Chapter 7

Net Present Value and Other Investment Rules

Acknowledgement

- This work is reproduced, based on the book [Ross, Westerfield, Jaffe and Jordan “Core Principles and Applications of Corporate Finance”].
- This work can be used in the financial management course with the original text book.
- This work uses the figures and tables from the original text book.

7.1 Net Present Value & Its Rules

- Net Present Value (NPV) =

  Total PV of future project CF's less the Initial Investment
- Estimating NPV:
  - The first step is to estimate the expected future cash flows.
  - The second step is to estimate the required return for projects of this risk level.
  - The third step is to find the present value of the cash flows and subtract the initial investment.
- Minimum Acceptance Criteria: Accept if NPV > 0
- Ranking Criteria: Choose the highest NPV

Why Use Net Present Value?

- Accepting positive NPV projects benefits shareholders.
  - NPV uses cash flows, e.g. dividend payments, other capital budgeting projects, payment of corporate interest)
  - NPV uses all relevant cash flows of the project
  - NPV discounts the cash flows properly

7.2 The Payback Period Method

- How long does it take the project to “pay back” its initial investment?
- Payback Period = number of years to recover initial costs
- Computation
  - Estimate the cash flows
  - Subtract the future cash flows from the initial cost until the initial investment has been recovered

- Minimum Acceptance Criteria:
  - Set by management; a predetermined time period
- Ranking Criteria:
  - Set by management; often the shortest payback period is preferred

The Payback Period Method

- **Disadvantages:**
  - Ignores the time value of money
  - Ignores cash flows after the payback period
  - Biased against long-term projects
  - Requires an arbitrary acceptance criteria
  - A project accepted based on the payback criteria may not have a positive NPV

- **Advantages:**
  - Easy to understand
  - Biased toward liquidity

Example: Payback Method

- Consider a project with an investment of $50,000 and cash inflows in years 1,2, & 3 of $30,000, $20,000, $10,000

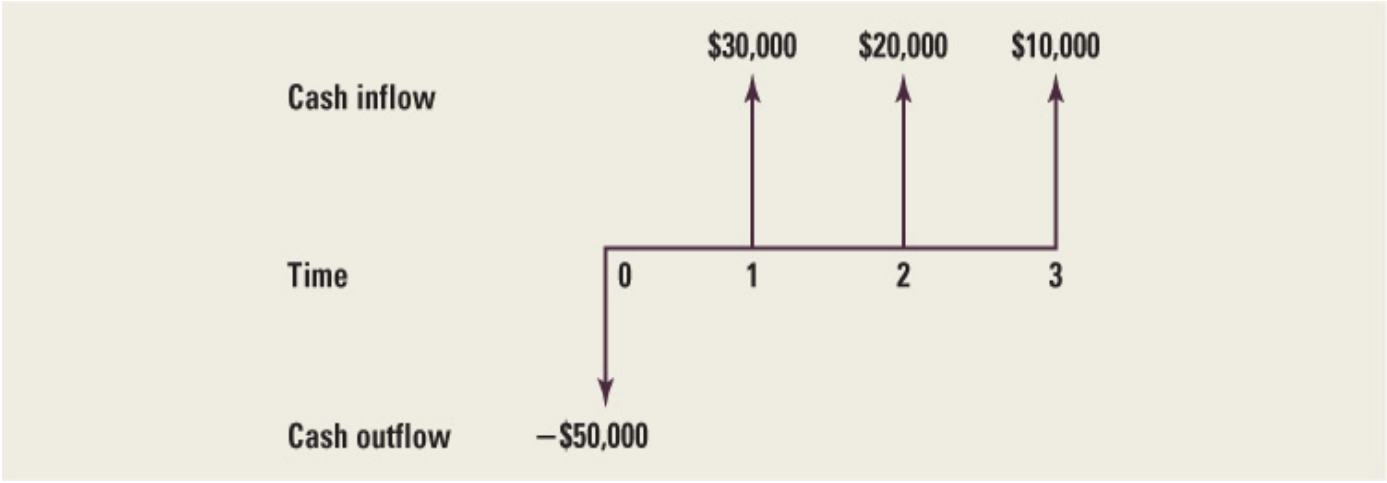


FIGURE 7.1
Cash Flows of an Investment Project

- The timeline above clearly illustrates that payback in this situation is 2 years.
- The first two years of return = $50,000 which exactly "pays back" the initial investment

Cited by the text book (p. 237)

Example: Payback Method

- Compare projects using payback method

YEAR	A	B	C
0	−100	−100	−100
1	20	50	50
2	30	30	30
3	50	20	20
4	60	60	60,000
Payback period (years)	3	3	3

TABLE 7.1

Expected Cash Flows for Projects *A* through *C* ($)

- Timing of cash flows within the payback period
- Payments after the payback period
- Arbitrary standard for payback period

Cited by the text book (p. 237)

7.3 The Discounted Payback Period

- How long does it take the project to “pay back” its initial investment, taking the time value of money into account?
- Decision rule: Accept the project if it pays back on a discounted basis within the specified time.
- By the time you have discounted the cash flows, you might as well calculate the NPV.

7.3 The Discounted Payback Period

- The discounted payback is four years

	Cash Flow		Accumulated Cash Flow	
Year	Undiscounted	Discounted	Undiscounted	Discounted
1	$100	$89	$100	$ 89
2	100	79	200	168
3	100	70	300	238
4	100	62	400	300
5	100	55	500	355

- The discounted payback is the time it takes to break even in an economic or financial sense because it considers the time value of money.
- We get our money back, along with the interest we could have earned elsewhere in four years.

The Discounted Payback Period Method

- **Disadvantages:**
  - The arbitrary cut-off period may eliminate projects that would increase firm value
  - If there are negative cash flows after the cut-off period, the rule may indicate acceptance of a project that has a negative NPV

- **Advantages:**
  - All those of the simple payback rule, plus, the time value of money is taken into account (at least for cash flows prior to the cutoff)
  - If a project pays back on a discounted basis, and has all positive cash flows after the initial investment, then it must have a positive NPV

7.4 Average Accounting Return

- Average net income / average book value
- Note that the average book value depends on how the asset is depreciated.

$$\text{AAR} = \frac{\text{Average Net Income}}{\text{Average Book Value of Investment}}$$

- Another attractive, but fatally flawed, approach
- Ranking Criteria and Minimum Acceptance Criteria set by management
- ***Accept the project if the AAR is greater than a preset rate***

Example: Average Accounting Return

TABLE 7.2

Projected Yearly Revenue and Costs for Average Accounting Return

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Revenue	$433,333	$450,000	$266,667	$200,000	$133,333
Expenses	200,000	150,000	100,000	100,000	100,000
Before-tax cash flow	233,333	300,000	166,667	100,000	33,333
Depreciation	100,000	100,000	100,000	100,000	100,000
Earnings before taxes	133,333	200,000	66,667	0	− 66,667
Taxes (t_c = .25)*	33,333	50,000	16,667	0	− 16,667
Net income	$100,000	$150,000	$ 50,000	$ 0	−$ 50,000

$$\text{Average net income} = \frac{(\$100{,}000 + 150{,}000 + 50{,}000 + 0 - 50{,}000)}{5} = \$50{,}000$$

$$\text{Average investment} = \frac{(\$500{,}000 + 400{,}000 + 300{,}000 + 200{,}000 + 100{,}000 + 0)}{6} = \$250{,}000$$

$$\text{AAR} = \frac{\$50{,}000}{\$250{,}000} = 20\%$$

*Corporate tax rate = t_c. The tax rebate in year 5 of −$16,667 occurs if the rest of the firm is profitable. Here, the loss in the project reduces the taxes of the entire firm.

Cited by the text book (p. 240)

Average Accounting Return

- **Disadvantages:**
  - Ignores the time value of money
  - Uses an arbitrary benchmark cutoff rate
  - Based on book values, not cash flows and market values
- **Advantages:**
  - The accounting information is usually available
  - Easy to calculate

7.5 The Internal Rate of Return

- This is the most important alternative to NPV
  - The discount rate that makes the NPV of an investment zero
- Minimum Acceptance Criteria:
  - Accept if the IRR exceeds the required return
- Ranking Criteria:
  - Select alternative with the highest IRR
- Reinvestment assumption:
  - All future cash flows assumed reinvested at the IRR

Internal Rate of Return (IRR)

- **Disadvantages:**
  - Does not distinguish between investing and borrowing
  - IRR may not exist, or there may be multiple IRRs
  - Problems with mutually exclusive investments

- **Advantages:**
  - Easy to understand and communicate

Internal Rate of Return (IRR)

- The IRR on an investment is the required return that results in a zero NPV when it is used as the discount rate.

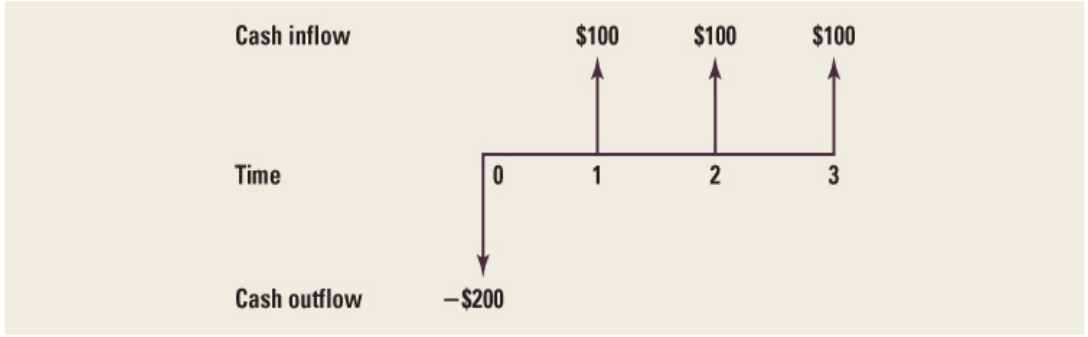


FIGURE 7.3
Cash Flows for a More Complex Project

$$NPV = 0 = -200 + \frac{\$100}{(1+IRR)} + \frac{\$100}{(1+IRR)^2} + \frac{\$100}{(1+IRR)^3}$$

Cited by the text book (p. 242)

NPV Payoff Profile

- NPV profile: A graphical representation of the relationship between an investment's NPVs and various discount rates.
- If we graph NPV versus the discount rate, we can see the IRR as the x-axis intercept.

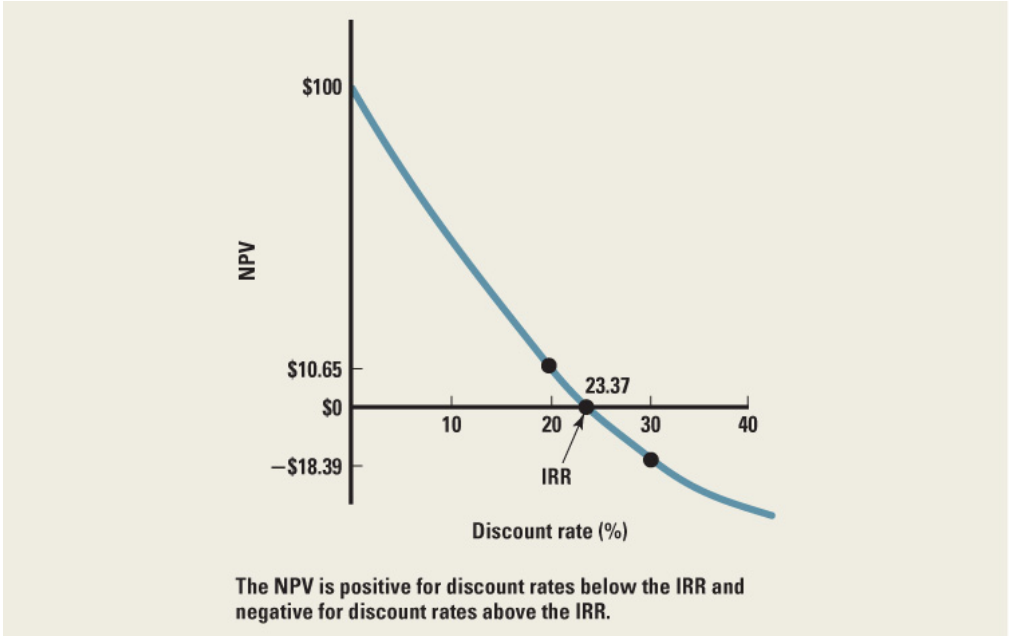


FIGURE 7.4
Net Present Value (NPV) and Discount Rates for a More Complex Project

Cited by the text book (p. 243)

Advantages of IRR

- Knowing a return is intuitively appealing

- It is a simple way to communicate the value of a project to someone who doesn't know all the estimation details

- If the IRR is high enough, you may not need to estimate a required return, which is often a difficult task

7.6 Problems with IRR

- Multiple IRRs
- Are We Borrowing or Lending
- The Scale Problem
- The Timing Problem

Mutually Exclusive vs. Independent

- Mutually Exclusive Projects: only ONE of several potential projects can be chosen, e.g., acquiring an accounting system.
  - RANK all alternatives, and select the best one.

- Independent Projects: accepting or rejecting one project does not affect the decision of the other projects.
  - Must exceed a MINIMUM acceptance criteria

Multiple IRR

- IRR and Nonconventional Cash Flows
  - When the cash flows change sign more than once, there is more than one IRR
  - When you solve for IRR you are solving for the root of an equation, and when you cross the x-axis more than once, there will be more than one return that solves the equation
  - If you have more than one IRR, which one do you use to make your decision?

Multiple IRR

TABLE 7.3

The Internal Rate of Return and Net Present Value

DATES:	PROJECT *A*			PROJECT *B*			PROJECT *C*		
	0	1	2	0	1	2	0	1	2
Cash flows	−$100	$130		$100	−$130		−$100	$230	−$132
IRR		30%			30%		10%	and	20%
NPV @10%		$18.2			−$18.2			$0	
Accept if market rate		<30%			>30%		>10%	but	<20%
Financing or investing		Investing			Financing			Mixture	

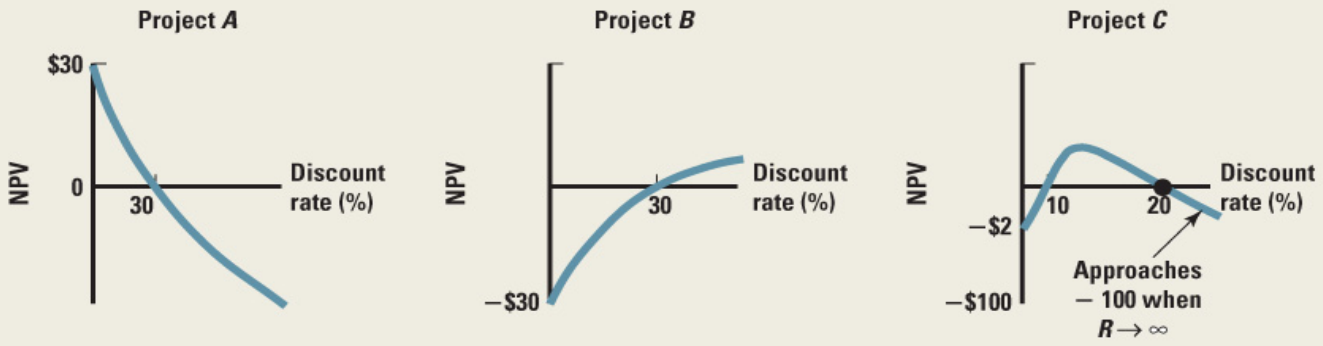
Project A has a cash outflow at date 0 followed by a cash inflow date 1
Project B has a cash inflow at date 0 followed by a cash outflow date 1
Project C has two change of sigh in its cash flows (non conventional cash flow)

Cited by the text book (p. 245)

Multiple IRR

FIGURE 7.5

Net Present Value and Discount Rates for Projects *A*, *B* and *C*



Project *A* has a cash outflow at date 0 followed by a cash inflow at date 1. Its NPV is negatively related to the discount rate.
Project *B* has a cash inflow at date 0 followed by a cash outflow at date 1. Its NPV is positively related to the discount rate.
Project *C* has two changes of sign in its cash flows. It has an outflow at date 0, an inflow at date 1, and an outflow at date 2.
Projects with more than one change of sign can have multiple rates of return.

Cited by the text book (p. 245)

General Rules

Flows	Number of IRRs	IRR criterion	NPV criterion
Investing	1	Accept if IRR>R Reject if IRR<R	Accept if NPV>0 Reject if NPV<0
Financing	1	Accept if IRR<R Reject if IRR>R	Accept if NPV>0 Reject if NPV<0
Mixture	Maybe more than 1	No valid IRR	Accept if NPV>0 Reject if NPV<0

Cited by the text book (p. 248)

Problems Specific to Mutually Exclusive Projects

- Two or more projects are mutually exclusive if the firm can, at most, accept only one of them

- We now face two problems
  - The scale problem
  - The time problem

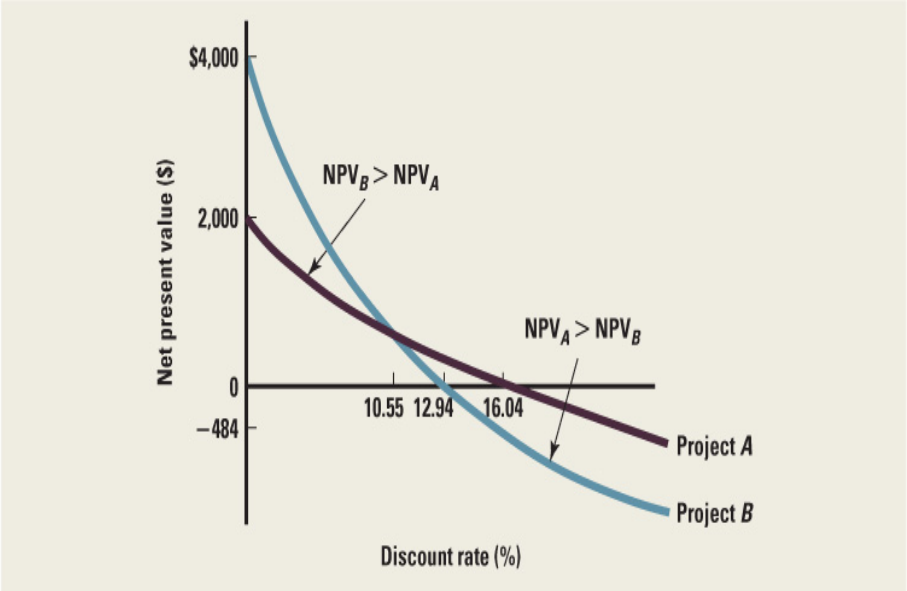
The Scale Problem

- Would you rather make 100% or 50% on your investments?
- What if the 100% return is on a $1 investment, while the 50% return is on a $1,000 investment?
- IRR does not account for the amount of total value created, only a percentage return.
- As a consequence, NPV is often a better measure if projects with substantially different scales are being valued against each other.

The Timing Problem

- The IRR for project A (16.04%): The IRR for project B (12.94%)
- Investment A must be acceptable according to the IRR rule.
- Calculated the NPV of these investments for different required returns.

FIGURE 7.6
Net Present Value and the Internal Rate of Return for Mutually Exclusive Projects



- Supposed that the required return is 10.55%, B should be acceptable
- otherwise A is a better investment.

Cited by the text book (p. 251)

NPV versus IRR

- NPV and IRR will generally give the same decision.
- Exceptions:
  - Non-conventional cash flows – cash flow signs change more than once
  - Mutually exclusive projects
    - Initial investments are substantially different
    - Timing of cash flows is substantially different

7.7 The Profitability Index (PI)

- Profitability index – present value of future cash flows divided by the initial investment (cost-benefit ratio)

$$PI = \frac{\text{Total PV of Future Cash Flows}}{\text{Initial Investment}}$$

- Minimum Acceptance Criteria:
  - Accept if PI > 1
- Ranking Criteria:
  - Select alternative with highest PI

The Profitability Index

- **Disadvantages:**
  - Problems with mutually exclusive investments
- **Advantages:**
  - May be useful when available investment funds are limited
  - Easy to understand and communicate
  - Correct decision when evaluating independent projects

Summary – Discounted Cash Flow

- **Net present value**
  - Difference between market value and cost
  - Accept the project if the NPV is positive
  - Has no serious problems
  - Preferred decision criterion
- **Internal rate of return**
  - Discount rate that makes NPV = 0
  - Take the project if the IRR is greater than the required return
  - Same decision as NPV with conventional cash flows
  - IRR is unreliable with non-conventional cash flows or mutually exclusive projects

Summary – Discounted Cash Flow

- **Profitability Index**
  - Benefit-cost ratio
  - Take investment if PI > 1
  - Cannot be used to rank mutually exclusive projects
  - May be used to rank projects in the presence of capital rationing
- **Payback period**
  - Length of time until initial investment is recovered
  - Take the project if it pays back in some specified period
  - Doesn't account for time value of money, and there is an arbitrary cutoff period

Summary – Payback Criteria

- **Discounted payback period**
  - Length of time until initial investment is recovered on a discounted basis
  - Take the project if it pays back in some specified period
  - There is an arbitrary cutoff period
- **Average Accounting Return**
  - Measure of accounting profit relative to book value
  - Similar to return on assets measure
  - Take the investment if the AAR exceeds some specified return level
  - Serious problems and should not be used

References

- Ross, Westerfield, Jaffe and Jordan, Core Principles and Application of Corporate Finance, 3ed, McGraw Hill.
- Jordan, Miller, and Dolvin, Fundamentals of Investments, 6ed, MacGraw Hill.
- Berk, DeMarzo and Harford, Fundamentals of Corporate Fiance, 2nd ed, Pearson.