data

- You are looking at a new project and have estimated the following cash flows:

Initial Investment	($165,000)
Cash flow in year 1	$63,120
Cash flow in year 2	$70,800
Cash flow in year 3	$91,080

- Your required return for investments of this risk is 12%.

Computing NPV for the Project



Would you approve this project?

A. Yes
B. No
C. More information is needed

Economics from Investor's Perspective

Let's look at this investment from the perspective of the investor and the cash flows that accrue to the investor.

	Year 1	Year 2	Year 3
Balance, Beginning of Year	($165,000)	($121,680)	($65,482)
Required Return (12%)	(19,800)	(14,602)	(7,858)
Cash Flow from Project	63,120	70,800	91,080
Balance, End of Year	($121,680)	($65,482)	$17,741

The investor has 1) recovered their investment principal; 2) earned the required 12% return; and 3) has $17,741 extra cash at the end of year 3.

Reconciling Investor's Perspective and NPV

- How does the $17,741 in the "investor's account" relate to the NPV of $12,627?

Project NPV

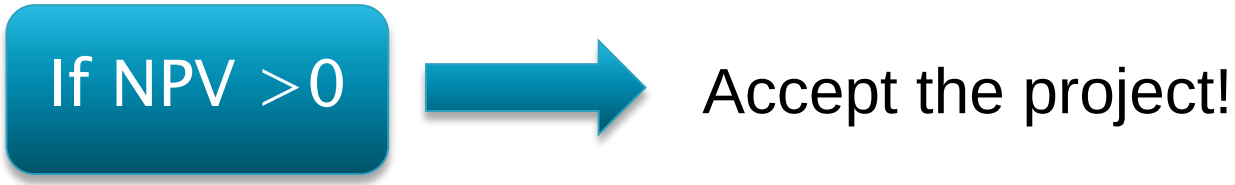
Year 0	Year 1	Year 2	Year 3
($165,000)	$63,120	$70,800	$91,080
$56,357.14	÷ 1.12		
$56,441.33		÷ (1.12)²	
$64,828.94			÷ (1.12)³
NPV = $12,627.41			

Investor's Account

	Year 1	Year 2	Year 3
Balance, Beginning of Year	($165,000)	($121,680)	($65,482)
Required Return	(19,800)	(14,602)	(7,858)
Cash Flow from Project	63,120	70,800	91,080
Balance, End of Year	($121,680)	($65,482)	$17,741

$17,741 ÷(1.12)³ = $12,627

NPV – Decision Rule



- 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.

Rationale for the NPV Method

- NPV = PV inflows – Cost
- What does it mean if the NPV = 0?
  - Project's inflows are exactly sufficient to repay the invested capital and provide the required rate of return
  - The required rate of return takes into account the risk level of the project
- Thus, anytime the NPV > 0, there is a net gain in shareholder wealth
- Rule: Accept project if NPV > 0

Decision Criteria Test – NPV

- Each evaluation method will be assessed against the following decision criteria
  - Are all cash flows considered? → *Yes*
  - Is time value of money considered? → *Yes*
  - Does the criteria adjust for risk? → *Yes*
  - Can project be ranked? → *Yes*
  - Does project add value to the firm? → *Yes*

NPV is the dominant method → Always prevails!

Question

Which one of the following will decrease the net present value of a project?

A. Increasing the value of each of the project's discounted cash inflows.

B. Moving each of the cash inflows forward to a sooner time period.

C. Decreasing the required discount rate.

D. Increasing the project's initial cost at time zero.

E. Increasing the amount of the final cash inflow.

Question

A project has a net present value of zero. Which one of the following best describes this project?

A. The project has a zero percent rate of return.

B. The project requires no initial cash investment.

C. The project has no cash flows.

D. The summation of all of the project's cash flows is zero

E. The project's cash inflows equal its cash outflows in current dollar terms.

Questions to Answer

- How do you calculate NPV?
- What is the NPV rule when it comes to accepting an investment project?
- What factors go into determining the discount rate to use in calculating the NPV?

Payback Rule

Payback Period

- The payback period is the amount of time required for an investment to generate cash flows sufficient to recover its initial cost.

Payback Period

- How long does it take to recover the initial cost of a project?

Step 1	Estimate the initial cost of the investment plus the future cash flows
Step 2	Subtract the future cash flows from the initial investment for as many months (or years) as required to recover the initial investment

A “breakeven” type measure

Payback Period – Simple Example

- What is the payback period for this investment of $50,000?

Year 0	Year 1	Year 2	Year 3	Year 4
-$50,000	$30,000	$20,000	$10,000	$5,000

- $50,000 of cash flows in first 2 years
- This equals the amount of the initial investment at year 0
- Thus, the payback period is 2 years

Payback Period – Simple Example

- This project shows a payback period of 2 years.
- Is this good or bad?
- Do you accept or reject the project?

A decision rule is needed

Payback Period – Decision Rule

- A preset time limit needs to be established that sets the time period by which the investment in a project needs to be "paid back"
  - This would be set by senior management
- You would accept the project if the payback period is less than this preset time limit

Payback Period – Decision Rule

If:

Payback Period < Predetermined Time Limit

Then:

Accept the project

Sample Project Data

- You are looking at a new project and have estimated the following cash flows:

Initial Investment	($165,000)
Cash flow in year 1	$63,120
Cash flow in year 2	$70,800
Cash flow in year 3	$91,080

- Do you accept or reject this project?

Computing Payback Period

- We need to calculate how many years it takes to exactly recover the initial investment

	Year 0	Year 1	Year 2	Year 3
Annual Cash Flows	($165,000)	$63,120	$70,800	$91,080
Cumulative Cash Flows	($165,000)	($101,980)	($31,080)	$60,000

- The payback period is between 2 and 3 years
- You need $31,080 of the $91,080 total cash flow in Year 3 to find the exact breakeven
  - This is $31,080/$91,080 or .34 of Year 3 cash flow
- The payback period is 2 years plus .34 of Year 3 (**2.34 years**)

Decision Criteria Test – Payback Period

- Each evaluation method will be assessed against the following decision criteria
  - Are all cash flows considered? → *No*
  - Is time value of money considered? → *No*
  - Does the criteria adjust for risk? → *No*
  - Can project be ranked? → *No*
  - Does project add value to the firm? → *Don't Know*

Payback period should not be the primary decision criteria

Question

A project has a required payback period of three years. Which one of the following statements is correct concerning the payback analysis of this project?

A. The cash flows in each of the three years must exceed one-third of the project's initial cost if the project is to be accepted.

B. The cash flow in year three is ignored.

C. The project's cash flow in year three is discounted by a factor of $(1+R)^3$

D. The cash flow in year two is valued just as highly as the cash flow in year one.

E. The project is acceptable whenever the payback period exceeds three years.

Profitability Index

Profitability Index

Profitability Index (PI)

The present value of an investment's future cash flows divided by its initial cost

$$\text{Profitability Index (PI)} = \frac{\text{PV (Cash Flows)}}{\text{Absolute Value of Initial Investment}}$$

PI –Decision Rule

$$\text{Profitability Index (PI)} = \frac{\text{PV (Cash Flows)}}{\text{Absolute Value of Initial Investment}}$$

The decision rule for the Profitability Index is which of the following? (Assume the rule is consistent with the NPV decision rule.)

A. Impossible to determine without more information.

B. Impossible for the PI decision rule to be consistent with the NPV decision rule.

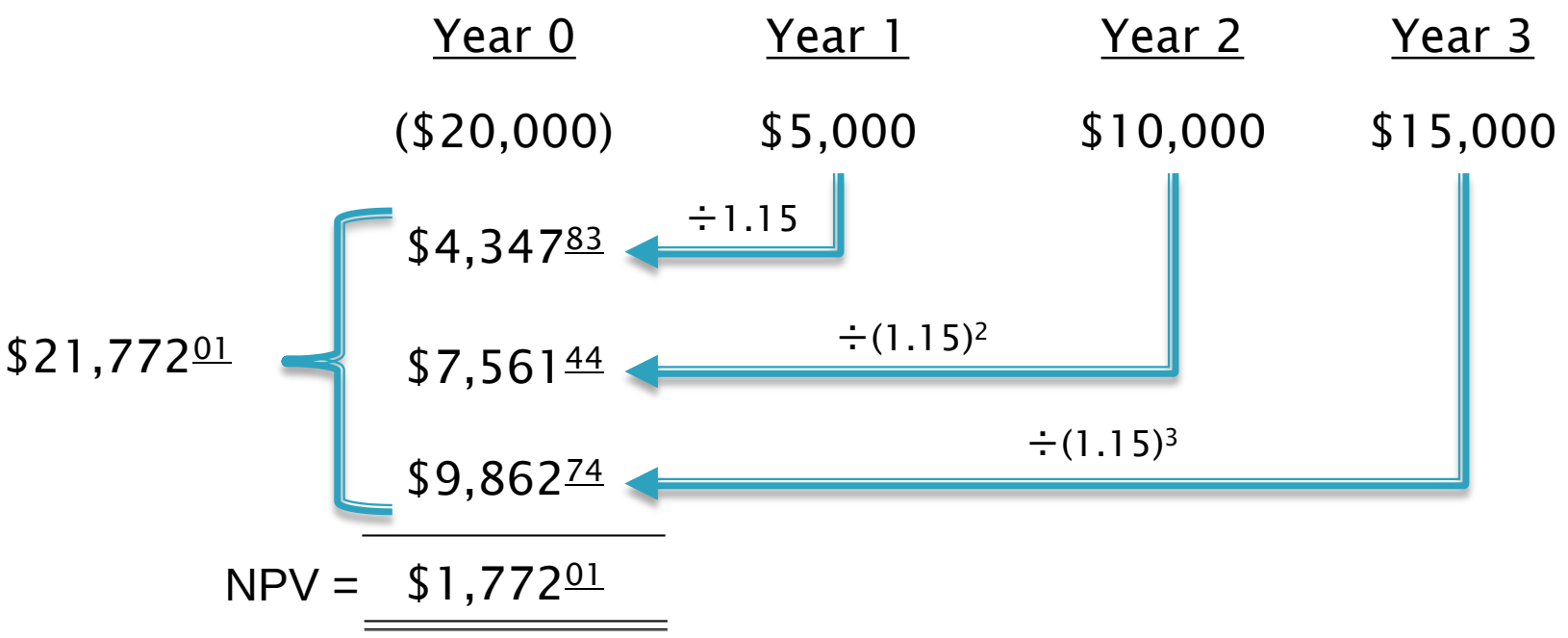
C. If PI is less than 0, accept the project.

D. If PI is greater than 1, accept the project

E. If PI is between 0 and 1, accept the project.

Profitability Index Example

Annual Cash Flows (Assume discount rate of 15%)



$$\text{Profitability Index} = \frac{\text{PV (Cash Flows)}}{\text{Absolute Value of Initial Investment}} = \frac{\$21,772.01}{\$20,000} = \boxed{1.09}$$

Accept project

Advantages and Disadvantage of Profitability Index

- Advantages
  - Closely related to NPV, generally leading to identical decisions
    - Considers all cash flows
    - Considers time value of money
  - Easy to understand and communicate
- Disadvantages
  - May lead to incorrect decisions in comparisons of mutually exclusive investments (can conflict with NPV)

Profitability Index vs. NPV

- Which project should you choose?

	Project A	Project B
Initial Investment	($10,000)	($100,000)
PV of Cash Flows	$15,000	$125,000
Profitability Index	1.50	1.25
NPV	$5,000	$25,000

Profitability Index – Example of Conflict with NPV

- Which project should you choose?

	Project A	Project B
Initial Investment	($10,000)	($100,000)
PV of Cash Flows	$15,000	$125,000
Profitability Index	1.50	1.25
NPV	$5,000	$25,000

Profitability index criteria → Project A

NPV criteria → Project B

Project B creates more value for shareholders

Question

The profitability index reflects the value created per dollar:

A. Invested.
B. Of sales.
C. Of net income.
D. Of taxable income.
E. Of shareholder's equity.

Question

If a project has a net present value equal to zero, then:

A. The total of the cash inflows must equal the initial cost of the project.

B. The project earns a return exactly equal to the discount rate.

C. A decrease in the project's initial cost will cause the project to have a negative NPV.

D. Any delay in receiving the projected cash inflows will cause the project to have a positive NPV.

E. The project's PI must also be equal to zero.

Internal Rate of Return (IRR)

Definition of IRR

Internal Rate of Return (IRR)

The discount rate that makes the NPV = 0

NPV vs. IRR

- Assume an investment idea that requires an $100,000 upfront investment and then will generate the following cash flows:
  - Year 1 = $30,000
  - Year 2 = $40,000
  - Year 3 = $50,000

NPV vs. IRR

Computing NPV

Year 0	Year 1	Year 2	Year 3
-$100,000	$30,000	$40,000	$50,000

Step #1: Compute the PV of these cash flows using a pre-determined required return

$X

-$100,000 + $X = NPV

Step #2: Subtract the upfront investment from the PV of cash flows

Computing IRR

Year 0	Year 1	Year 2	Year 3
-$100,000	$30,000	$40,000	$50,000

What is the discount rate to make the NPV = $0?

Question – Estimate IRR

Year 0	Year 1	Year 2	Year 3
–$100,000	$30,000	$40,000	$50,000

What is the approximate discount rate to make the NPV = $0?

A. Less than 0%
B. 0% to 4%
C. 4% to 8%
D. 8% to 12%
E. Greater than 12%

NPV vs. IRR

NPV Calculation

IRR Calculation

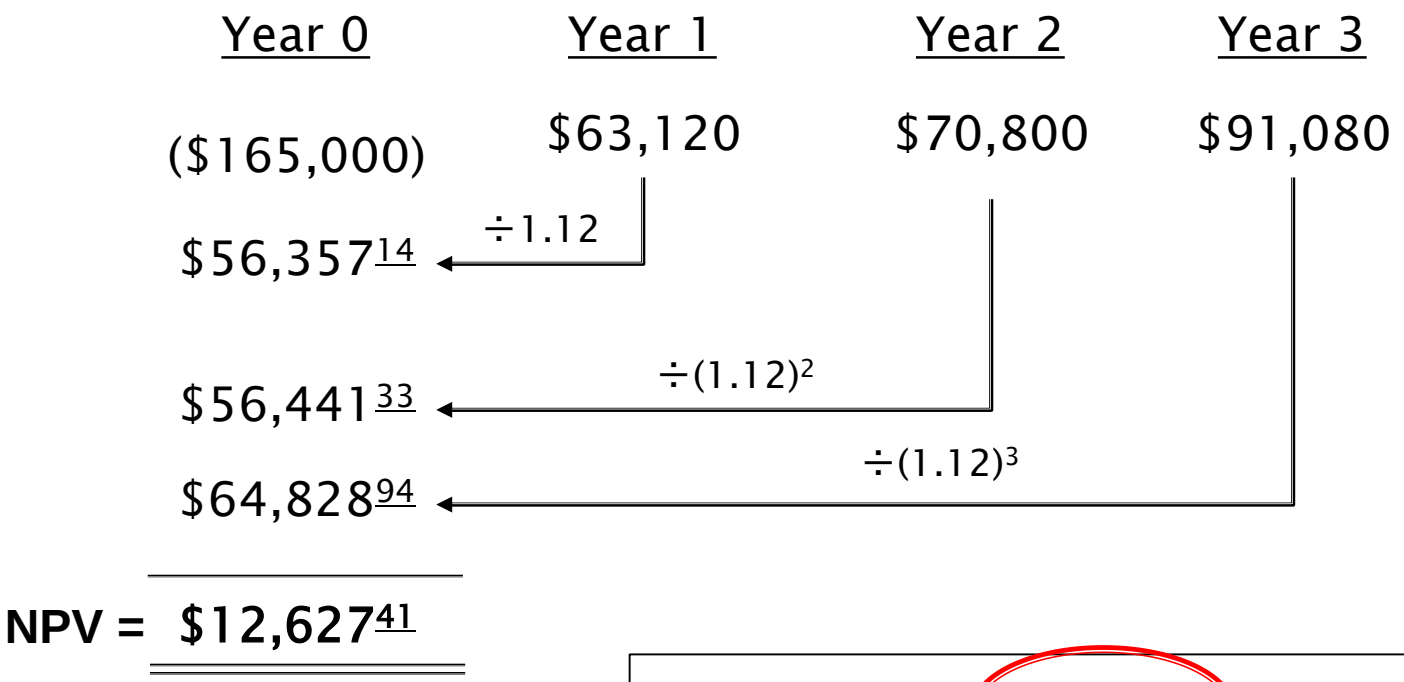
Sample Project Data

- You are looking at a new project and have estimated the following cash flows and net income:

Initial Investment	($165,000)
Cash flow in year 1	$63,120
Cash flow in year 2	$70,800
Cash flow in year 3	$91,080

- Your required return for investments of this risk is 12%.

Computing NPV for the Project



Is the IRR higher or lower than 12%?

Calculating IRR with Excel

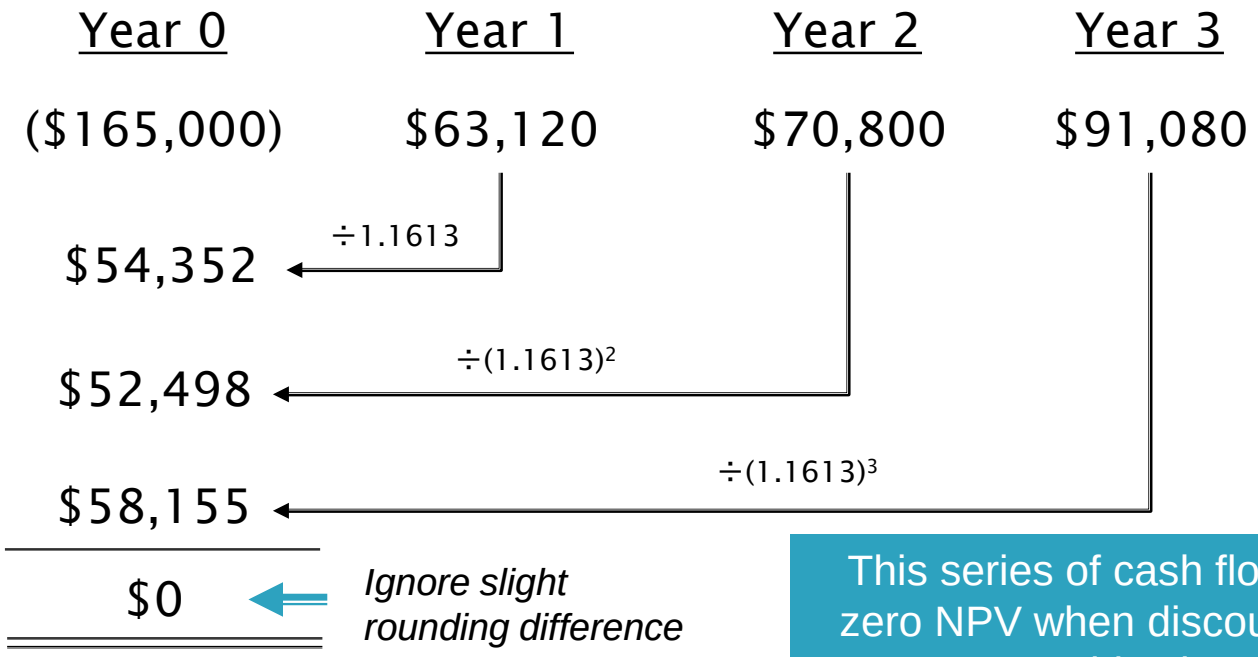
- Start with the cash flows as you did to solve for NPV
- Use the "IRR" function
  - Enter the range of cash flows, beginning with the initial cash flow (Cash flow 0)
  - It is not necessary to enter a "guess"

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%**

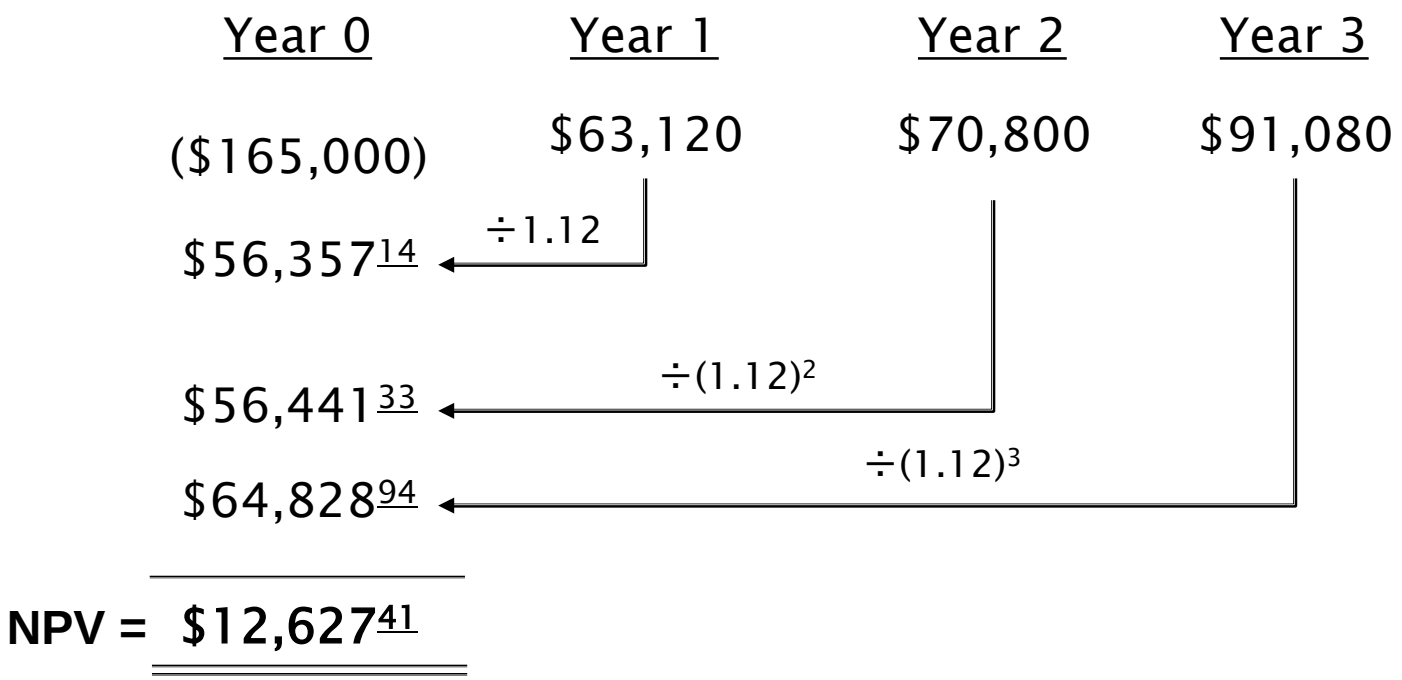
Proving the IRR/NPV Relationship

- What is the NPV of the following cash flows assuming a discount rate of 16.13%

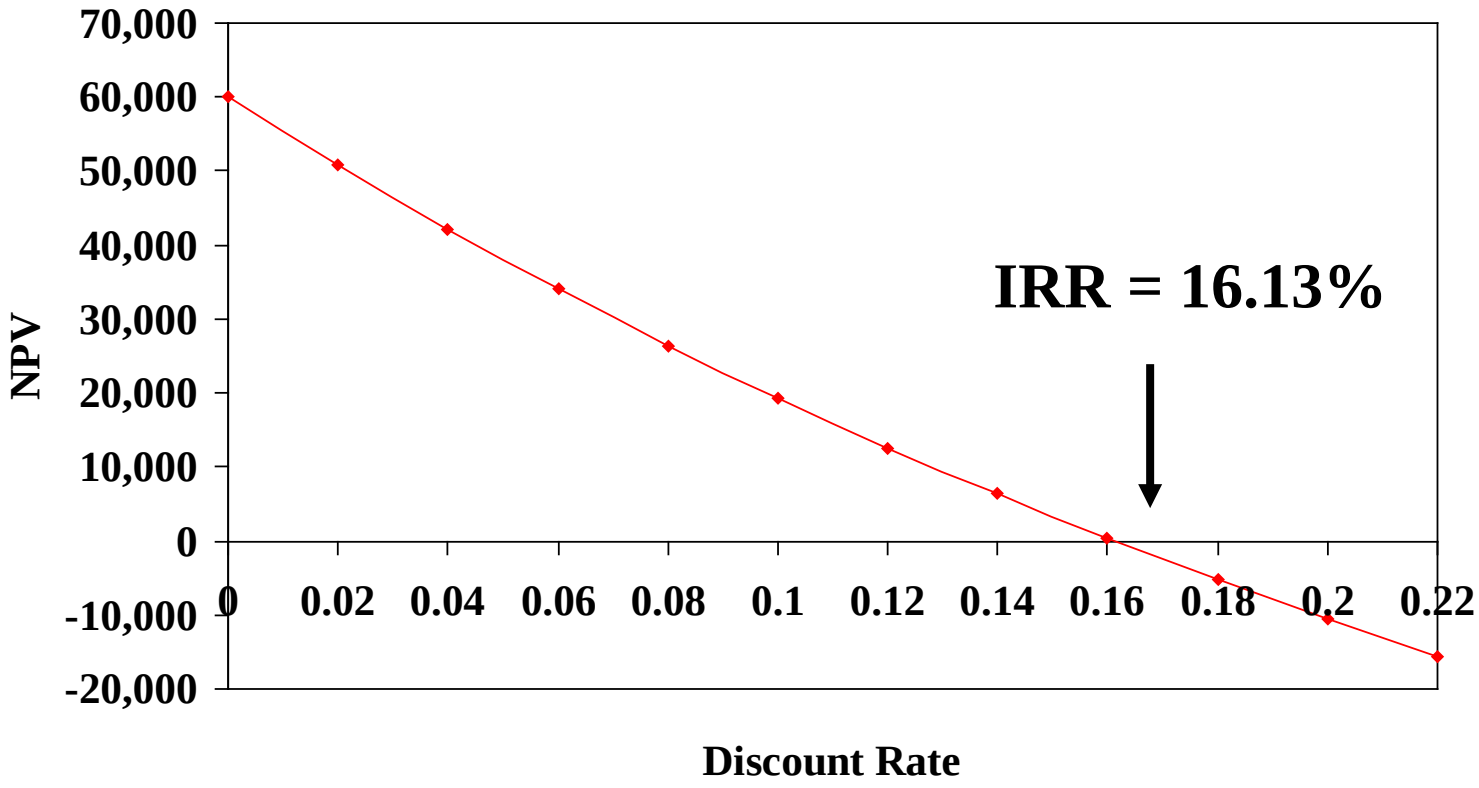


This series of cash flows has a zero NPV when discounted at a 16.13% rate. This, therefore, is the IRR of these cash flows.

Computing NPV for the Project



NPV Profile for the Project



NPV vs. IRR – Decision Rule

NPV Calculation

IRR Calculation

Decision Rule

Accept the project if NPV > $0

Accept the project if IRR > Required Return

IRR – Issues

- There are situations where NPV and IRR give conflicting answers
  - Non-conventional cash flows
  - Mutually-exclusive projects
- Use NPV when there is a conflict

Decision Criteria Test – IRR

- Each evaluation method will be assessed against the following decision criteria
  - Are all cash flows considered? → *Yes*
  - Is time value of money considered? → *Yes*
  - Does the criteria adjust for risk? → *Yes*
  - Can project be ranked? → *Not always*
  - Does the project add value to the firm? →

    Generally yes, but you can have multiple answers

IRR should not be the primary decision criteria

Question

The NPV of a series of cash flows is the following based on different required rates of return:

The IRR for the series of cash flows is in which range?

A. 0% to 5%

B. Between 5% and 10%

C. Between 10% and 15%

D. Between 15% and 20%

E. Greater than 20%

Required Return	NPV
5%	$41,728
10%	$24,708
15%	$9,940
20%	-$2,968

Question

The internal rate of return is defined as the:

A. Maximum rate of return a firm expects to earn on a project.

B. Rate of return a project will generate if the project is financed solely with internal funds.

C. Discount rate that equates the net cash inflows of a project to zero.

D. Discount rate which causes the net present value of a project to equal zero.

E. Discount rate that causes the profitability index for a project to equal zero.

Question

Tedder Mining has analyzed a proposed expansion project and determined that the internal rate of return is lower than the firm desires. Which one of the following changes to the project would be most expected to increase the project's internal rate of return?

A. Decreasing the required discount rate.

B. Increasing the initial investment in fixed assets.

C. Condensing the firm's cash inflows into fewer years without lowering the total amount of those inflows.

D. Eliminating the salvage value.

E. Decreasing the amount of the final cash inflow.

Capital Budgeting

Capital Budget Examples

- Purchase a fixed asset
- Launch a new product
- Enter a new market
- Acquire a company

These decisions determine the strategic direction of the firm

The capital budgeting question is one of the most important issue in corporate finance

Evaluation Methods

- We learned the following four methods for evaluating investments

Net Present Value (NPV)

Payback Rule

Profitability Index

Internal Rate of Return (IRR)

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 value to the firm	$
Payback	Liquidity	Years
IRR	Expected return	%
PI	Value created per $ invested	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

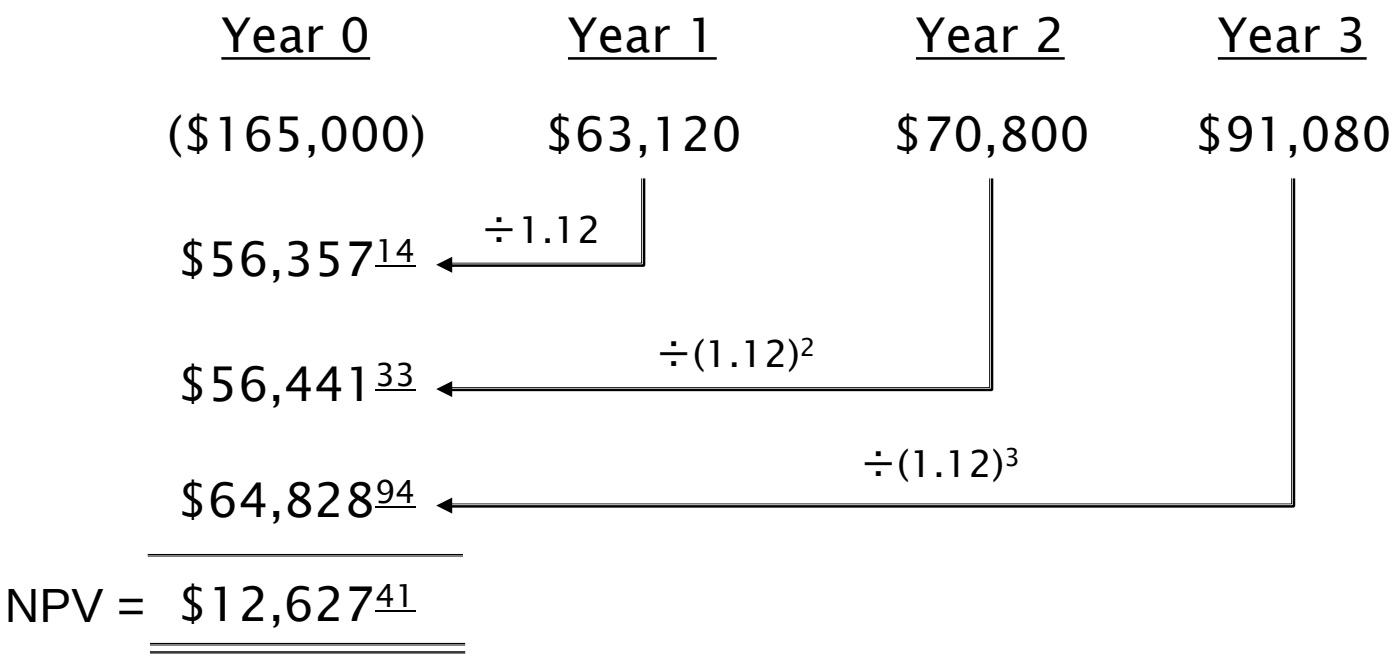
Sample Project Data

- You are looking at a new project and have estimated the following cash flows:

Initial Investment	($165,000)
Cash flow in year 1	$63,120
Cash flow in year 2	$70,800
Cash flow in year 3	$91,080

- Your required return for investments of this risk is 12%.

Computing NPV for the Project



IRR Summary

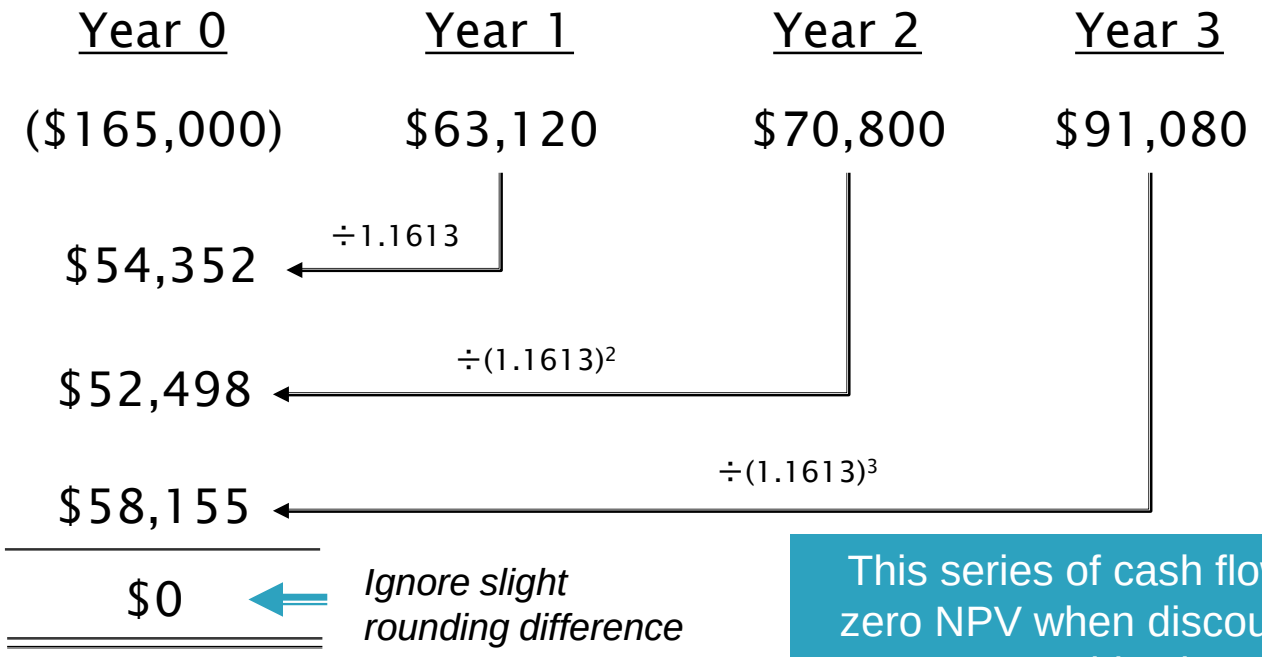
- **Internal rate of return**
  - Discount rate that makes NPV = 0
  - Accept if IRR > required return
  - Same decision as NPV with conventional cash flows
  - Unreliable with:
    - Non-conventional cash flows
    - Mutually exclusive projects

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%**

Proving the IRR/NPV Relationship

- What is the NPV of the following cash flows assuming a discount rate of 16.13%



This series of cash flows has a zero NPV when discounted at a 16.13% rate. This, therefore, is the IRR of these cash flows.

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

Sample Project Data

- You are looking at a new project and have estimated the following cash flows:

Initial Investment	($165,000)
Cash flow in year 1	$63,120
Cash flow in year 2	$70,800
Cash flow in year 3	$91,080

- Do you accept or reject this project?

Computing Payback Period

- We need to calculate how many years it takes to exactly recover the initial investment

	Year 0	Year 1	Year 2	Year 3
Annual Cash Flows	($165,000)	$63,120	$70,800	$91,080
Cumulative Cash Flows	($165,000)	($101,980)	($31,080)	$60,000

- The payback period is between 2 and 3 years
- You need $31,080 of the $91,080 total cash flow in Year 3 to find the exact breakeven
  - This is $31,080/$91,080 or .34 of Year 3 cash flow
- The payback period is 2 years plus .34 of Year 3 (**2.34 years**)

Profitability Index

Profitability Index

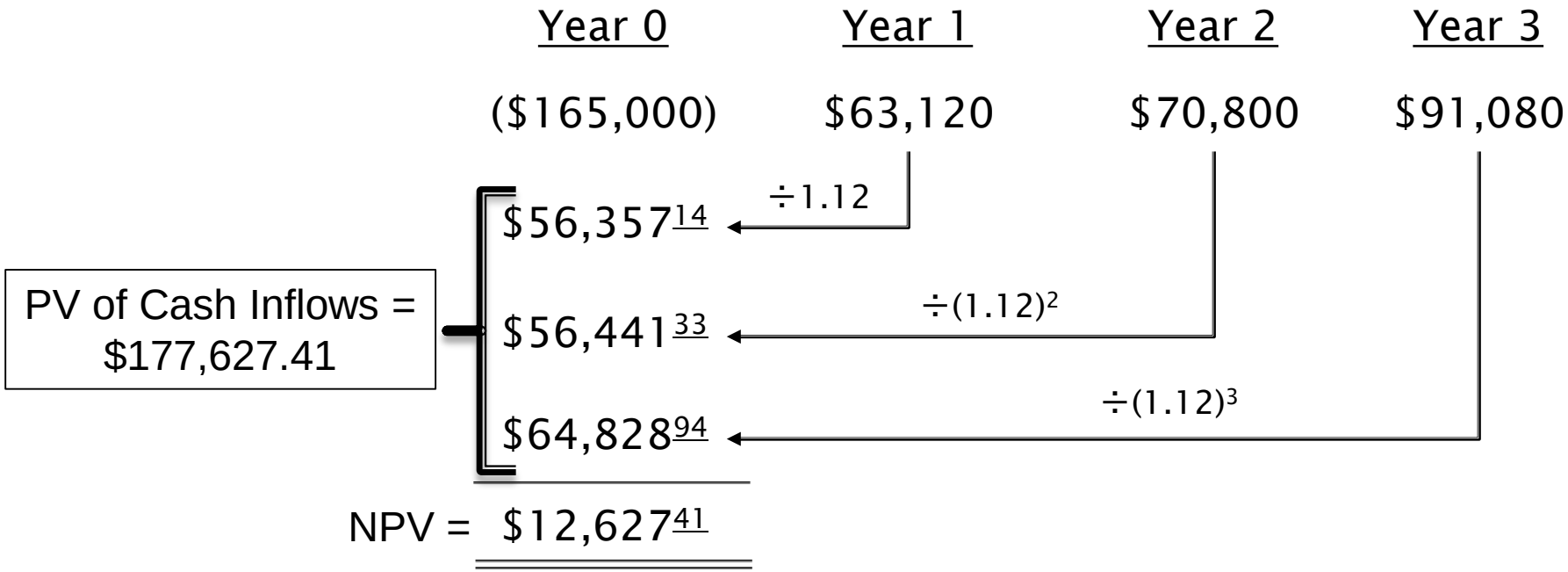
The present value of an investment's future cash flows divided by its initial cost

$$\text{Profitability Index} = \frac{\text{PV (Cash Flows)}}{\text{Absolute Value of Initial Investment}}$$

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

Computing Profitability Index



$$\text{Profitability Index} = \frac{\text{PV (Cash Flows)}}{\text{Initial Investment}} = \frac{\$177,627}{\$165,000} = \boxed{1.08}$$

Problem Example

- For the following two mutually exclusive projects, which one do you choose assuming a required return of 13%?

Annual cash flows:	A	B
Year 0	$ (235,000)	$ (47,000)
Year 1	$ 29,000	$ 28,700
Year 2	$ 45,000	$ 19,900
Year 3	$ 51,000	$ 17,300
Year 4	$ 325,000	$ 16,200
Required return		13%

Payback (A)	3.34
Payback (B)	1.92
Which one do you accept?	Project B

NPV (A)	$ 60,579.46
NPV (B)	$ 15,908.38
Which one do you accept?	Project A

IRR (A)	21.02%
IRR (B)	30.57%
Which one do you accept?	Project B

PI (A)	1.258
PI (B)	1.338
Which one do you accept?	Project B

Based on all criteria, which one do you accept?	Project A

Which Do You Choose?

$528.8 million over 30 years

– or –

$327.8 million today?

Powerball Winner Options

Year of Payout	Payout Before Taxes	Taxes*	Payout After Taxes
0	$7,959,201	($2,785,721)	$5,173,481
1	$8,357,155	($2,925,004)	$5,432,151
2	$8,775,013	($3,071,255)	$5,703,758
3	$9,213,769	($3,224,819)	$5,988,950
4	$9,674,459	($3,386,061)	$6,288,399
5	$10,158,174	($3,555,361)	$6,602,813
6	$10,666,086	($3,733,130)	$6,932,956
7	$11,199,392	($3,919,787)	$7,279,605
8	$11,759,359	($4,115,776)	$7,643,583
9	$12,347,332	($4,321,566)	$8,025,766
10	$12,964,695	($4,537,643)	$8,427,052
11	$13,612,930	($4,764,526)	$8,848,405
12	$14,293,580	($5,002,753)	$9,290,827
13	$15,008,254	($5,252,889)	$9,755,365
14	$15,758,674	($5,515,536)	$10,243,138
15	$16,546,607	($5,791,312)	$10,755,294
16	$17,373,936	($6,080,877)	$11,293,058
17	$18,242,627	($6,384,919)	$11,857,708
18	$19,154,765	($6,704,168)	$12,450,597
19	$20,112,496	($7,039,373)	$13,073,122
20	$21,118,125	($7,391,344)	$13,726,781
21	$22,174,033	($7,760,912)	$14,413,121
22	$23,282,736	($8,148,958)	$15,133,778
23	$24,446,868	($8,556,404)	$15,890,464
24	$25,669,211	($8,984,224)	$16,684,987
25	$26,952,672	($9,433,435)	$17,519,237
26	$28,300,308	($9,905,108)	$18,395,200
27	$29,715,324	($10,400,363)	$19,314,960
28	$31,201,083	($10,920,379)	$20,280,704
29	$32,761,138	($11,466,398)	$21,294,740
Total	**$528,800,000**	**($185,080,000)**	**$343,720,000**

Option 1: 30 Annual Payments

Total before taxes = $528.8 MM

Total after taxes = $343.7 MM

*Assume combined federal and state income tax of 35%

Powerball Winner Options

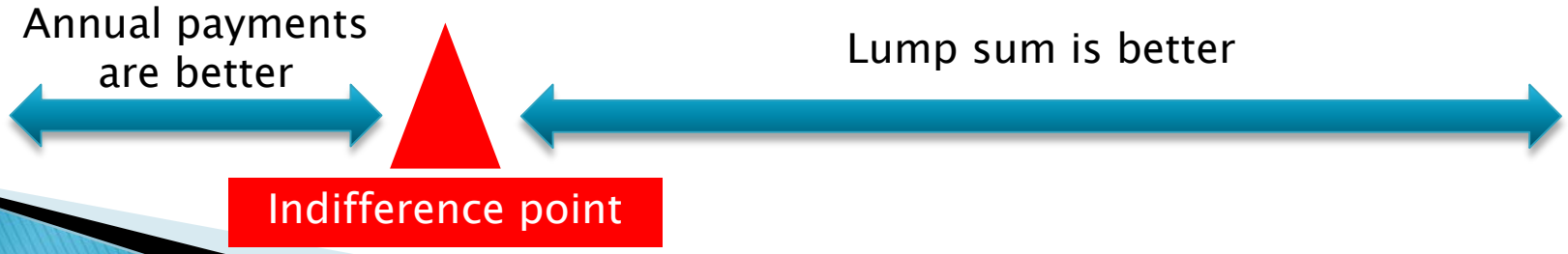
Option 2:
1 Lump Sum Payment at Time 0

$327.8 MM = Total before taxes
($114.7 MM) = Taxes*
$213.1 MM = Total after taxes

*Assume combined federal and state income tax of 35%

Powerball Payout Scenarios

	Estimate of Annual Return Over 30 Years									
	1.0%	**2.0%**	**2.84%**	**4.0%**	**5.0%**	**6.0%**	**8.0%**	**10.0%**	**12.0%**	**15.0%**
After-Tax Present Value of 30-Year Payment	$288.2	$243.8	$213.1	$178.9	$155.2	$135.7	$106.3	$85.6	$70.8	$55.6
After-Tax Lump sum Amount at Time 0	$213.1	$213.1	$213.1	$213.1	$213.1	$213.1	$213.1	$213.1	$213.1	$213.1
Difference in Present Value Dollars -- Better (Worse)	$75.2	$30.7	$0.0	($34.2)	($57.9)	($77.3)	($106.8)	($127.4)	($142.2)	($157.5)



Question

Which one of the following will decrease the net present value of a project?

A. Increasing the value of each of the project's discounted cash inflows.

B. Moving each of the cash inflows forward to a sooner time period.

C. Decreasing the required discount rate.

D. Increasing the project's initial cost at time zero.

E. Increasing the amount of the final cash inflow.

Question

Which one of the following indicates that a project should be rejected? Assume the cash flows are normal, i.e., the initial cash flow is negative.

A. Payback period that is shorter than the requirement period

B. Positive net present value

C. Profitability index less than 1.0

D. Internal rate of return that exceeds the required return.

Question

An investment has conventional cash flows and a profitability index of 1.0. Given this, which one of the following must be true?

A. The internal rate of return exceeds the required rate of return.

B. The investment never pays back.

C. The net present value is equal to zero

D. The net present value is greater than 1.0

Question

If a project with conventional cash flows has a profitability index of 1.0, the project will:

A. Never pay back

B. Have a negative net present value

C. Have a negative internal rate of return

D. Produce more cash inflows than outflows in today's dollars

E. Have an internal rate of return that equals the required return

Question

The internal rate of return is:

A. The discount rate that makes the net present value of a project equal to the initial cash outlay.

B. Equivalent to the discount rate that makes the net present value equal to one.

C. Tedious to compute without the use of either a financial calculator or a computer.

D. Highly dependent upon the current interest rates offered in the marketplace.

E. A better methodology than net present value when dealing with unconventional cash flows.