Capital Budgeting

r = Required rate of return
NPV = Net Present Value
IRR = Internal Rate of Return
TVM = Time Value of Money
Sal_T = Cash proceeds from sale of fixed capital at Termination date
B_T = Book value at Termination date
FCInv = Fixed Capital Investment
NWCInv = Net Working Capital Investment
S = Sales
C = Cash operating expenses
TNOCF = Terminal year after tax non-op cash flow

T = Tax rate.
CF = after tax operating Cash Flow
EAA = Equal Annual Annuity
CAPM = Capital Asset Pricing Model
APT = Arbitrage Pricing Theory
MRP = Market Risk Premium
MV = Market Value
PV = Present Value
NOPAT = Net Operating Profit After tax
MVA = Market Value Added
D = Depreciation

1. INTRODUCTION

- Important for long term projects
- Principles adapted for other corporate decisions
- Valuation principles similar to these used in security analysis
- Focus on maximizing shareholder value

2. THE CAPITAL BUDGETING PROCESS

Steps

1. Generating Ideas
   - Most important step
2. Analyzing Individual Proposals
   - Gathering information
   - Forecasting cash flows
   - Evaluating profitability
3. Planning the Capital Budget
   - Organize profitable proposals
4. Monitoring & Post-auditing
   - Actual results compared with projections

Project Categories

1. Replacement projects
   - Easier decisions
   - Can be normal replacement of equipment or replacing with technology
2. Expansion Projects
   - Increase size of business
   - More uncertain
   - Carefully considered
3. New product & services
   - ↑ uncertainty
   - Complex & involve more people in decision making process
4. Regulatory, safety, and environmental projects
   - Frequently required by external party
   - May generate no revenue
   - Mandatory
5. Other Projects
   - Can escape project analysis
   - Pet projects (can be)
   - Some R&D decisions (can be)

3. BASIC PRINCIPLES OF CAPITAL BUDGETING

Common Assumption & Principles

1. Decision based on cash flows
2. Timing of cash flow crucial
3. Cash flows based on opportunity cost
4. After-tax cash flows analyzed
5. Financing costs are ignored → reflected in required rate of return

Some Important Concepts

- Sunk cost: Already incurred, do not affect capital budgeting
- Opportunity cost: What resource is worth in next best use. Considered in capital budgeting
- Incremental cash flow: Cash flow with decision – cash flow without that decision
- Externality: Effect of investment on other things beside investment e.g. *cannibalization*
- Conventional Cash flow: Initial outflow followed by series of inflows
- Nonconventional cash flow: Cash flows can flip from +ve to –ve, or even multiple times

- Independent projects: Cash flows independent of each other
- Mutually exclusive projects: That compete directly with one and other
- Project sequencing: Done through time to create option to invest in future project
- Unlimited funds environment: Company capable of raising funds for all profitable projects
- Capital rationing: limited funds → allocated to achieve maximum shareholder value subject to funding constraints

4. Investment Decision Criteria

4.1 Net Present Value (NPV)

- $NPV = \sum_{t=1}^{n} \frac{CF_t}{(1+r)^t} - outlay$
- Invest if NPV > 0
- Do not Invest if NPV < 0

4.2 Internal Rate of Return

- $\sum_{t=1}^{n} \frac{CF_t}{(1+IRR)^t} = outlay$
- Invest if IRR > r
- Do not invest if IRR < r

4.3 Payback Period

- No. of years required to cover the original investment
- Cash flows are not discounted → major drawback
- Does not measure profitability
- Indicator of project liquidity
- No decision rule due to lack of economic viability

4.4 Discounted Payback Period

- No. of years taken by cumulative discounted cash flows to equal the original investment
- ↑ than payback period
- Usually – NPV projects → No discounted payback period
- Ignores cash flows after payback period reached
- – NPV but + discounted cash flow can happen

4.5 Average Accounting Rate of Return (AAR)

- AAR = $\frac{PAvg.net\ income}{Avg.book\ value}$
- Easy to understand & calculate
- Based on accounting not on cash flow →practical limitation
- TVM not accounted for
- No conceptual criterion of distinguishing between profitable & non-profitable project investments

4.6 Profitability Index (PI)

- PI = $\frac{\text{PV of future cash flows}}{\text{initial Investment}} = 1 + \frac{NPV}{initial\ Investment}$
- Invest if PI>1.0
- Do not invest if PI < 1.0
- PI → indicates value received against 1 unit invested
- Used as guide in capital rationing
- Also known as *benefit-cost ratio*

4.7 NPV Profile

- Shows NPV as function of discount rates
- y-axis ⇒ NPV, x-axis ⇒ Discount rates in %

4.8 Ranking Conflicts between NPV and IRR

- Conflicts arise in mutually exclusive projects
- Choose project based on ↑NPV
- Projects with different scale can also create conflicts

4.9 The Multiple IRR Problem and the No IRR Problem

- Unconventional cash flows can cause multiple IRR problem
- No IRR problem → No discount rate at which NPV is 0
- No IRR project → good investment

4.10 Popularity and Usage of the Capital Budgeting Methods

- Larger companies usually use NPV/IRR techniques
- European countries usually use payback period
- MBA's prefer using discounted cash flow techniques
- NPV criterion most directly related to stock prices
- Typically value of company = Existing investment + NPV of future investments
- Impact of investment on stock price is based on expectations
- Management's capital budgeting process can demonstrate quality of management and degree to which management ↑ shareholders' wealth.

5. Cash Flow Projections

5.1 Table Format with Cash Flows Collected by year

- Cash flows from conventional expansion project grouped as
  - Investment outlay
  - After-tax operating cash flows over project's life
  - Terminal year after-tax non-operating cash flows
- See Volume III, Reading 19, Table 14.

5.2 Table Format with Cash Flows Collected by Type

- See Volume III, Reading 19, Table 15.
- Another way of organizing cash flows
- Cash flows accumulated by type

5.3 Equation Format for Organizing Cash Flows

- Initial outlay = FCInv + NWCInc
- Annual after-tax op. cash flow = (S-C-D)(1-T) + D
- TNOCF = Sal_T + NWCInv – T(Sal_T – B_T)

6. More on Cash Flow Projections

6.1 Straight Line and Accelerated Depreciation Methods

- Accelerated depreciation generally improves NPV compared to straight-line depreciation
- Modified Accelerated Cost Recovery System (MACRS) is generally used for tax reporting
- Assets under MACRS are classified into 3,5,7 or 10 year classes
- Each year's depreciation calculated through given percentage.
- Under MACRS depreciation period is assumed to start at middle of year

See Volume III, Reading 19, Table 17.

6.2 Cash Flows for a Replacement Project

- Incremental cash flows are used
- Outlay= FCInv + NWCInv –Sal_0 +T(Sal_0 –B_0)
- CF= (△S –△C –△D) (I–T) + △D
- TNOCF= △Sal_T + NWCInv – T(△Sal_T – △B_T)

6.3 Spreadsheet Modeling

- Capital budgeting usually done on computers using spreadsheets

See Volume III, Reading 19, Example 7.

6.4 Effects of Inflation on Capital Budgeting Analysis

- Nominal CF ⇒ includes effects of inflation
- Real CF ⇒ adjusted ↓ to remove effects of inflation
- Nominal CFs discounted at nominal discount rate
- Real CFs discounted at real discount rate
- 1+Nominal rate= (1+Real rate)(1+Inflation rate)
- With inflation WACC↑, NPV↓, IRR↓
- If inflation > expected → profitability ↓ than expected
- ↑ inflation ↓ depreciation tax saving ↑ wealth transfer from tax payers to government
- Higher than expected inflation, ↑ wealth transfer from bondholders to issuers
- Unequal effect of inflation on revenues & costs
  - After-tax cash flows will be better or worse depending on how sales outputs and cost inputs are affected.

7. Project Analysis & Evaluation

7.1 Mutually Exclusive Projects with Unequal Lives

7.1.1 Least common multiple of lives approach

- Life of projects with unequal lives is made equal using LCM
- Project with ↑ NPV is selected

7.1.2 Equivalent annual annuity approach

- Annuity payment = NPV is calculated for each project
- Project with ↑ EAA is chosen
- Project with -EAA is chosen if – NPV (pet projects)

7.2 Capital Rationing

- Done when company has constrained budget
- Allocation is done in choosing projects that ↑ shareholders' wealth
- Projects chosen within budget with ↑ NPV.
- Individual ↑ NPV projects → not necessarily chosen
- PI is used, IRR is not used
- Misallocation of resources; potential disadvantage of capital rationing
- Hard Capital Rationing: fixed budget, managers cannot go beyond it.
- Soft capital rationing: fixed budget but managers are allowed to over-spend it under profitable opportunities.

7.3 Risk Analysis of Capital Investments – Stand-Alone Methods

7.3.1 Sensitivity Analysis

- 1 variable is changed at a time to check △ in NPV
- Useful in analyzing most influential variable
- Variables are plotted on graphs
- This analysis is used to establish the most influential variables on project's success or failure.

7.3.2 Scenario Analysis

- Several variables changed at a time to gauge △ in NPV.
- Three scenarios may be used

Pessimistic
- ↑Costs
- ↓ revenues
- ↑ r (used to calc. NPV).

Optimistic
- ↑revenues
- ↓ costs
- ↓ r (used to calc. NPV).

Most likely
- Base case scenario
- Project inputs costs, revenues & r are used to calc. NPV

7.3.3 Simulation (Monte Carlo) Analysis

- Procedure of estimating probability distribution of outcomes.
- Good estimate built by simulating results hundreds/thousand of times.

See Volume III Reading 19, Example 8.

7.4 Risk Analysis of Capital Investments – Market Risk Methods

- Discount rate should be adjusted for market risk
- Market risk measure depends on how projected cash flows correlate with market returns
- CAPM & APT are used to estimate MRP

CAPM divides total risk into

Systematic risk	Unsystematic risk
• Related to market • Can't be diversified	• Unrelated to market • Can be diversified

- For diversified firm total risk measurement is inappropriate
- Asset beta is used to measure systematic risk
- SML is used to determine r which is used as discount rate
- Using r → NPV > 0 & IRR > r →

- If project riskiness ↑ avg. company's riskiness – use project r not company's WACC
- Using WACC for ↓ (↑) beta project overstate (understate) r
- If publically data unavailable → use pure play method to estimate beta.

7.5 Real Options

- Capital budgeting options allow flexibility regarding future decisions
- Like financial options but with underlying real assets
- Contingent on future events, option not compulsion

Timing options: option to delay the investment timing

Sizing option
- Abandonment option: opportunity to abandon project when profitable to do
- Growth/ Expansion option: ability to undertake additional investments when profitable

Flexibility options
- Price setting option to ↑price when demand > supply (capacity)
- Production Flexibility option to add more shifts, working overtime when demand ↑ in production

Fundamental Options
- Whole investment is an option
- R&D projects are most likely fundamental options
- Whole venture decision is based on underlying assets

Approaches to evaluate capital budgeting projects with
i. NPV +ve without real options → go ahead no need to value option, they add value
ii. Project NPV= NPV (without options) + value of options – cost of option
iii. Use decision trees
iv. Use option pricing models to evaluate the options

7.6 Common Capital Budgeting Pitfalls

i. Failure to incorporate economic response into investment analysis
ii. Using standardized capital budgeting templates for unique projects
iii. Using normal analysis for pet projects, overly estimating forecasts or undertaking no analysis
iv. Using short term profitability measures like ROE, NI, EPS instead of NPV, (long term measure)
v. Using IRR for mutually exclusive projects
vi. Bad accounting for cash flows
vii. Over estimating overhead costs
viii. Using WACC instead of r for project with risk different than company's avg. risk
ix. Spending entire capital budget just because it is available
x. Not focusing on alternative projects which could be profitable
xi. Mishandling opportunity and sunk costs

8. OTHER INCOME MEASURES & VALUATION MODELS

8.1 The Basic Capital Budgeting Model

See Volume III, Reading 19, Table 28.

8.2 Economic & Accounting Income

Economic Income = Cash flow + △ in MV

- △ in MV = Ending MV – Beg. MV
- △ in MV is also termed as economic depreciation
- MV at any point in time= PV of future CF
- Interest is ignored
- Economic rate of return is used to calculate MV

Accounting Income

- Measured as Revenue - Expense
- Depreciation based on original cost not MV
- Interest is adjusted while calculating it

8.3 Economic Profit, Residual Income & Claims Valuation

8.3.1 Economic Profit

- EP = NOPAT - $ WACC
- NOPAT = EBIT (1 – TAX)
- $WACC = Capital x WACC
- NPV = $\sum_{t=1}^{\infty} \frac{EP_t}{(1+WACC)^t}$
- NPV = MVA

8.3.2 Residual Income

- $RI_t = NI_t – EC_{t-1}$
- $EC_t = r \times B_{t-1}$
- NPV = $\sum_{t=1}^{\infty} \frac{RI_t}{(1+r_e)^t}$
- Value of company = Original BV of debt & equity + PV of RI

8.3.3 Claim Valuation

- Estimates value of liabilities / equity claims against assets.
- Value of company = Liabilities value + equity value
- Value of liabilities = PV of interest & principal proceeds at r_d
- Value of equity = PV of cash flows at r_e
- In principal EP, RI and claim valuation results in same valuation
- Only measure value of company

Real world complications

- Pension liability adjustments
- Financial instruments MV
- Gains/losses (exchange rate)
- Adjustments → deferred tax, goodwill, inventories, lease