15.401 Recitation

8: Capital Budgeting

Learning Objectives

- Review of Concepts
  - NPV
  - Payback Period
  - IRR
  - Profitability index
- Examples
  - Bart's Super-Widget*

* Bart's Super-Widget by Bart Raeymaekers

Review: capital budgeting

- Decision:
  - Accept or reject a project
  - Compare two projects
- Decision rule:
  - NPV, IRR, payback period, etc.
- Information
  - Cash flow projection
  - Risk projection
  - Tax regulation

Review: NPV

- **Net present value (NPV)** of a project is

$$\mathrm{NPV} \equiv \sum_{t=0}^{\infty} \frac{\mathrm{CF}_t}{\left(1+r_t\right)^t} > 0$$

- Decision should be based on **after-tax cash flow** instead of **accounting earnings**.
- Operating profit = operating revenue – operating expenses without depreciation
- CF = (1 – τ) x operating profit – capital expenditure
  + τ x depreciation

  (τ is the tax rate)

Review: NPV

- Decision rule:
  - Independent projects: take all projects with NPV>0
  - Mutually exclusive projects: take projects with the highest NPVs
- The NPV rule **dominates all other rules** because it takes into account the **maximum amount of information**, including timing of all cash flows and risks, and makes the correct decision based on value creation.

Review: payback period

- The **payback period** is the minimum *T* such that

$$\sum_{t=1}^{T} \mathrm{CF}_t \geq \mathrm{CF}_0 = I_0$$

- T is the minimum number of period required to "recover" the initial investment, I_0.
- Decision rule:
  - Independent projects: take all projects with a payback period less than a fixed threshold *T**.
  - Mutually exclusive projects: take the project with the lowest payback period.

Review: payback period

- Pro:
  - Easy to calculate
- Con:
  - Ignores cash flows after the payback period
  - Ignores time value of money
- Discounted payback period: minimum T such that

$$\sum_{t=1}^{T} \frac{\mathrm{CF}_t}{(1+r_t)^t} \geq \mathrm{CF}_0 = I_0$$

  - Problem: still ignores cash flows after the payback period

Review: IRR

- The **internal rate of return (IRR)** is the discount rate that satisfies

$$0 = \sum_{t=0}^{\infty} \frac{\mathrm{CF}_t}{(1+\mathrm{IRR})^t}$$

- IRR is the implied rate of return of the project.
- Decision rule:
  - Independent projects: take the projects with IRR > r*, where r* is the required rate of return.
  - Mutually exclusive projects: take the project with the highest IRR (provided it is greater than r*).

Review: IRR

- IRR gives the same decision as NPV if
  - Cash outflow occurs only at time o
  - Only one project is under consideration
  - Required cost of capital is the same for all periods
  - Threshold rate is set to the required cost of capital
- Potential problem:
  - IRR may not exist
  - There may be multiple IRRs for a single cash flow.
  - IRR rule gives the wrong decision for mutually exclusive projects.

Review: profitability index

- The profitability index of a project is

$$\mathrm{PI} = \frac{1}{I_0} \sum_{t=1}^{\infty} \frac{\mathrm{CF}_t}{(1+r_t)^t}$$

- Decision rule:
  - Independent projects: take all projects with PI > 1.
  - Mutually exclusive projects: take the project with the highest PI.
- PI gives the same decision as NPV if
  - Cash outflow occurs only at time 0
  - There is only one project under consideration.

Example: Bart's Super-Widget

- **Project overview:**
  - Bart Co., a profitable widget maker, has developed an innovative new product called the Super-Widget. The company has invested $300,000 in R&D to develop the product and expects that it will capture a large share of the market.
- **Capital requirement:**
  - Bart Co. will have to invest $750,000 in new equipment. The machines have a useful life of 5 years, with an expected salvage value of $0.

Example: Bart's Super-Widget

- **Revenue projection:**
  - Over the next five years, unit sales are expected to be (5, 8, 12, 10, 6) thousand units.
  - Prices in the first year will be $480, and then will grow 2% annually.
- **Operating expenses:**
  - Sales and administrative costs will be $150,000/year.
  - Production costs will be $500/unit in the first year, but will decline by 8% every year thereafter.
  - The tax rate is 35% and the after-tax cost of capital is 12%.

Example: Bart's Super-Widget

❑ Revenue and Cost

	t=1	2	3	4	5
Revenue					
Units	5,000	8,000	12,000	10,000	6,000
Price/Unit	480	490	499	509	520
Total	2,400,000	3,916,800	5,992,704	5,093,798	3,117,405
Expenses					
SG&A	150,000	150,000	150,000	150,000	150,000
Cost/Unit	500	460	423	389	358
Total	(2,650,000)	(3,830,000)	(5,228,400)	(4,043,440)	(2,299,179)
Op. Profit	**(250,000)**	**86,800**	**764,304**	**1,050,358**	**818,226**

Example: Bart's Super-Widget

❑ Depreciation and Tax

	t=1	2	3	4	5
Op. Profit	(250,000)	86,800	764,304	1,050,358	818,226
Depreciation	(150,000)	(150,000)	(150,000)	(150,000)	(150,000)
EBIT	(400,000)	(63,200)	614,304	900,358	668,226
Taxes @35%	140,000	22,120	(215,006)	(315,125)	(233,879)
Net income	**(260,000)**	**(41,080)**	**399,298**	**585,233**	**434,347**

Example: Bart's Super-Widget

❑ Cash Flow

	t=0	1	2	3	4	5
Net income		(260,000)	(41,080)	399,298	585,233	434,347
CAPEX	(1,000,000)					
Cash flow	(1,000,000)	(110,000)	108,920	549,298	735,233	584,347
PV @ 12%	(1,000,000)	(98,214)	86,830	390,979	467,254	331,574
NPV	**$178,423**					

Example: Bart's Super-Widget

- Reminder:
  - CF = after-tax operating income + depreciation tax shield
    – capital expenditure

    = (1 – τ) x operating income + τ x depreciation
    – capital expenditure
  - The accounting net income is taxed even if it is negative.
  - Depreciation is not a cash flow but reduces taxes.

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