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Module 3 Financing and Investing

PAD 501

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Overview

- Required Reading: Chapters 5 and 6
- Understand the definitions of these concepts:
  - Capital projects and capital budgets
  - Interest rate, annuity, and present value
  - Characteristics of a bond
  - Mortgage and lease
- Understand these skills:
  - Conduct TVM calculations for financing and investing scenarios
  - Conduct NPV and NPC calculations for capital projects
  - Calculate the price of a bond based on market rate and coupon rate

Capital asset and capital budgeting

Features of a Capital Asset

- Large initial cost – e.g., building a bridge, school, or treatment plant may cost millions of dollars.
- Long useful life – these assets last many years;
  - For example, a $20 million water facility may provide benefits over 40 years.
- Timing mismatch – costs are paid early, but benefits occur over the long term;
  - The time value of money must be considered.

Time value of money (TVM)

- A dollar that you receive today is not the same as a dollar in the future.
- Why?
  - Inflation: $1 today may only buy $0.60 (or even less) worth of goods in 10 years.
  - Interest: At 5% interest, if you invest it, $1 today grows to about $1.63 in 10 years.

- How much is $1 in 10 year?
  - It depends

Interest

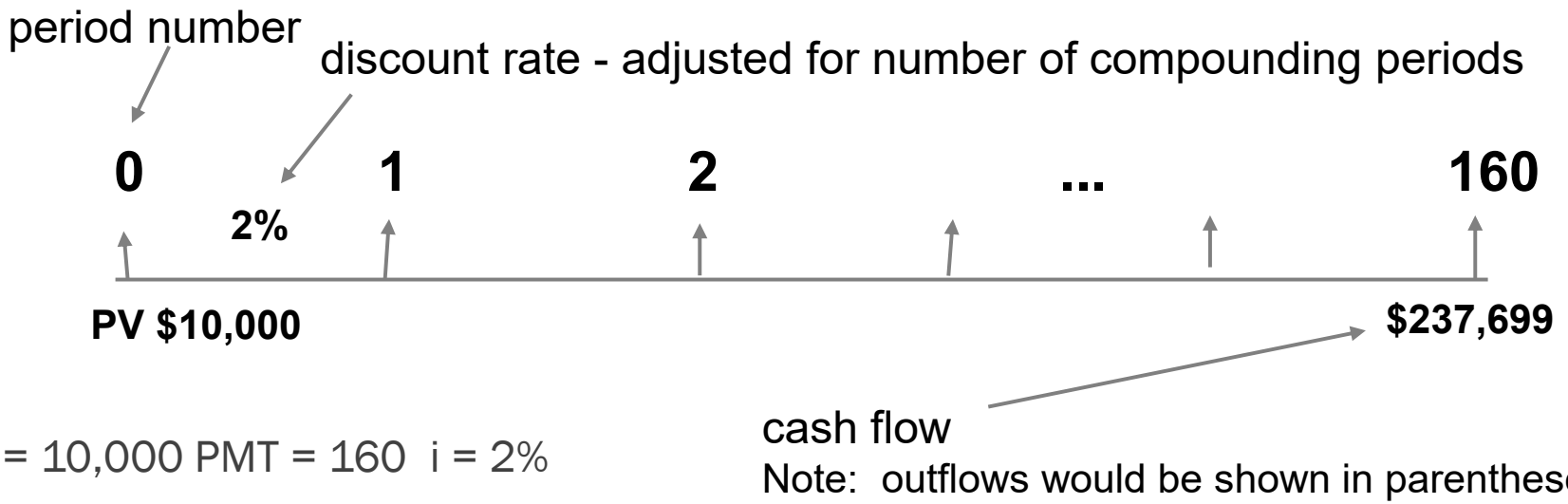
- Simple Interest: Interest earned each period on the original investment (principal).
  - Example: $100 at 10% simple interest = $10 each year. After 5 years = $150 total.
- Compound Interest: Includes simple interest + interest earned on prior interest (considering reinvestment of prior earnings).
  - Example: $100 at 10% compound interest grows to about $163 after 5 years. (yearly compound)
  - We consider compound interest in TVM analysis
  - Compounding can occur monthly, yearly, or daily. ($100+first day interest)*(10%/365) = second day interest
- Discounting is the reverse of compounding.

Time Value of Money TVM

- Four factors in a TVM calculation
  - PV: present value
  - FV: future value
  - i or r: interest rate per compounding period
  - N: number of compounding periods
- $FV = PV * (1 + i)^n$
- $PV = \frac{FV}{(1+i)^n}$
- Example: PV = $100, i = 5%, N = 10 ⟶ FV = $163 (yearly compound)
- Another Example: FV = $163, i = 5%, N = 10 → PV = $100 (yearly compound)

The Timeline

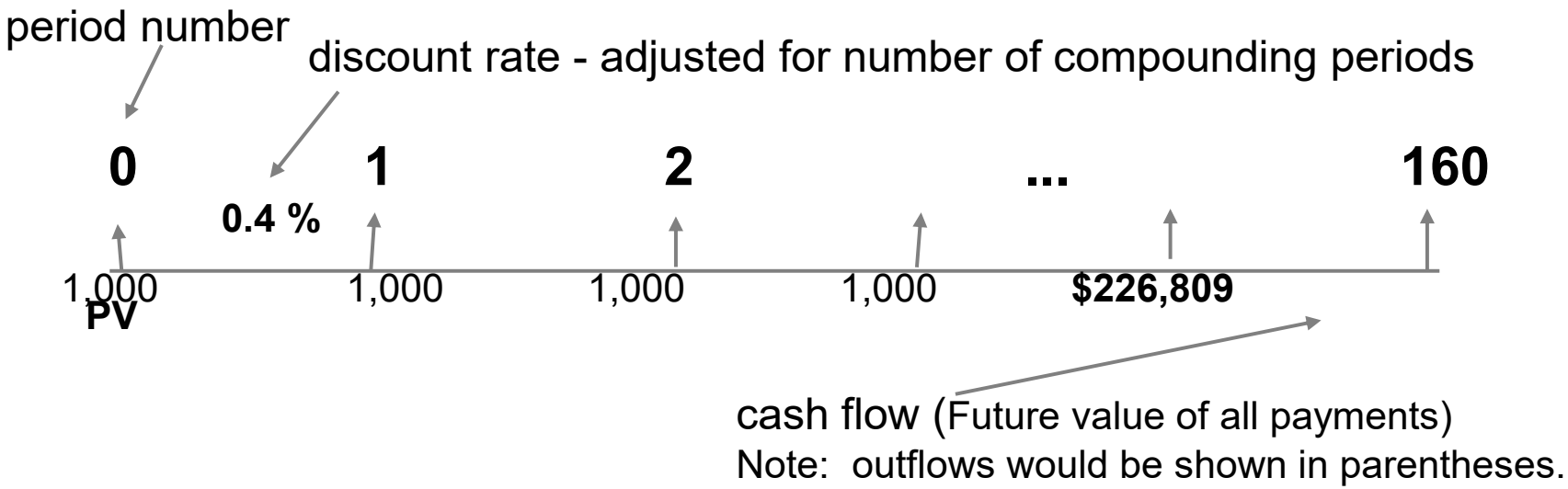
- When analyzing complex Time Value of Money problems, it is often helpful to lay the cash flows out on a timeline.



- PV = 10,000 PMT = 160 i = 2%
- If you invest $10,000 today at 2% per period for 160 periods, the future value will be $237,699.
- In Excel, use ”=FV(2%, 160, 0, 10000)” (will be discussed in example video)

The Time Line for annuity (PMT)

- Annuity: Equal payments made each period, compounded at a constant rate. No single lump sum, but a series of payments instead.



In Excel, use ”=FV(0.4%, 160, 1000)” (will be discussed in example video)

Annuity

- Ordinary annuity
  - All of the cash flows are equal and they are paid or received at evenly spaced time intervals.
  - Example: Loan or bond payments made at the end of each month.
- Annuity in advance (annuity due)
  - Annuity in which the first payment is made at the start of each period.
  - Example: Rent payments at the start of each month.

- Extra point: if you can draw a timeline for ordinary annuity and annuity in advance, and take a photo to upload to discussion post, you can get one extra point.

Useful Excel functions

- FV - Future Value - e.g., savings growth: =FV(rate, nper, pmt, pv, type)
- PV - Present Value, e.g., today's value of future payments: =PV(rate, nper, pmt, fv, type)
- Pmt - Find loan or annuity payment: =Pmt(rate, nper, pv, fv, type)
- Rate: the interest rate for each time period
- Nper: the number of periods

Examples of FV function in Excel

- =FV(5%, 10, 0, 1000)
  - Meaning: I want to calculate the future value of $1,000 in 10 periods with an interest rate of 5% per period.
  - When to use: You invest $1,000 today in a savings account with 5% annual interest for 10 years.
  - As you can see in the structure of the FV function: =FV(rate, nper, pmt, pv, type)
  - Note: Use comma to separate the numbers. The order of the numbers is important. The first number is the rate, the second number is the number of periods, the third numbers is payment in each time period, which we input 0 because there is no additional investment in each time period, the fourth number is the present value (PV), which is the $1,000 we invest today. Don't use "," within the numbers.
  - Try this in Excel and see if it works. It should give you $1,628.89, meaning that if you invest $1,000 today for 10 periods (year, for example) with an interest rate of 5% per period, you will get $1,628.89 at the end of 10 periods

Examples of PV function in Excel

- =PV(5%, 10, 0, 2000)
  - Meaning: I want to calculate the present value of $2,000 to be received in 10 years with an interest rate of 5% per period.
  - When to use: To find out if you need $2000 10 years from now, how much you need to invest today.
  - Result: About $1,227 today is equivalent to $2,000 in 10 years at 5%.
  - Structure reminder: PV(rate, nper, pmt, fv, type)
  - Check you result in Excel

Examples of PMT function in Excel

- =PMT(5%, 10, -10000, 0)
  - Meaning: I want to calculate the annual payment needed to pay off a $10,000 loan in 10 years at 5% interest.
  - When to use: To calculate loan or mortgage payments.
  - Result: About $1,295 per year for 10 years.
  - Structure reminder: PMT(rate, nper, pv, fv, type)
  - Check you result in Excel

PV with PMT

- Note that in the PV and FV example, we entered “0” for the third position PMT. What if we enter a number there as well? It will change the scenario substantially.
- Example 1: PV with PMT
  - =PV(5%, 10, -1000, 0)
  - Meaning: What is the present value of receiving $1,000 every year for 10 years at 5% interest?
  - Result: About $7,722 today.
  - Use case: This is like valuing an annuity — for example, for a scholarship fund paying $1,000 per year, how much do you need to put into the fund today.
  - Note that the fourth number is zero, meaning that we don’t expect any cash flow at the end of all the periods.
  - Check your result in Excel.

FV with PMT

- Example 2: FV with PMT
  - =FV(5%, 10, -1000, 0)
  - Meaning: What is the future value if you save $1,000 every year for 10 years at 5% interest?
  - Result: About $12,578 in 10 years.
  - Use case: This is like calculating how much you'll have in a retirement account if you contribute yearly.

- More examples are included in another video

Analysis on capital projects

- The Net Present Cost Method
  - The present value of the costs of each alternative are calculated, and the alternative with the lowest net present cost is selected.
- The Annualized Cost Method
  - “Annualize” that amount by finding the value of the annuity payment that is equal to the net present cost over the useful life of each piece of equipment.
  - Select the alternative with the lowest annualized cost.

Net Present Cost (NPC) example

- Goal: Compare two 5-year equipment options (discount rate 5%).
- Option A:
  - Initial cost $5,000; annual maintenance $1,000 for 5 years
  - NPC = Initial + PV (maintenance)
  - Excel (annuity form): =5000 + PV(5%, 5, -1000)
  - Result ≈ $9,329.48
- Option B:
  - Initial cost $7,000; annual maintenance $800 for 5 years
  - NPC = Initial + PV (maintenance)
  - Excel (annuity form): =7000 + PV(5%, 5, -800)
  - Result ≈ $10,463.58
- Decision: Choose the lower NPC ⟶ Option A.

*Example for annualized cost

- Goal: Compare two machines with different lifespans using annualized cost (discount rate 5%).
- Machine A
  - Initial cost: $10,000; Annual maintenance: $1,000; **Life: 5 years**
  - NPC = Initial + PV(maintenance); Excel: =10000 + PV(5%, 5, -1000); **NPC ≈ $13,329.48**
  - Annualized Cost: =PMT(5%, 5, 13329.48); Result ≈ $3,072 per year
- Machine B
  - Initial cost: $12,000; Annual maintenance: $800; **Life: 10 years**
  - NPC = Initial + PV(maintenance); Excel: =12000 + PV(5%, 10, -800); **NPC ≈ $18,169.54**
  - Annualized Cost: =PMT(5%, 10, 18169.54); Result ≈ $2,357 per year
- Decision: Even though Machine B has a higher total NPC, it spreads out over 10 years at a lower annualized cost. ⟶ Choose Machine B.

NPV Analysis on capital projects

The Net Present Value Method

- NPV = PV of the Inflows - PV of the Outflows
- Find the present value of the net cash flows generated by each investment.
- Rank the investments in order of their net present values.

Other issues

- The appropriate discount rate
  - Cost of capital rate: municipal bond rate
  - Investment return rate
- Risk
- Social costs and benefits

Types of long-term financing

- Short-term debt refers to borrowed money that must be repaid within one year.
- Long-Term Debt—borrowed money with a *maturity* of more than one year.
  - Leases—contracts to make fixed payments in return for the right to use a capital asset.
  - Mortgages—loans that are backed by a security interest in land and/or buildings that are owned by the borrower.
  - Bonds—standardized loan agreements between borrowers and lenders.

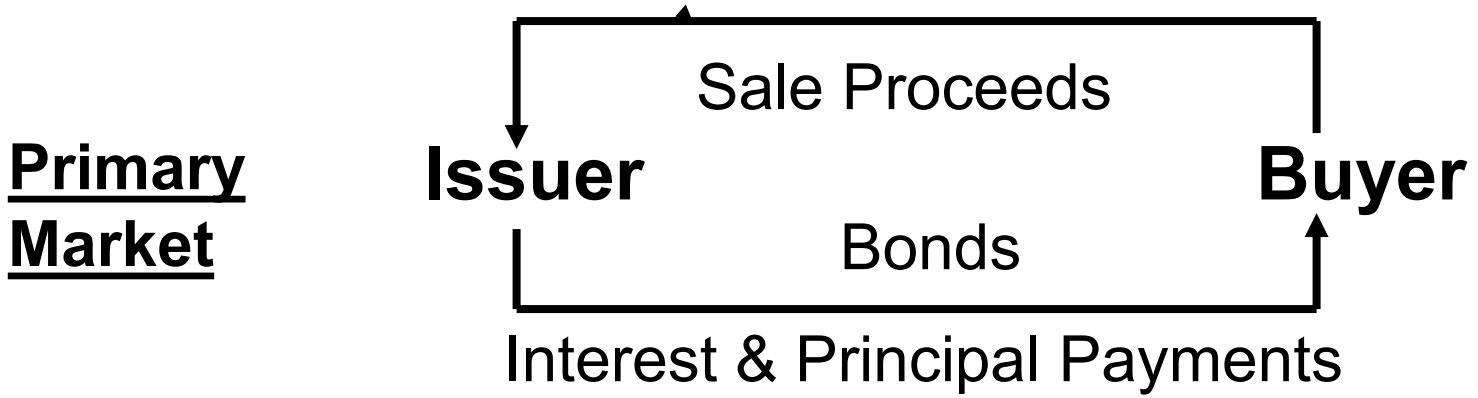
Characteristics of a bond

- Par, stated, face, or maturity value of the bond
  - Amount paid back at maturity (e.g., $1,000).
- Maturity date
  - Date when the par value is repaid (end of bond life).
- Coupon rate
  - Stated interest rate (e.g., 5% → $50 annual interest).
- Time intervals
  - How often coupon is paid (e.g., semiannual = $25 twice a year).
- Example: A $1,000 bond, 5% coupon rate, semiannual payments → $25 every 6 months, $1,000 returned at maturity.

Valuing a bond

- Bonds are worth the present value of the stream of cash flows that they will generate, discounted at the prevailing market rate of interest.
- Example:
  - Bond face value: $1,000
  - Coupon rate: 5% annual, paid semiannually → $25 every 6 months
  - Maturity: 10 years
  - Market interest rate: 6% annual (3% per half-year)
  - Value = PV of coupons + PV of $1,000 face value
  - Excel: =PV(3%, 20, 25, 1000) ≈ $926.40
  - Note: the coupon rate is used to calculate the coupon payments; while the market rate is used for discounting
- Interpretation: Since the market rate is higher than the coupon rate, the bond sells at a discount (below $1,000).

Primary and Secondary Markets





Leases

- Types of leases
  - Operating Leases:
    - Short-term or cancelable agreements.
    - Payments are treated like rent — no ownership at the end.
  - Capital Leases:
    - Long-term, non-cancelable agreements.
    - At the end of the lease, the lessee often gains ownership of the asset.
    - Capital lease obligations are valued at the present value of the remaining future lease payments
- Example
  - A city leases equipment for $10,000 per year for 5 years at a 5% discount rate.
  - PV of lease payments =PV(5%, 5, -10000) ≈ $43,294