Module 6

USING THE NET PRESENT VALUE RULE TO MAKE VALUE-CREATING INVESTMENT DECISIONS

Background

- A good investment decision
  - One that raises the current market value of the firm's equity, thereby creating value for the firm's owners
- Capital budgeting involves
  - Comparing the amount of cash spent on an investment today with the cash inflows expected from it in the future
- Discounting is the mechanism used to account for the time value of money
  - Converts future cash flows into today's equivalent value called present value or discounted value
- Apart the timing issue, there is also the issue of the risk associated with future cash flows
  - Since there is always some probability that the cash flows realized in the future may not be the expected ones

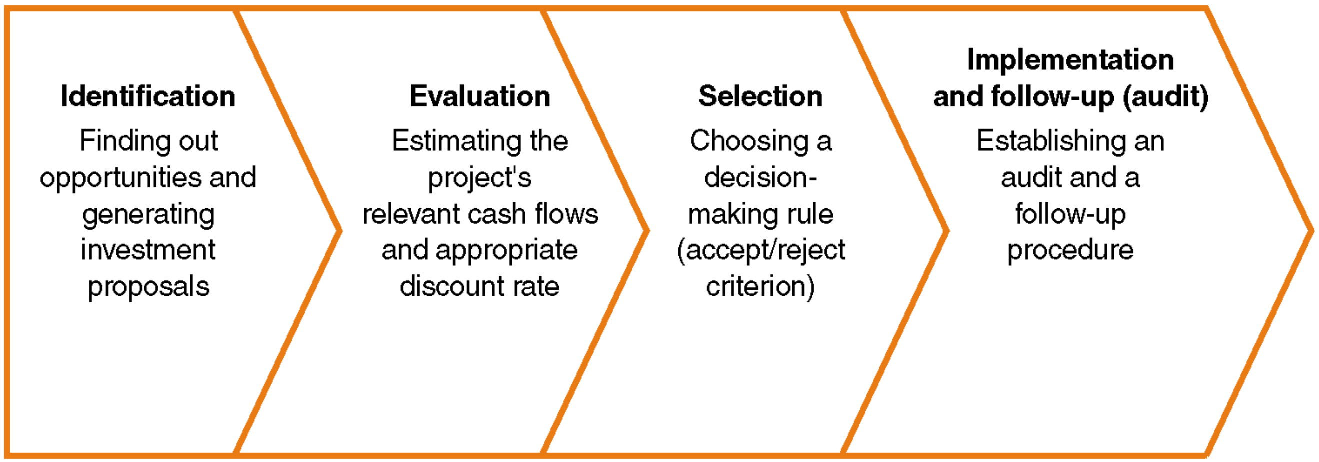
Background

- After reading this Module, students should understand:
  - The major steps involved in a capital budgeting decision
  - How to calculate the present value of a stream of future cash flows
  - The net present value (NPV) rule and how to apply it to investment decisions
  - Why a project's NPV is a measure of the value it creates
  - How to use the NPV rule to choose between projects of different sizes or different useful lives
  - How the flexibility of a project can be described with the help of managerial options

The Capital Investment Process

- Capital investment decision (capital budgeting decision, capital expenditure decision) involves four steps
  - Identification
  - Evaluation
  - Selection
  - Implementation and audit
- Investment proposals are also often classified according to the difficulty in estimating the key valuation parameters
  - Required investments
  - Replacement investments
  - Expansion investments
  - Diversification investments

EXHIBIT 6.1:
The Capital Investment Process.



Type of investment

- Required investment
- Replacement investment
- Expansion investment
- Diversification investment

Input

- Expected cash-flow stream
- Discount rate

Decision rule

- Net present value
- Profitability index
- Internal rate of return
- Payback period

Performance evaluation

- Monitor the magnitude and timing of cash flows
- Check if the project still meets the selection criterion
- Decide on continuation or abandonment
- Review previous steps if failure rate is high

EXHIBIT 6.2:
Cash-Flow Time Line for Parcel of Land.

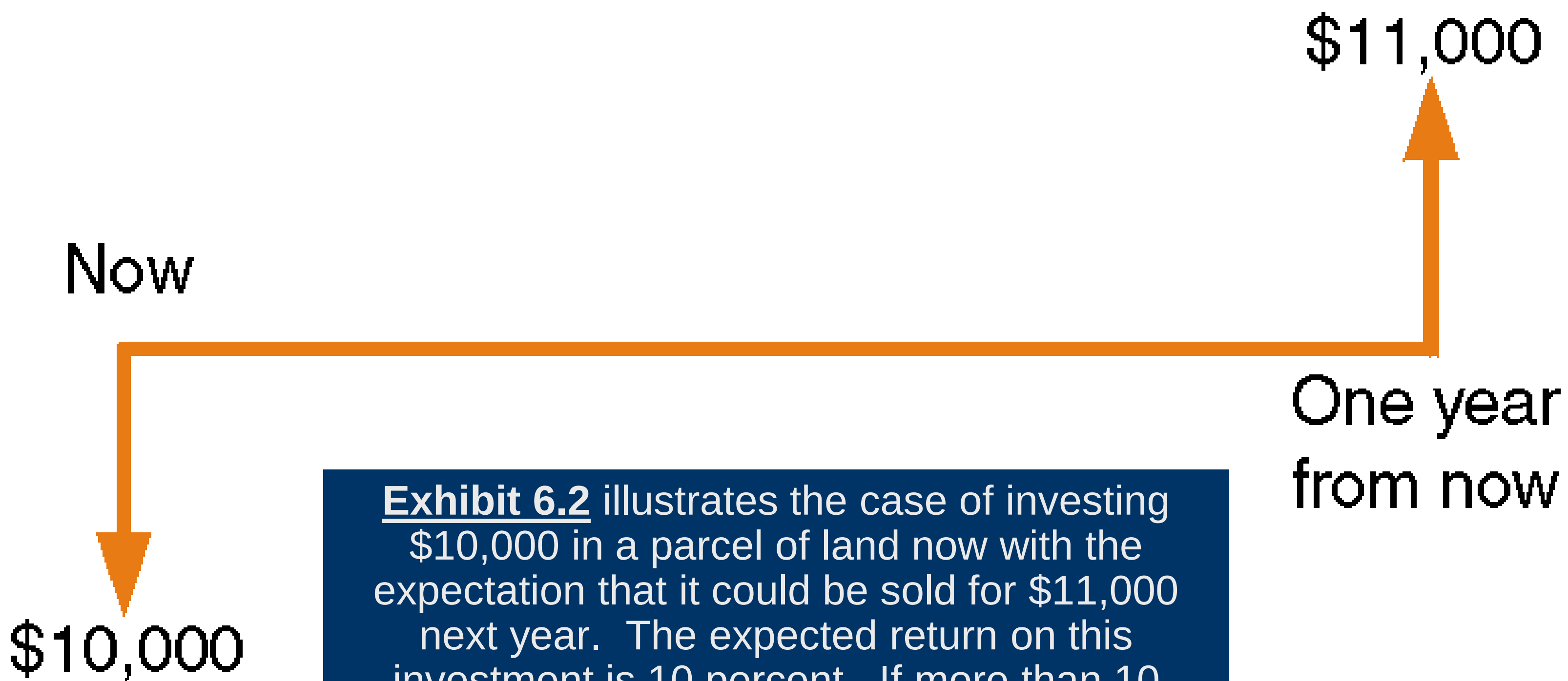


Exhibit 6.2 illustrates the case of investing $10,000 in a parcel of land now with the expectation that it could be sold for $11,000 next year. The expected return on this investment is 10 percent. If more than 10 percent can be earned on a truly comparable or **alternative investment**, we should not buy the land.

The Alternative Investment

- Both the alternative investment and the one under consideration must share the same attributes
  - Most relevant
    - Risk
    - Tax treatment
    - Liquidity

The Opportunity Cost Of Capital

- We assume that the proposed investment is riskless
  - Thus, the alternative investment is the deposit of $10,000 in a government-insured savings account, which is currently offering a 6 percent return
    - Since it is the return we would give up if we buy the land, it is called the **project's opportunity cost of capital**, or simply, the **cost of capital**
- Comparing a project's return with that of an alternative investment is a straightforward approach to investment analysis
  - But it may fail under some particular patterns of cash flows (see next Module)
  - The net present value approach, in contrast, can deal with any pattern of cash flows

The Net Present Value Rule

- Instead of comparing the rates of return for the two investments—the parcel of land and the savings account
  - Compare the $10,000 payable now to acquire the land with the dollar amount that we would have to invest now in the savings account to have $11,000 one year from now
    - This comparison is the foundation of the net present value rule

A One-Period Investment

- How much should we invest now in a savings account with a 6 percent interest rate if we want to receive $11,000 in one year?
  - $10,377
    - $10,377 + $10,377 x 6% = $11,000 or 11,000 ÷ 1.06 = $10,377 or

$$\$11{,}000\left(\frac{1}{1.06}\right) = \$11{,}000 \times 0.9434 = \$10{,}377$$

- Working out this example allows us to introduce the concepts of the **future value** (**compounded value**) and the **present value** (**discounted value**), as well as **compound** and **discount factors** for a one-period project (as illustrated in **Exhibit 6.3**)
  - **Compounding** provides the future value ($11,000) of the present one ($10,377) while **discounting** provides the present value of the future one
    - The compound factor is the factor by which the initial cash outlay ($10,000) must be multiplied to get its future value, while the discount factor is the factor by which the expected cash flow ($11,000) must be multiplied to get its present value

A One-Period Investment

- At 6 percent, we should be indifferent between $10,377 now and $11,000 in one year
  - At that rate, the two cash flows are equivalent
- The difference between the present value of the future cash flow and the initial outlay is called the **net present value** (**NPV**)
  - An investment should be accepted if its NPV is positive and should be rejected if its NPV is negative
  - If the NPV is zero, we would be indifferent between the project and an alternative investment

EXHIBIT 6.3:
Time Line for One-Period Project.

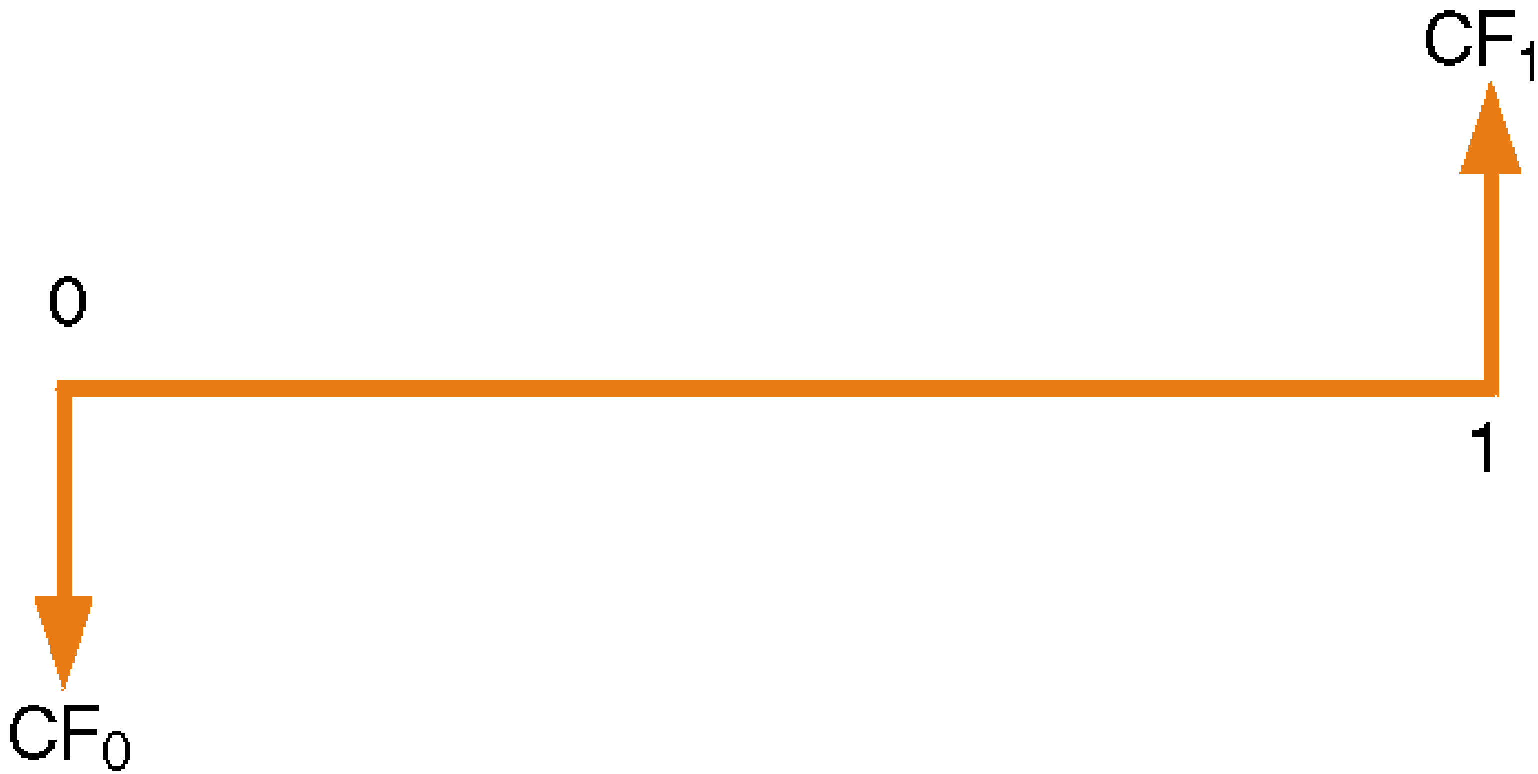


EXHIBIT 6.4:
Time Line for Two-Period Investment, No Intermediate Cash Flows.

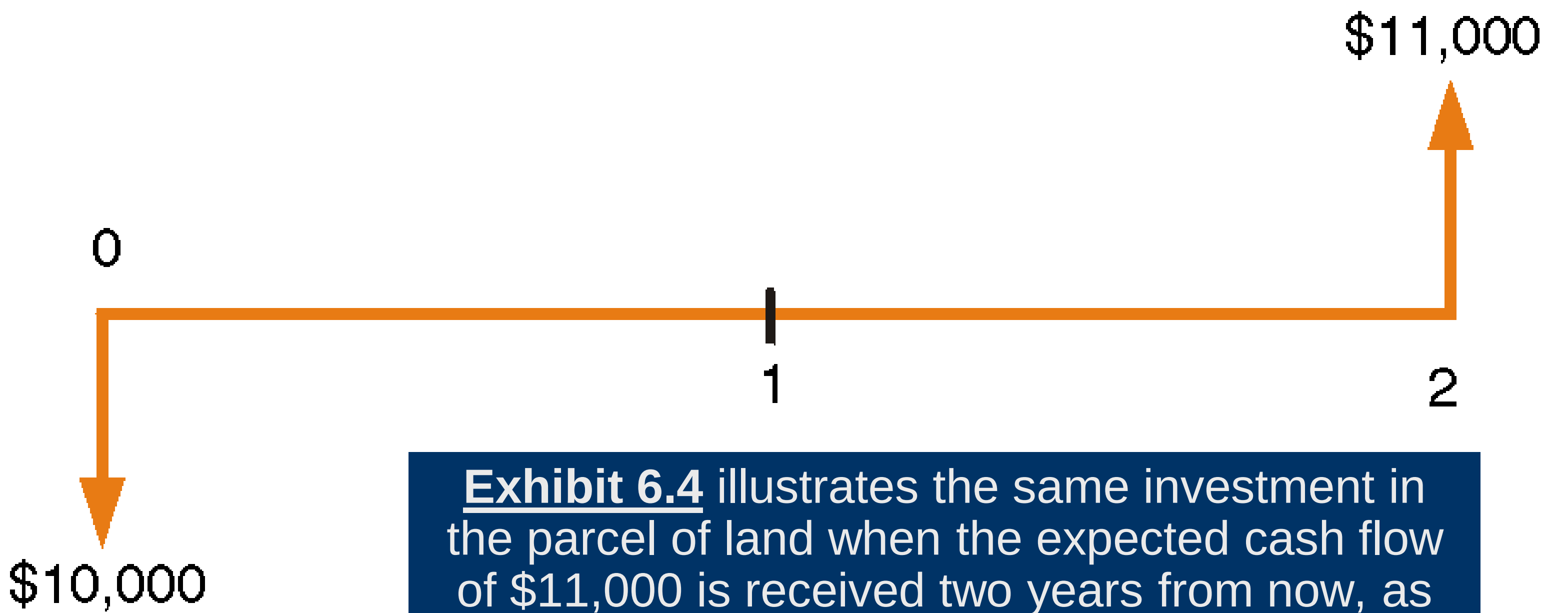
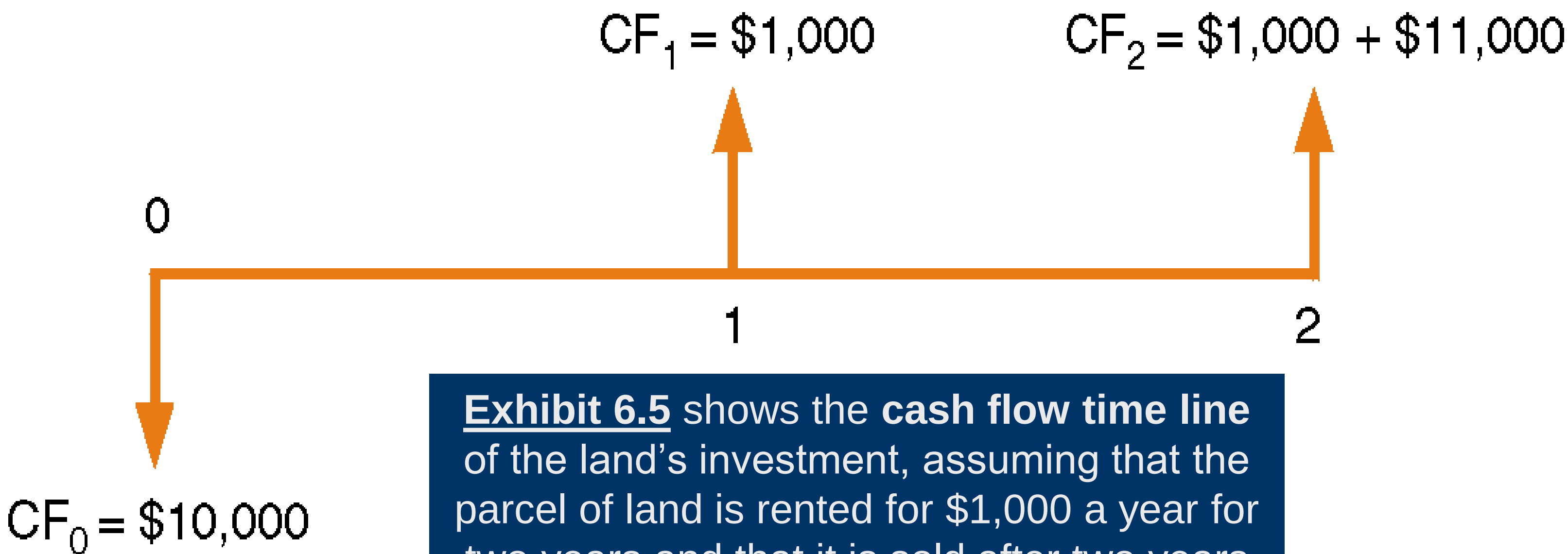


Exhibit 6.4 illustrates the same investment in the parcel of land when the expected cash flow of $11,000 is received two years from now, as opposed to one year from now. We show how the previous approach can be extended to a two-period investment without intermediate cash flows.

EXHIBIT 6.5:
Time Line for Two-Period Investment with Intermediate Cash Flow.



<u>Exhibit 6.5</u> shows the **cash flow time line** of the land's investment, assuming that the parcel of land is rented for $1,000 a year for two years and that it is sold after two years for $11,000. We show how the same approach used in the previous scenarios can be extended to a three-period investment with an intermediate cash flow.

EXHIBIT 6.6:
Time Line for Multiple-Period Investments—The General Case.

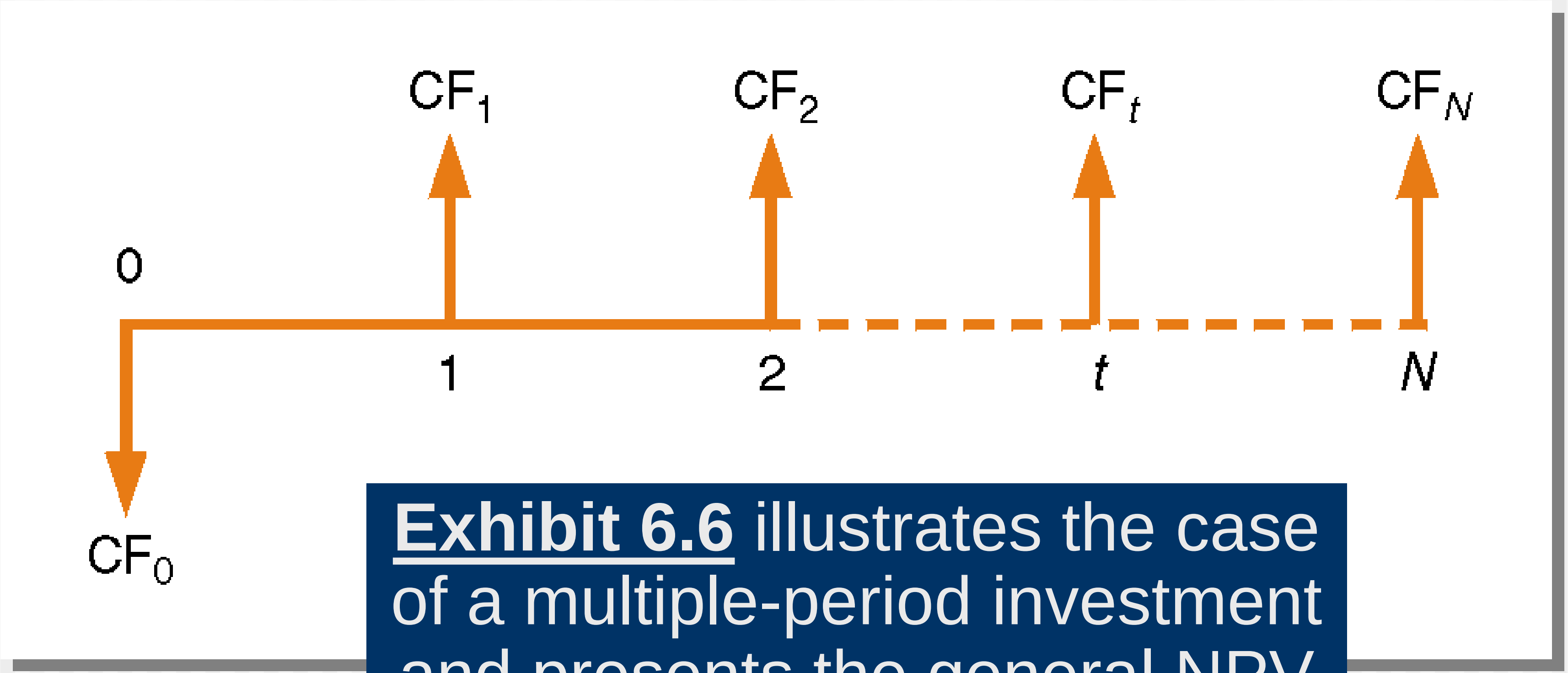


Exhibit 6.6 illustrates the case of a multiple-period investment and presents the general NPV formula.

Applying The Net Present Value Rule To A Capital Investment Decision

- Applying the net present value rule to an industrial investment project
  - Example: Sunlight Manufacturing Company, which is considering adding a new product to its existing line
    - Example assumes that the inputs (*i.e.,* the cash flows and the cost of capital) have already been estimated
      - Estimation of those inputs is addressed in Module 8 (cash flows) and Module 10 (cost of capital) with the same company
    - Computations are shown in **Exhibit 6.7**

EXHIBIT 6.7:
Calculation of Present Value for SMC Designer Desk Lamp.

$$\text{Present value of } CF_1 = \$832{,}000 \times \frac{1}{(1+0.09)^1} = \$832{,}000 \times 0.9174 = \$763{,}276$$

$$\text{Present value of } CF_2 = \$822{,}000 \times \frac{1}{(1+0.09)^2} = \$822{,}000 \times 0.8417 = \$691{,}878$$

$$\text{Present value of } CF_3 = \$692{,}000 \times \frac{1}{(1+0.09)^3} = \$692{,}000 \times 0.7722 = \$534{,}362$$

$$\text{Present value of } CF_4 = \$554{,}000 \times \frac{1}{(1+0.09)^4} = \$554{,}000 \times 0.7084 = \$392{,}454$$

$$\text{Present value of } CF_5 = \$466{,}000 \times \frac{1}{(1+0.09)^5} = \$466{,}000 \times 0.6499 = \$302{,}853$$

Total present value at 10% **$2,684,823**

Why The NPV Rule Is A Good Investment Rule

- The NPV rule is a good investment rule because
  - Measures value creation
  - Reflects the timing of the project's cash flows
  - Reflects its risk
  - Additive

A Measure Of Value-Creation

- The present value of a project's expected cash flows stream at its cost of capital
  - Estimate of how much the project would sell for if a market existed for it
- The net present value of an investment project represents the immediate change in the wealth of the firm's owners if the project is accepted
  - If positive, the project creates value for the firm's owners; if negative, it destroys value

Adjustment For The Timing Of The Project's Cash Flows

- NPV rule takes into consideration the timing of the expected future cash flows
  - Demonstrated by comparing two **mutually exclusive** investments with the same initial cash outlay and the same cumulated expected cash flows
    - But with different cash flow profiles
- **Exhibit 6.8** describes the two investments
- **Exhibit 6.9** shows the computation of the two investments' net present values

EXHIBIT 6.8:
Cash Flows for Two Investments with CF_0 = $1 Million and *k* = 0.10.

END OF YEAR	INVESTMENT A	INVESTMENT B
1	CF_1 = $800,000	CF_1 = $100,000
2	CF_2 = 600,000	CF_2 = 200,000
3	CF_3 = 400,000	CF_3 = 400,000
4	CF_4 = 200,000	CF_4 = 600,000
5	CF_5 = 100,000	CF_5 = 800,000
Total Cash Flows	**$2,100,000**	**$2,100,000**

EXHIBIT 6.9: Present Values of Cash Flows for Two Investments.

Figures from Exhibit 6.8

END OF YEAR	INVESTMENT A OPPORTUNITY COST OF CAPITAL = 10%		
1	PV($800,000) = $800,000 × 0.9091 =	$727,273	Total Present Values $1,722,361
2	PV($600,000) = 600,000 × 0.8264 =	495,868	
3	PV($400,000) = 400,000 × 0.7513 =	300,526	
4	PV($200,000) = 200,000 × 0.6830 =	136,602	
5	PV($100,000) = 100,000 × 0.6209 =	62,092	

END OF YEAR	INVESTMENT B OPPORTUNITY COST OF CAPITAL = 10%		
1	PV($100,000) = $100,000 × 0.9091 =	$ 90,909	Total Present Values $1,463,269
2	PV($200,000) = 200,000 × 0.8264 =	165,289	
3	PV($400,000) = 400,000 × 0.7513 =	300,526	
4	PV($600,000) = 600,000 × 0.6830 =	409,808	
5	PV($800,000) = 800,000 × 0.6209 =	496,737	

Adjustment For The Risk Of The Project's Cash Flows

- Risk adjustment is made through the project's discount rate
  - Because investors are **risk averse,** they will require a higher return from riskier investments
    - As a result, a project's opportunity cost of capital will increase as the risk of the investment increases
      - By discounting the project' cash flows at a higher rate, the project's net present value will decrease

EXHIBIT 6.10:
Cash Flows for Two Investments with CF_0 = $1 Million, *k* = 0.12 for Investment C, and *k* = 0.15 for Investment D.

END OF YEAR	INVESTMENT C	INVESTMENT D
1	CF_1 = $300,000	CF_1 = $300,000
2	CF_2 = 300,000	CF_2 = 300,000
3	CF_3 = 300,000	CF_3 = 300,000
4	CF_4 = 300,000	CF_4 = 300,000
5	CF_5 = 300,000	CF_5 = 300,000
Total Cash Flows	$1,500,000	$1,500,000

Exhibit 6.10 describes two investments with the same initial cash outlay, the same cumulative cash flows, the same cash flow profile, but with different cost of capital.

EXHIBIT 6.11a:
Present Values of Cash Flows for Two Investments.

Figures from Exhibit 6.10

END OF YEAR	INVESTMENT C OPPORTUNITY COST OF CAPITAL = 12%			
1	PV($300,000) = $300,000	× 0.8929	=	$267,857
2	PV($300,000) = 300,000	× 0.7972	=	239,158
3	PV($300,000) = 300,000	× 0.7118	=	213,534
4	PV($300,000) = 300,000	× 0.6355	=	190,655
5	PV($300,000) = 300,000	× 0.5674	=	170,228
	Total Present Values			$1,081,432

Exhibit 6.11 shows the computation of the two investments' net present values.

EXHIBIT 6.11b:
Present Values of Cash Flows for Two Investments.

Figures from Exhibit 6.10

END OF YEAR	INVESTMENT D OPPORTUNITY COST OF CAPITAL = 15%		
1	PV($300,000) = $300,000	× 0.8696	= $260,869
2	PV($300,000) = 300,000	× 0.7561	= 226,843
3	PV($300,000) = 300,000	× 0.6575	= 197,255
4	PV($300,000) = 300,000	× 0.5718	= 171,526
5	PV($300,000) = 300,000	× 0.4972	= 149,153
	Total Present Values		$1,005,646

Additive Property

- If one project has an NPV of $100,000 and another an NPV of $50,000
  - The two projects have a combined NPV of $150,000
    - Assuming that the two projects are independent
- Additive property has some useful implications
  - Makes it easier to estimate the impact on the net present value of a project of changes in its expected cash flows, or in its cost of capital (risk)
- An investment's positive NPV is a measure of value creation to the firm's owners only if the project proceeds according to the budgeted figures
  - Consequently, from the managers' perspective, a project's positive NPV is the maximum present value that they can afford to "lose" on the project and still earn the project's cost of capital

Special Cases Of Capital Budgeting

- **Comparing projects with unequal sizes**
  - If there is a limit on the total capital available for investment
    - Firm cannot simply select the project(s) with the highest NPV
      - Must first find out the combination of investments with the highest present value of future cash flows per dollar of initial cash outlay
        - Can be done using the projects' **profitability index**

Special Cases Of Capital Budgeting

- Firm should first rank the projects in decreasing order of their profitability indexes
  - Then select projects with the highest profitability index
    - Until it has allocated the total amount of funds at its disposal
- However, the profitability index rule may not be reliable
  - When choosing among mutually exclusive investments
  - When capital rationing extends beyond the first year of the project

EXHIBIT 6.12:
Cash Flows, Present Values, and Net Present Values for Three Investments of Unequal Size with *k*= 0.10.

	INVESTMENT E	INVESTMENT F	INVESTMENT G
(1) Initial cash outlay (CF_0)	\$1,000,000	\$500,000	\$500,000
Year-one cash flow (CF_1)	800,000	200,000	100,000
Year-two cash flow (CF_2)	500,000	510,000	700,000
(2) Present value of CF_1 and CF_2 at 10%	\$1,140,496	\$603,306	\$669,421
Net present value = (2) – (1)	\$140,496	\$103,306	\$169,421

Exhibit 6.12 describes the analysis of three investment projects of different sizes.

EXHIBIT 6.13:
Profitability Indexes for Three Investments of Unequal Size.

Figures from Exhibit 6.12

	INVESTMENT E	INVESTMENT F	INVESTMENT G
(1) Initial cash outlay	$1,000,000	$500,000	$500,000
(2) Present value of future cash-flow stream	$1,140,496	$603,306	$669,421
(3) Profitability index = $\frac{(2)}{(1)}$	$\frac{\$1,140,496}{\$1,000,000} = 1.14$	$\frac{\$603,306}{\$500,000} = 1.21$	$\frac{\$669,421}{\$500,000} = 1.34$

Exhibit 6.13 shows the profitability index of the three investments.

Special Cases Of Capital Budgeting

- **Comparing projects with unequal life spans**
  - If projects have unequal lives
    - Comparison should be made between sequences of projects such that all sequences have the same duration
      - In many instances, the calculations may be tedious
        - Possible to convert each project's stream of cash flows into an equivalent stream of equal annual cash flows with the same present value as the total cash flow stream
        - Called the **constant annual-equivalent cash flow** or annuity-equivalent cash flow
        - Then, simply compare the size of the annuities

EXHIBIT 6.14a:
Cash Outflows and Present Values of Cost for Two Investments with Unequal Life Spans.

SEQUENCE OF TWO MACHINE A'S

END OF YEAR	CASH OUTFLOWS MACHINE 1	MACHINE 2	TOTAL	PRESENT VALUE COST OF CAPITAL = 10%
Now	–$80,000		–$80,000	–$80,000
1	–4,000		–4,000	–3,636
2	–4,000	–$80,000	–$84,000	–69,422
3		–4,000	–4,000	–3,005
4		–4,000	–4,000	–2,732
			Present Value of Costs	–$158,795

Exhibit 6.14 illustrates the case of choosing between two machines, one having an economic life half that of the other.

EXHIBIT 6.14b:
Cash Outflows and Present Values of Cost for Two Investments with Unequal Life Spans.

ONE MACHINE B

END OF YEAR	CASH OUTFLOWS	PRESENT VALUE COST OF CAPITAL = 10%
Now	–$120,000	–$120,000
1	–3,000	–2,727
2	–3,000	–2,479
3	–3,000	–2,254
4	–3,000	–2,049
	Present Value of Costs	–$129,509

EXHIBIT 6.15:
Original and Annuity-Equivalent Cash Flows for Two Investments with Unequal Life Spans.

Figures from Exhibit 6.14 and Appendix 6.1

	Machine A		Machine B	
End of Year	Original Cash Flow	Annuity-Equivalent Cash Flow	Original Cash Flow	Annuity-Equivalent Cash Flow
Now	-$80,000		-$120,000	
1	-4,000	-50,096	-3,000	
2	-4,000	-50,096	-3,000	-40,855
3			-3,000	-40,855
4			-3,000	-40,855
Present value (10%)	-$86,942	-$86,942	-$129,509	-$129,509

Exhibit 6.15 shows how to apply the annuity-equivalent cash flow approach to the choice between the two machines.

Limitations Of The Net Present Value Criterion

- Although the net present value criterion can be adjusted for some situations
  - It ignores the opportunities to make changes to projects as time passes and more information becomes available
    - NPV rule is a take-it-or-live-it rule
- A project that can adjust easily and at a low cost to significant changes such as
  - Marketability of the product
  - Selling price
  - Risk of obsolescence
  - Manufacturing technology
  - Economic, regulatory, and tax environments
    - Will contribute more to the value of the firm than indicated by its NPV
      - Will be more valuable than an alternative project with the same NPV, but which cannot be altered as easily and as cheaply
- A project's flexibility is usually described by **managerial options**

Managerial Options Embedded In Investment Projects

- **The option to switch technologies**
  - Discussed using the designer desk lamp project of Sunlight Manufacturing Company (SMC) as an illustration
- **The option to abandon a project**
  - Can affect its net present value
  - Demonstrated using an extended version of the designer-desk lamp project
    - Although the project was planned to last for five years, we assume now that SMC's management will always have the option to abandon the project at an earlier date
      - Depending on if the project is a success or a failure

EXHIBIT 6.16:
Expected Cash Flows, Years 2 through 5, and Their Present Values for Success and Failure of SMC Designer Desk Lamp.

	YEAR 2	YEAR 3	YEAR 4	YEAR 5	PRESENT VALUE COST OF CAPITAL = 9%
Expected cash flows according to the initial estimation	**$832,000**	**$692,000**	**$554,000**	**$466,000**	**—**
Expected cash flows if the project is successful	**$890,000**	**$783,000**	**$612,000**	**$520,000**	**$2,316,507**
Expected cash flows if the project is a failure	**$662,000**	**$480,000**	**$420,000**	**$340,000**	**$1,576,527**

The expected cash flows under the two scenarios are shown in **Exhibit 6.16**. Given the option to abandon the project before its expected economic life and assuming a certain probability of the failure scenario, the project's NPV can be recalculated, which may or may not affect the investment decision.

Dealing With Managerial Options

- Above options are not the only managerial options embedded in investment projects
  - Option to expand
  - Option to defer a project
- Managerial options are either worthless or have a positive value
  - Thus, NPV of a project will always underestimate the value of an investment project
  - The larger the number of options embedded in a project and the higher the probability that the value of the project is sensitive to changing circumstances
    - The greater the value of those options and the higher the value of the investment project itself

Dealing With Managerial Options

- Valuing managerial options is a very difficult task
  - Managers should at least conduct a sensitivity analysis to identify the most salient options embedded in a project, try at valuing them and then exercise sound judgment

EXHIBIT 6.17: Steps Involved in Applying the Net Present Value Rule.