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FACULTY OF ECONOMICS & COMMERCE

333-201 Business Finance

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Lecture 16:
Capital Budgeting / Project Evaluation 3

Capital Budgeting III

- Examine the issues related to the estimation of incremental cash flows
- Examine the role of inflation in the capital budgeting process
- Analyze mutually exclusive projects with different lives

Issues in Cash Flow Estimation

- Timing of cash flows
    - The exact timing of project cash flows can affect the valuation of a project
    - The simplifying assumption used is that the net cash flows are received at the end of a period

- Financing charges
    - Cash outflows relating to how the project is to be financed are not included in the analysis
    - The value of a project is independent of how it will be financed
    - The discount rate used represents the rate of return required by equityholders, debtholders and other securityholders
    - Financing costs are not used in the cash flows because that results in their being double counted!

Issues in Cash Flow Estimation

- Incremental cash flows
  - Only cash flows that change if the project is accepted are relevant in evaluating a project
  - Need to be careful with sunk costs and allocated costs

- Sunk costs
  - These costs are not included as they have been incurred in the past and will not be affected by the project's acceptance or ejection

- Allocated costs
  - Overhead costs allocated by management to firm's divisions
  - These costs do not vary with the decision and are usually ignored
  - Examples are administrative costs incurred by head office and allocated to divisions

Issues in Cash Flow Estimation

- Taxes and tax effects
  - Taxes need to be included where they have an effect on the net cash flows generated by a project

- Taxes have *three* main effects on cash flows
  - Corporate taxes
  - Depreciation tax shield
  - Taxes on disposal of assets

- Corporate income tax
  - Corporate taxes should be included as a cash outflow
  - After tax cash flow = Before tax cash flow × (1 - t_c)
  - t_c = The effective corporate tax rate

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Issues in Cash Flow Estimation

- Depreciation tax savings or depreciation tax shield

  - Depreciation itself is not an operating expense and is excluded from the net cash flows

  - However, depreciation affects net cash flows as it decreases the taxes payable due to the depreciation tax shield

  - Depreciation tax savings (or shield) = t_c × Depreciation expense

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Issues in Cash Flow Estimation

- Disposal or salvage value of assets
  - The disposal or salvage value of assets needs to be taken into account after taxes
  - Taxes are payable when an asset is sold for more than its book value
  - There is a tax saving when an asset is sold for less than its book value as the loss can be offset against taxable income

- Book value = Acquisition cost - Accumulated depreciation

- Gain (or loss) = Disposal value - Book value

- Taxes payable of gain = $t_c \times$ Gain on sale

- Tax saving on loss = $t_c \times$ Loss on sale

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Issues in Cash Flow Estimation

The incremental net after-tax cash flows are...

$$C_t = (R_t - OC_t - D_t)(1 - t_c) + D_t$$

Alternatively, the incremental net after-tax cash flows are...

$$C_t = (R_t - OC_t)(1 - t_c) + t_c D_t$$

Separating the after-tax residual or salvage value (SV), we get…

$$NPV = \sum_{t=1}^{N} \left[\frac{(R_t - OC_t)(1 - t_c) + t_c D_t}{(1+k)^t} \right] + \frac{SV_N}{(1+k)^N} - I_0$$

Note: SV_N = After-tax residual (or salvage) value

Issues in Cash Flow Estimation

Example: Suppose the initial cost of a machine is $12,000. It has a useful life of 6 years and will be depreciated on a straight line basis over 6 years. The machine will generate a before-tax cash flows of $6,000 per year over its useful life and the effective corporate tax rate is 30%. If at the end of year 4 the company sells the machine for $5,000 what is the net cash flow in year 4 of the machine's life?

The net after tax cash inflows are…

$$C_4\ (R_4 - OC_4\ )(1 - t_c\ ) = 6000(1 - 0.3) = \$4,200$$

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Issues in Cash Flow Estimation

The depreciation tax saving in year 4 is...

$$t_c D_4 = 0.3 \times 2000 = \$600$$

The book value of assets in year 4 is...

End of Year	Depreciation	Accumulated Depreciation	Book Value
0			$12,000
1	$2,000	$2,000	$10,000
2	$2,000	$4,000	$8,000
3	$2,000	$6,000	$6,000
4	$2,000	$8,000	$4,000

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Issues in Cash Flow Estimation

- Before tax proceeds from the sale of the machine = $5,000

- Taxes on proceeds from sale of the machine are…
    - Total gain = Disposal value . Book value
    - Total gain = 5000 – 4000 = $1,000
    - Taxes payable = 0.3 × 1000 = $300

- The net, after-tax salvage value is.
    - SV_4 = 5000 – 300 = $4,700

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Issues in Cash Flow Estimation

The total after tax net cash flow in year 4 is…

$$\boxed{C_4 = (R_4 - OC_4)(1 - t_c) + t_c D_4 + SV_4}$$

After tax net cash inflow	$4,200	$(R_4 - OC_4)(1 - t_c)$
Depreciation tax saving	$600	$t_c D_4$
Proceeds from sale	$5,000	SV_4
Taxes payable on gains	-$300	
Total after tax net cash flow	$9,500	

Inflation and Capital Budgeting

- It is important to be consistent in your treatment of inflation
  - For nominal cash flows use the nominal discount rate
  - For real cash flows use the real discount rate

- From the Fisher relationship we have…

❖ $(1 + r) = (1 + r^*)(1 + i)$ *or*

❖ $(1 + r^*) = (1 + r)/(1 + i)$

❖ r = Nominal rate of return (or nominal interest rate) per annum

❖ r^* = Real rate of return (or real interest rate) per annum

❖ i = Expected inflation rate per annum

Inflation and Capital Budgeting

Example: *A one-year project is expected to generate net after* tax cash flows of $1,000,000 in real terms one year from now.

The nominal discount rate is 10% p.a. and the expected inflation rate is 2% p.a. If the project costs $900,000 what is the net present value of the project?

- Two methods can be used.
  - Use real net cash flows and discount with the real discount rate
  - Use nominal net cash flows and discount with the nominal discount rate

- Don't mix these up!
  - Real cash flows discounted using the nominal discount rate
  - Nominal cash flows discounted using the real discount rate

Inflation and Capital Budgeting

Method 1: Use real discount rate with real cash flows

- Real rate, $r^* = (1 + r)/(1 + i) - 1 = 1.10/1.02 - 1 = 7.84\%$
- Present value of cash inflows = 1000/1.0784 = \$927.27
- Net present value = 927.27 – 900 = \$27.27

Method 2: Use nominal discount rate with nominal cash flows

- The nominal cash flow = 1000(1.02) = \$1020
- Present value of cash inflows = 1020/1.10 = \$927.27
- Net present value = 927.27 – 900 = \$27.27

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Projects With Different Lives

Example: Consider the following two mutually exclusive projects and assume a 10% p.a. discount rate. Which machine should the firm choose at this discount rate?

End of Year	Project A	Project B
0	-$100,000	-$50,000
1	$60,000	$40,000
2	$50,000	$30,000
3	$40,000	
NPV (at 10%)	$25,920	$11,157

We cannot compare the NPVs of the projects because project B lasts only 2 years

Projects With Different Lives

- We assume that both projects are repeated with identical projects until they achieve a common duration (or life)
    - The constant chain of replacement assumption

- The constant chain of replacement assumption can be applied using two different methods…
    - The lowest common multiple method
    - The perpetuity method
    - Both methods will give the same decision

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Projects With Different Lives

- Constant chain of replacement using the lowest common multiple method
  - Replicate the projects until they achieve the same "lives"
  - A 2-year versus a 3-year project is replicated 3 and 2 times…
  - A 2-year versus a 4-year project is replicated 2 and 1 time(s)…
  - A 4-year versus a 5-year project is replicated 5 and 4 times…

Projects With Different Lives

End of Year	Project A	Project B
0	-$100,000	-$50,000
1	$60,000	$40,000
2	$50,000	$30,000 – $50,000
3	$40,000 – $100,000	$40,000
4	$60,000	$30,000 – $50,000
5	$50,000	$40,000
6	$40,000	$30,000

NPV for repeated project A = $45,390

NPV for repeated project B = $28,000

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Projects With Different Lives

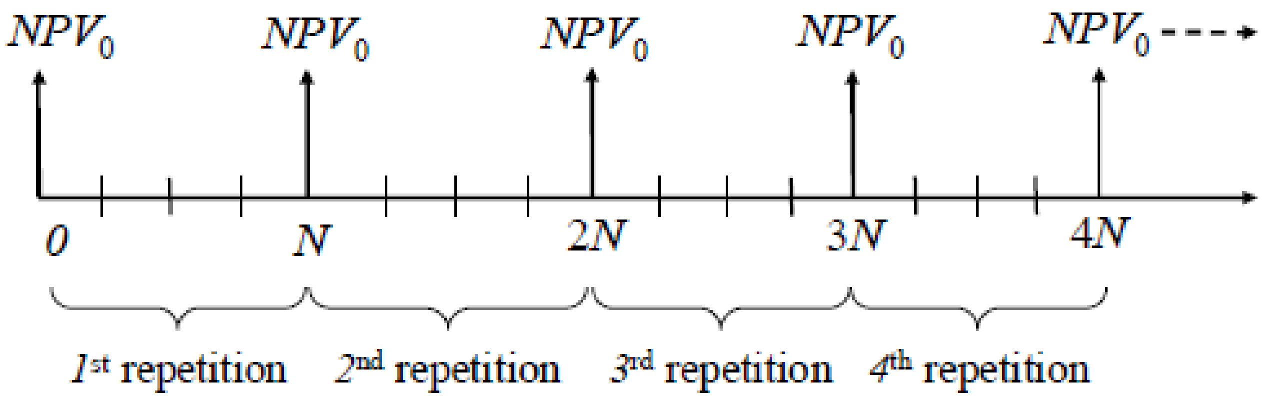
- The lowest common multiple method can be cumbersome
  - Example: Two projects with lives of 11 and 13 years require present value calculations for 143 (= 11 × 13) years!

- Constant chain of replacement in perpetuity method
  - Assumes that both projects are replicated forever
  - The chains of cash flows are of "equal length" because they are both of infinite length
  - Method is generally easier to use

Projects With Different Lives

• Consider a project with a life of N years and a required rate of return of k% p.a. Its net present value is NPV_0

• The project repeated forever will have the following profile of NPVs



Projects With Different Lives

The net present value of the infinite chain (NPV_∞) *is…*

$$NPV_\infty = NPV_0 + \frac{NPV_0}{(1+k)^N} + \frac{NPV_0}{(1+k)^{2N}} + \ldots + \frac{NPV_0}{(1+k)^\infty}$$

$$NPV_\infty = NPV_0 \left[1 + \frac{1}{(1+k)^N} + \frac{1}{(1+k)^{2N}} + \ldots + \frac{1}{(1+k)^\infty} \right]$$

$$NPV_\infty = NPV_0 \left[\frac{1}{1 - \frac{1}{(1+k)^N}} \right] = NPV_0 \frac{(1+k)^N}{(1+k)^N - 1}$$

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Projects With Different Lives

Example (continued): Consider the previous two mutually exclusive projects and assume the same 10% p.a. discount rate. Reevaluate the two machines using the constant chain of replacement method

End of Year	Project A	Project B
0	-$100,000	-$50,000
1	$60,000	$40,000
2	$50,000	$30,000
3	$40,000	
NPV (at 10%)	$25,920	$11,157

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Projects With Different Lives

- The net present values of the machines are given as.
    - NPV for project A = $25,920
    - NPV for project B = $11,157

- The net present value of the infinite chain (NPV_∞) is…

$$NPV_\infty = NPV_0 \frac{(1+k)^N}{(1+k)^N - 1}$$

$$NPV_\infty^A = 25920 \frac{(1.10)^3}{(1.10)^3 - 1} = \$104,228$$

$$NPV_\infty^B = 11157 \frac{(1.10)^2}{(1.10)^2 - 1} = \$64,286$$

Projects With Different Lives

A variant to the constant chain of replacement in perpetuity method is the equivalent annuity value method which involves the following steps.

Step 1: Obtain the NPVs of the projects
NPV for project A = \$25,920
NPV for project B = \$11,157

Step 2: Convert these NPVs to an equivalent annual value (EAV) series by dividing the NPVs by the present value of an ordinary annuity factor, that is, $[1 – (1 + k)^{-n}]/k$

- EAV for project A = $25920/\{[1 – (1 + 0.10)^{-3}]/0.10\}$ = \$10,423
- EAV for project B = $11157/\{[1 – (1 + 0.10)^{-2}]/0.10\}$ = \$6,429

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Projects With Different Lives

Step 3: Because the EAVs obtained in Step 2 are assumed to be perpetuities, their present values are obtained by dividing by the discount rate as follows

NPV of project A = EAV/k = 10423/0.10 = $104,228

NPV of project B = EAV/k = 6429/0.10 = $64,286

- Note that…
    - NPV_{∞} = EAV/k

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Key Concepts

- The NPV method is recommended for investment evaluation because it is consistent with the maximization of shareholder wealth

- The NPV method requires a careful analysis of which incremental cash flows are included in the analysis

- Inflation can distort NPV analysis and it is important to evaluate real (nominal) net cash flows using the real (nominal) discount rate

- The constant chain of replacement assumption is used to evaluate and compare projects of differing lives

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Key Relationships/Formula Sheet

- Fisher relationship: $(1 + r) = (1 + r^*)(1 + i)$
- Net present value

$$NPV = \frac{C_1}{(1+k)} + \frac{C_2}{(1+k)^2} + \ldots + \frac{C_N}{(1+k)^N} - I_0$$

$$NPV = \sum_{t=1}^{N} \frac{C_t}{(1+k)^t} - I_0$$

$$NPV = \sum_{t=1}^{N} \left[\frac{(R_t - OC_t)(1-t_c) + t_c D_t}{(1+k)^t} \right] + \frac{SV_N}{(1+k)^N} - I_0$$

- Net present value (constant chain replacement method in perpetuity and the equivalent annuity value method)

$$NPV_\infty = NPV_0 \frac{(1+k)^N}{(1+k)^N - 1} = EAV / k$$

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