ENGINEERING ECONOMIC ANALYSIS

Compound Interest & Equivalence

主讲人：Team 11

Learning Objective

01

Compound Interest Concept

02

Compound Interest Formula

03

Simple vs. Compound Interest

04

The power of compounding

05

Equivalence with Compound Interest

Part 01

Compound Interest Concept

CORE CONCEPT

What is Compound Interest?

Definition

Compound interest is interest calculated on both the principal amount AND the accumulated interest from previous periods.

Key Difference from Simple Interest:

- ✗ Simple: Interest only on principal
- ✓ Compound: Interest on principal + accumulated interest

Why Compound Interest Matters

- Creates exponential growth over time
- Standard for most financial transactions
- Essential for long-term investment planning

Compound Interest in Action

Example: $1,000 at 8% for 3 years

Year 1:

Interest = $1,000 × 0.08 = $80

Balance = $1,080

Year 2:

Interest = $1,080 × 0.08 = $86.40

Balance = $1,166.40

Year 3:

Interest = $1,166.40 × 0.08 = $93.31

Balance = $1,259.71

Total Interest: $259.71 (vs. $240 with simple interest)

Part 02

Compound Interest Formula

01. Compound Interest Formula

$$F = P(1 + i)^n$$

F = Future value ($)

P = Principal ($)

i = Interest rate per period (decimal)

n = Number of periods

Problem:

$1,000 invested at 8% compounded annually for 5 years. What is the future value?

Solution:

$F = P(1 + i)^n$

$P = \$1{,}000,\ i = 8\% = 0.08,\ n = 5$

$F = 1000(1.08)^5$

$F = 1000 \times 1.4693 = \$1{,}469.33$

Interest earned: $1,469.33 - $1,000 =$469.33

Part 03

Simple vs. Compound Interest

01. Simple Interest Example

Simple Interest Example

Problem: You agree to lend a friend $5,000 for 5 years at an annual simple interest rate of 8%. Calculate:

① The total interest earned over the loan term;

② The total amount the friend must repay after 5 years.

Year	Simple	Compound	Difference
1	$ 5400	$ 5400	$ 0
2	$ 5800	$ 5832	$ 32
3	$ 6200	$ 6299	$ 99
4	$ 6600	$ 6802	$ 202
5	$ 7000	$ 7347	$ 347

Part 04

The power of compounding

02. The Power of Compoudding

Years to Double≈72%Interest Rate

The Magic of Time	
$ 2000 at 15% compound interest	
After 10 Years	$ 8091
After 20 Years	$ 32733
After 30 Years	$ 132423
After 40 Years	$ 535727

Part 05

Equivalence with Compound Interest

01.

Equivalence Concept

Two cash flows are equivalent at a given compound interest rate if they have the same economic value when converted to the same point in time.

Example:

At 8% compound interest:

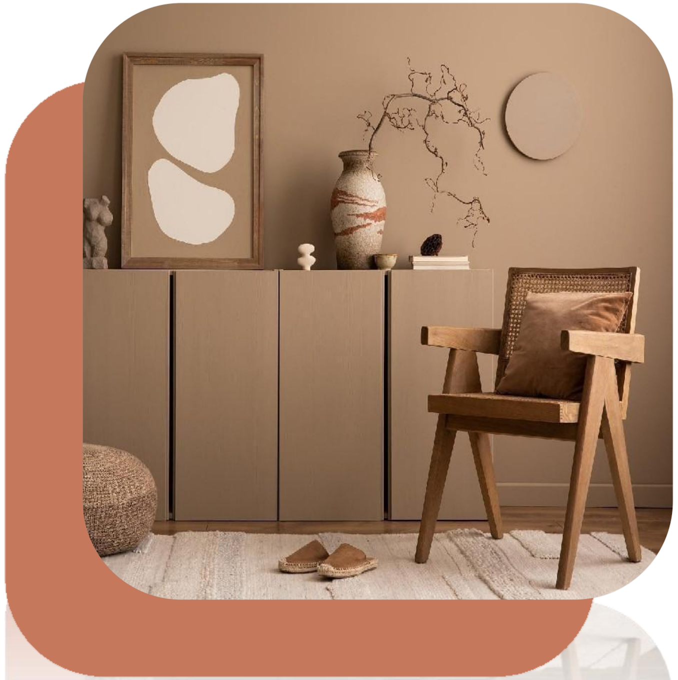
$1,000 today = $1,469 in 5 years

$1,000 today = $681 five years ago

$1,469 in 5 years = $681 five years ago

02.

Finding Equivalence Values



Future Value:

$F = P(1 + i)^n$

Present Value:

$P = F/(1 + i)^n$

Example:

At 10% compound interest, what amount in 3 years is equivalent to $2,000 today?

$P = \$2{,}000,\ i = 10\%,\ n = 3$

$F = P(1 + i)^n = 2000 \times 1.331 = \$2{,}662$

Practice Problems

Compound Interest

Doubling Time

Simple vs. Compound

Finding Interest Rate

Problem 1： Compound Interest

Calculate the future value using compound interest：

$F = P(1 + i)^n$

a) $3,000 at 6% for 4 years

$F = P(1 + i)^n = 3000 \times (1 + 0.06)^4 = \$3787.43$

b) $7,500 at 9% for 6 years

$F = P(1 + i)^n = 7500 \times (1 + 0.09)^{10} = \$12578.25$

c) $2,000 at 5% for 10 years

$F = P(1 + i)^n = 2000 \times (1 + 0.05)^{10} = \$3257.79$

Problem 2： Doubling Time

How long will it take for an investment to double at:

Use Rule of 72: Years ≈ 72 ÷ Rate

a) 6% annual interest

Years = 72 ÷ 6 =12

b) 10% annual interest

Years = 72 ÷ 10 =7.2

c) 15% annual interest

Years = 72 ÷ 15 =4.8

Problem 3： Simple vs. Compound

Compare simple and compound interest for $5,000 at 7% for 8 years. Calculate the difference

Calculate both and find the difference

Simple: $F = P(1 + i \times n) = 5000 \times (1 + 0.07 \times 8) = \$7800$

$$7800 - 5000 = \$2800$$

Compound: $F = P(1 + i)^n = 5000 \times (1 + 0.07)^8 = \$8590.93$

$$8590.93 - 5000 = \$3590.93$$

diffference = 8509.93 - 7800 = $790.93

Problem 4： Finding Interest Rate

If $2,000 invested 5 years ago has grown to $3,000 today, what annual compound interest rate was earned?

Use: $F = P(1 + i)^n$

i = (F/P)^(1/n) - 1

$$= \left(\frac{3000}{2000}\right)^{\frac{1}{5}} - 1$$

$$= 1.5^{0.2} - 1 = 0.084472$$

$$= 8.45\%$$

Key Take aways

02. Compound Interest

• Formula: F = P(1+i)^n (Define parameters: F = Future Value, P = Present Value, i = Interest Rate, n = Number of Compounding Periods)

• Core Logic: Interest is calculated on both principal + accumulated interest, breaking free from simple interest (which only taxes principal) to drive exponential growth.

• Simple vs. Compound Example:

◦ Principal (P) = 1,000; Interest Rate (i) = 10%; Periods (n$) = 3 years

◦ Simple Interest Future Value = $1,300

◦ Compound Interest Future Value = $1,331
Layout: Split into left (compound interest formula + parameter explanations) and right (simple vs. compound growth curve visual).

01. What is Time Value of Money (TVM)?

Definition: Money today is worth more than the same amount in the future due to its earning potential.

• Underlying Logic:

◦ Opportunity Cost: Money available now can be invested immediately to generate returns; forgoing its use in the future incurs opportunity cost.

◦ Risk & Uncertainty: Future fund access carries risks like default or inflation, which must be quantified via TVM.

• Foundational Formula: $F = P(1+i)^n$ (Basis for single/multiple-period future value calculations)
Layout: Left side for definitions; right side for a simple "timeline + fund icon" showing value growth from "Now → Future".

03. Power of Compounding

• Core Conclusion: Small differences in interest rate or time horizon create large gaps in final outcomes. Time is the ultimate amplifier of compounding.

• Key Insights:

◦ Invest Early: Longer time horizons amplify compounding effects (e.g., investing $10k/year at 25 vs. 35 leads to massive 60-year value gap at same rate).

◦ Stay Committed: Compounding is a "snowball effect"—avoid frequent interruptions.

• Tagline: Small differences in rate or time create large differences in outcomes. Start early and let time work for you.
Layout: "Rolling snowball" dynamic graphic; side-by-side final value comparison for different starting ages.

04. Equivalence

• Definition: Cash flows at different time points can be converted to equivalent values at a given interest rate, enabling cross-time comparison.

• Core Method: Use $F = P(1+i)^n$ to align cash flows to a single point (present or future value).

• Practical Example: Compare "Pay $100k now" vs. "Pay $130k in 5 years". At 8% interest, the present value of $130k in 5 years ≈ $88.4k—paying now is more favorable.
Layout: Left for equivalence definition + core formula; right for a two-cash-flow comparison table with conversion logic.

Thank you！

主讲人：