Investment Appraisal

Chapter 3
Investments: Spot and Derivative Markets
Compounding vs. Discounting

• Invest sum over years, how much will it be worth?
• Terminal Value after \( n \) years @ \( r \): 

\[
TV_n = P (1 + r)^n \quad \text{if } r_1 = r_2 = \ldots = r_n
\]

\[
- \quad 1000 \times (1.1)^2 = 1210
\]

• Offer a final sum in \( n \) years, how much should I get now?
• Discounted Present Value:

\[
DPV = \frac{TV_n}{(1 + r)^n} = \frac{1210}{1.1^2} = 1000
\]

• Discounting is the inverse or mirror image of compounding.
Investment Appraisal
(a.k.a. Capital Budgeting)

• Central concepts:
  – Capital cost (KC)
  – Opportunity cost of capital (typically \( r \))
  – Net Present Value (NPV)
  – Internal Rate of Return (IIR)
  – In principle equivalent concepts, but one may be more informative than another, depending on the context used.
A Project Proposal

• Cash Flow:
  – $CF_1 = 1100$ and $CF_2 = 1210$

• $KC = 2100$

• $R = 10\%$

• Should you invest?
  • $2310 > 2100$
NPV

\[ DPV_{CF} = \frac{CF_1}{(1+r)} + \frac{CF_2}{(1+r)^2} = \frac{1100}{1.1} + \frac{1210}{(1.1)^2} = 2000 \]

- KC = 2100
- DPV – KC < 0
- Do not invest, because opportunity cost of capital not compensated for.
- Equivalently,
  - Place KC in bank for 2 years: \( TV_{KC} = 2541 \)
  - Terminal Value of Project: 2420
  - Why?
IRR

• IRR is that rate of interest that equates an initial outlay with the DPV of an income stream.

\[
2000 = \frac{1100}{1+y} + \frac{1210}{(1+y)^2}
\]

• \(y = ?\)

• Implicit assumptions:
  – \(y\) is an average growth rate.
  – All payments received before the terminal investment are re-invested at \(y\). Why?
Different CF Profiles

• \{-,-,\ldots,+,+\ldots\} \text{ NPV}>\text{KC or } y > r \rightarrow \text{Invest}
• \{+,+,\ldots,-,-,\ldots\} \text{ NPV}>\text{KC or } y < r \rightarrow \text{Invest}
• \{-,+,-,\ldots\} \text{ NPV}>\text{KC} \rightarrow \text{Invest. IRR ambiguous.}
Mutually Exclusive Projects

- **Scale/Timing Problem**: \( \{CF_t, CF_{t+1}\} \)
  - Project A: \{-10, +15\} with \( r = 10\% \) \( \rightarrow \) IRR = 50\%, NPV = 3.64
  - Project B: \{-80, +110\} & \( r = 10\% \) \( \rightarrow \) IRR = 37.5, NPV = 20.
  - Use NPV or adjust IRR:

- Incremental CF: \( CF_B - CF_A \rightarrow \) \{ -70, 95\}

- Incremental IRR:
  \[ 0 = -70 + \frac{105}{(1 + \text{IncIRR})} \]

- Incremental NPV
  \[ -70 + \frac{95}{1.1} = 16.36 > 0 \]
Real vs. Nominal

\[(1+r_n) = (1+r_r)(1+\pi)\]

- Nominal CF discounted at nominal rate
- Real CF discounted at real rate
- Assume \(\pi = 5\%\), \(r_r = 3\%\) & get €100 in a year:

\[
\begin{align*}
100/1.0815 &= 100/(1.05*1.03) = 92.464 \\
100/1.05 &= 95.238 \\
95.238/1.03 &= 92.464
\end{align*}
\]
Timing of Capital Expenditures

• The timing of the initiation of a project can be crucial. But when is a good time?
• Delays imply lose out on revenue but save on interest payments.
• If we know the CFs (and \( r \)) with certainty we can work out the NPV of the project at different start dates.
• Take care express the NPVs for different start dates in present value terms (i.e. \( \text{NPV}_1 \) is discounted for one period, \( \text{NPV}_2 \) for two periods…).
• Choose Project with highest NPV.
• Intuitive delay if growth in NPV > \( r \)
Uncertainty & Risk

• Cash Flows (& \( r \)) tend to vary over time.
• Use probability distributions to account for this: use expected CF
• E.g., a good and a bad state of the economy \( \{V_G, V_B\} = \{100, 40\} \) & \( \{\Pr_G = 0.75, \Pr_B = 0.25\} \):

\[
V^e = 0.75 \times 100 + 0.25 \times 40 = 85
\]

\( \Rightarrow \) NPV = -KC + \( V^e / (1+r) \)
• Decision Trees:
  – How many contingencies?
  – Exponential increase in complexity over time.

• Liquidation Value

• Real Options Theory, Sensitivity Analysis, Scenario Analysis

• Discount Factor:
  – ‘Safe’ Rate? Projections of yield curve.
  – Risk Premium? (e.g. CAPM, WACC)

• Capital Rationing → NPV fails, so use Profitability Index to rank projects:

\[ PI = \frac{DPV(CF)}{KC} \]
Other Decision Rules

• Payback Period:
  – Number of years it takes for CF to exceed KC.
  – Problem is CF not discounted.
  – Unsophisticated (and therefore useful) Rule of Thumb often used alongside NPV.
  – More frequently used in small firms and Europe according to CEO survey.

• Return on Capital Employed (ROC) [Return on Investment (ROI), Accounting Rate of Return (ARR)]:
  – ‘Profits’/KC
  – What profits to use? Current, average past, projections…
  – Investment may take place over several periods.
Financing & Investment Decisions

• The financing and investment decisions are treated separately → A project’s PV is calculated independent of debt considerations.

• Many possible sources of finance → Weighted Average Cost of Capital. Consider a Debt & Equity financed firm for example:

\[ 1 + r_{WACC} = \left( \frac{D}{D + E} \right)(1 + r_D) + \left( \frac{E}{D + E} \right)(1 + r_E) \]

• Does bankruptcy risk increase WACC? Chapter 11 Modigliani & Miller ‘Irrelevance of Funding Theorem’.
Some Practical Considerations

- EBITD = Revenue – Inputs Costs
- Depreciation (price, scrap value, lifetime)
- Tax \( T = t(R-C-D) \)
- Post tax CF:
  \[ CF_{Post\ Tax} = (R-C)(1-t)+tD \]
- \( tD \) is the depreciation tax shield
Working Capital

• Predictions on CF & KC tend to be smoothed out, WC is to account for the leads and lags.

• WC = Inventory + accounts receivable – accounts payable

• Change in WC = Change in inventory + change in accounts receivable – change in accounts payable
• Opportunity Cost
• Sunk Costs
M&A

\[ Gain = NPV_{A+B} - \left( NPV_A + NPV_B \right) - tc \]

- Success? Mixed assessment & difficult to assess \( NPV_{A+B} \).
- Synergies? Economies of scale related cost sharing, market power, customer base, …
- Are these beneficial to society?
- Discount Rate?
  - Horizontal (similar industry & rate) vs. Vertical (prob. differ) Merger
- Shareholder Maximisation vs. Empire Building
- Should invest in all own projects with \( NPV > 0 \), then release excess cash to shareholders to invest as they want. M&A only if gains accrue from joining itself.