S4: Basic concepts in finance

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Recap

- Finance deals with consumption smoothing of all economic agents: individuals, firms, governments.
- Firms are built using debt and equity.
- A bond is a debt security, while shares are equity securities.
- Securities allow debt and equity to be traded.
- Financial markets trade securities to discover prices, provide liquidity and allow risk to be managed.
- Different markets have different microstructures to carry out the same functions.

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Goals of this class

- Assets as a combination of cashflow, maturity pairs.
- Basics in the framework to compare assets: rate of return, period of investment, frequency of compounding.
- The discounted present value approach to price assets, DPV.
- Pricing bonds, physical projects, stocks.

Assets as a combination of cashflow, maturity pairs

Basic definition of any financial asset

1. Every asset is a *legal contract* between two counterparties.
2. Parameters of contract definition:
   - Every contract has an *expected cashflow*
   - at a *defined maturity*.

   Cashflows: what amount and type of income is received.

Every asset can be described as a series of (Cashflow, Maturity) pairs.

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Classifying financial assets

- Assets with fixed (deterministic) cashflows and fixed maturities: **loans, bonds**
- Assets with fixed cashflows and uncertain maturities: **insurance products**
- Assets with uncertain cashflows and fixed maturities: **derivatives**
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Basic concepts of investments and returns on investments

Comparing investments

- Financial comparisons are done on rates of returns on investments.
- Return over a period, $(1 + R) = P_1/P_0$ where P_1, P_0 are prices at sale and purchase.
- If the periods of investment are different, then R cannot be used to compare across investments.
- Need to standardise returns as an annual rate of return for comparison.

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From rates to terminal investment value

- What you need:
  1. Rate of return: R per year.
  2. Period of investment: T
  3. Frequency of payment within the year: n
- Terminal value of investment, A:

$$\mathrm{TV} = \mathrm{A}(1 + \frac{R}{n})^{nT}$$

- Annual compounding, at R per annum: $\mathrm{A}(1 + R)^t$
- Continuous compounding, at R per annum: $\mathrm{A}e^{ln(1+R)T}$
- Example:
  - TV = 110 with Rs.100 invested for a year at 10 percent annual rate of return.
  - TV = 110.5171 when the return is continously compounded.
- In this course, we use continuous compounding.

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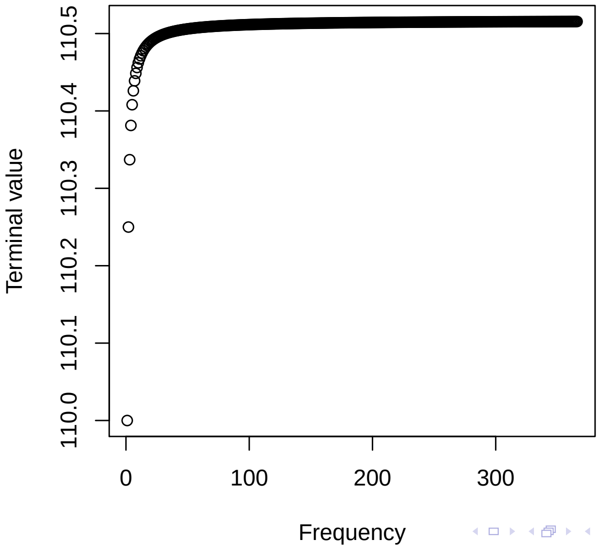
The difference that compounding makes



Effective rate of return

- Effective return is the annualised, single payment based return on any investment. (R_e)

$$(1 + R_e)^1 = (1 + \frac{R}{n})^n$$

- Example: investment pays returns at a periodic rate of 5% every six months, which is quoted as simple annual rate of 10% every year.

  Rs.100 becomes Rs.110.25 after a year. ($100 * (1.05)^2$)

  Effective return = 10.25 percent ($= 100 * (110.25/100 - 1)$)

- Example: Continuously compounded investment at 10%.

  $R_e = 2ln(1 + 0.10/2)$

- Effective annual rate = 9.758% per year.

Arithmetic vs. geometric average of returns

- Annual effective returns can be calculated as:
  - $\bar{R}_a$ (arithmetic) = $(r_1 + r_2)/2$
  - $(1 + \bar{R}_g)$ (geometric) = $((1 + r_1)(1 + r_2))^{1/2}$

$$\log(1 + \bar{R}_g) = \frac{1}{2}(log(1 + R_1) + \log(1 + R_2))$$

$$\bar{R}_g \sim \frac{1}{2}(R_1 + R_2)$$

When $R_1 \neq R_2$, $\bar{R}_a > \bar{R}_g$.

- Terminal wealth, $A_2 = A(1 + \bar{R}_g)^2$

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Long horizon returns

- A_0, A_T is wealth at start and end. Then:

$$\begin{aligned} A_T &= A_0(1+R_1)(1+R_2)\ldots(1+R_T) \\ ln(A_T/A_0) &= ln(1+R_1)+ln(1+R_2)+\ldots+ln(1+R_T) \\ &= r_{c1}+r_{c2}+\ldots+r_{cT} \end{aligned}$$

  r_{ci} is the continously compounded interest rate.

- Then final wealth is:

$$A_T = A_0 e^{(r_{c1}+r_{c2}+\ldots+r_{cT})} \sim A_0(1+\bar{R}_g)^T$$

Nominal vs. real returns

- All calculations so far gave us nominal returns.
- Real return has meaning wrt purchasing power.

  Example, real annualised return of 1% $\rightarrow$ your investment allows purchasing 1% more of a fixed basket of goods at year end.
- Measurement is relative to price of the basket of goods, $P_{g,t}$.
- Then real wealth $A_{r,0}$ at $t = 0$ is

$$A_{r,0} = A_0 / P_{g,0}$$

- If R is *nominal return* on wealth, then at $t = 1$,

$$\begin{aligned}
\text{Nominal wealth at } t = 1, A_1 &= A_0(1 + R) \\
\text{Real wealth at } t = 1, A_{r,1} &= \frac{A_1}{P_{g,1}} = \frac{A_{r,0}P_{g,0}(1 + R)}{P_{g,1}}
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The effect of inflation on returns

- Inflation, π: $P_{g,1}/P_{g,0} - 1$
- Real rate of return, r for period 1 is calculated as:

$$(1 + \mathrm{r}_1) = \frac{\mathrm{A}_{r,1}}{\mathrm{A}_{r,0}} = (1 + \mathrm{R}_1)/(1 + \pi)$$

$$\mathrm{r}_1 \sim \mathrm{R}_1 - \pi$$

Returns on foreign investments

- Nominal return on a foreign investment =
  Foreign currency return + appreciation in the foreign currency.
  Example, an Indian investment in the US returns:
  USD nominal returns on the investment +
  USD-INR returns.
- If US nominal returns R^{us} and INR for 1 USD at $t = 0$ is E_0, then:
- A_0 investment (in INR) becomes nominal A_1 over a year as:

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\begin{aligned}
A_1 &= \frac{A_0(1 + R^{us})E_1}{E_0} \\
R = (A_1 - A_0)/A_0 &= R^{us} + (E_1 - E_0)/E_0 + R^{us}((E_1 - E_0)/E_0) \\
&\sim R^{us} + R^{fx}
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- **HW:** Show that the real return on foreign investment is

$$R_{r,1} \sim R^{us} + R^{fx} - \pi^{India}$$

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Pricing assets

Discounted present value

- Terminal value of investment over T years:

$$\mathrm{TV}_T = A(1 + r_T)^T$$

where r_T is the interest rate over that period.

- Discounted present value, DPV is:

$$\mathrm{TV}_T/(1 + r_T)^T$$

This is what you would be willing to pay to get *FV* in the future. This is the price of the investment today.

- Inputs to price an asset using DPV:
  1. Cashflows
  2. Their maturity
  3. The rate of return over the period.
- When there are several payments in the future, and the rate of return is constant for all points in the payment structure,

$$\mathrm{P} = \sum_{t=1}^{T} \mathrm{TV}_t/(1 + r)^t$$

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Example: Price of an annuity

Features: Constant cashflows at every interval for the rest of your life.
If r is constant, then:

$$\mathrm{P}_{\mathrm{annuity}} = \frac{\mathrm{TV}}{r}(1 - 1/(1+r)^T$$

Pricing projects

Pricing physical investment projects

- A project has a capital cost: K and
  Expected cashflow at fixed maturities: C_i, t_i.
- DPV of cashflows is $\sum_{i=1}^{T} C_i/(1+r)^i$, or:

$$\sum_{i=1}^{T} \delta_i C_i$$

- Net Present Value, NPV = DPV - K
- Invest in the project if NPV is positive.
- Observation: Higher the r, smaller the NPV.
- Observation: r at which NPV = 0 is called the *internal rate of return* (IRR).
  IRR is problematic because (a) rates in the real world change every period, and (b) IRR and NPV do not always lead to the same decision.
- The above calculations have no uncertainty.
  Alternative calculation of DPV include a 'premium' in addition to r_i $(r_i + p_i)$ to adjust for this.

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Pricing bonds

Pricing a GOI bond

- A bond has cashflows $(c_1, t_1), (c_2, t_2), \ldots, (c_N, t_N)$.
- Then the price is:

$$\mathrm{P} = \sum \frac{c_i}{(1+r)^{t_i}}$$

- GOI bonds are credit risk free, so there is no uncertainty premium.
- In the real world, r changes with t.

  Eg, Rs.100 to be received one year later has a different value today compared to the same Rs.100 to be received ten years later.
- In that case, the DPV notation used for a cashflow C at date T is:

$$\mathrm{P} = \frac{C}{(1+z_t)^T}$$

- z_t is called the risk-free interest rate or

  the “zero coupon rate” at t.

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A term structure of interest rates

- One unique “interest rate in the economy” does not exist. There is a different interest rate for every different maturities, $z(t)$.
- The graph of maturity t on the x-axis and corresponding interest rates z_t on the y-axis is called the **term structure of interest rates**.
- It is also called the **spot yield curve** or the **zero coupon yield curve (ZCYC)**.
- Features of the ZCYC for any country:
  - In general, this graph is not flat.
  - It can change every day.

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Data sources on ZCYC for India

- In India, NSE-WDM and CCIL calculate a daily ZCYC from market prices of GOI bonds.
- NSE-WDM is the *Wholesale Debt Market* at the *National Stock Exchange*.
- CCIL is the *Clearing Corporation of India Ltd.*
- Time series of daily ZCYC from 1/1/1997 onwards.

Pricing equity

Equity

- Equity is harder than bonds in that future cashflows are uncertain.
- Equity can pay some cashflow (dividends) at some undefined future time.
- If a company is successful, dividends grow, and often quite fast.
- If the company fails, dividends go to zero!!
- This gives a possible range for stock prices: $0 \ldots \infty$.

Pricing stocks

- The value of a stock could be calculated as the DPV of expected dividends.

$$V = \sum_{t=1}^{\infty} \frac{E(d_t)}{(1 + R_E)^t}$$

  where R_E is the return on equity.

- This can also be written as:

$$V = \sum_{t=1}^{\infty} \delta_t E(d_t)$$

  where δ_t is $\frac{1}{(1+R_E)^t}$ and is called the discount rate.

- In an ideal situation,
  Price of the stock, P should be V.

Traditional accounting methods for V

- Stockholders information about the firm's income, cashflows to debt holders and other repayments.

  This is one possible proxy for dividends.
- Another source of information is past dividends.
- Two models of stock price based on accounting information: **free cashflow** and the **dividend discount** model.
- They assume:
  1. Consensus on the expected dividend payout, $E(d_t)$
  2. Consensus on the discount rate, or the return on equity, R_E.
  3. Equity is infinitely lived.
- Developed economies have financial analysts that forecast future cashflows from the balance sheets/P&Ls of companies.

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Stock price assuming a constant E(d)

- If $E(d_i) = d_i$ is a constant for every time period,
- Then for infinitely lived equity, $P_i = d_i / r_i$.
- Alternatively, assume a holding period (upto $t = 1 \ldots T$). Then

$$P_i = \sum_{j=1}^{T-1} \frac{d_i}{(1 + r_i)^j} + \frac{DPV_T}{(1 + r_i)^T}$$

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Example of pricing stocks assuming a constant E(d)

- Geojit Securities Ltd. has a policy of paying out dividends of Rs.2 every year.
- If the required rate of return for Geojit Securities is 3.5%, what is the price of Geojit Securities?
- The equity is valued as a perpetuity as follows:

$$\begin{aligned} P_{\mathrm{GSL}} &= \frac{2}{1.035^1} + \frac{2}{1.035^2} + \frac{2}{1.035^3} + \ldots \\ &= 2/0.035 \\ &= Rs.57.1429 \end{aligned}$$

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Example of pricing stocks assuming a changing E(d)

- Suppose after three years, Geojit Securities Ltd. plans to change the dividend payout from Rs.2 every year to Rs.3 every year.

  What is the price of Geojit Securities?

- After three years out, the stock is valued as a perpetuity as follows:

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\begin{aligned}
P_{\mathrm{GSL}_4} &= \frac{3}{1.035^1} + \frac{3}{1.035^2} + \frac{3}{1.035^3} + \ldots \\
&= 3/0.035 \\
&= Rs.85.7143
\end{aligned}
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- From today, the pricing becomes:

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P_{\mathrm{GSL}_4} &= \frac{3}{1.035^1} + \frac{3}{1.035^2} + \frac{3}{1.035^3} + \ldots \\
&= 3/0.035 \\
&= Rs.85.7143
\end{aligned}
$$

- From today, the pricing becomes:

$$
\begin{aligned}
P_{\mathrm{GSL}} &= \frac{2}{1.035^1} + \frac{2}{1.035^2} + \frac{2}{1.035^3} + \frac{P_{\mathrm{GSL}_4}}{1.035^4} \\
&= Rs.80.2983
\end{aligned}
$$

Pricing stocks assuming growth in dividends

- If dividends are earnings paid out, then it is troublesome to assume that there is no growth in cashflows.
- The adjustment is the valuation model assuming a constant rate of growth in dividends of g_i for firm i.
- Then

$$
\begin{aligned}
P_i &= \frac{d_i}{(1+r_i)} + \frac{d_i(1+g_i)}{(1+r_i)^2} + \frac{d_i(1+g_i)^2}{(1+r_i)^3} + \ldots \\
&= \frac{d_i}{(r_i - g_i)}
\end{aligned}
$$

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Example of pricing stocks assuming a constant growth of dividends

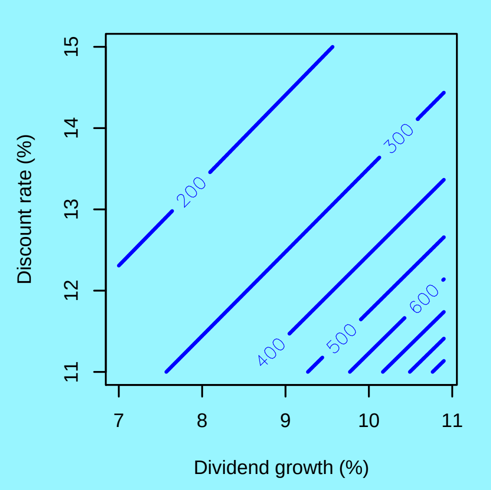
- Suppose Geojit dividends grow by 2% every year.
  What is the new valuation of Geojit equity?
- $P_{\text{GSL}} = \frac{2}{(0.035-0.02)} = \text{Rs.}133.33$

Why stock prices are hard to estimate

- The DPV of the stock depends supremely on your understanding about:
  1. future dividend growth, and
  2. the required return on equity.
- Slight changes to these views generate large changes in the price!

Sensitivity of stock prices: a simulation

Starting point: $d_0 = 10$



Small changes in $\mathrm{E}(g_D)$ and/or $\mathrm{E}(R_E) \rightarrow$ Large changes in prices.

Observation about asset pricing

- Asset pricing uses cashflows and asks what the R_E should be for the risk characteristics of the firm.
- It requires forecasting expected cashflows at future dates.
- Even if R_E were known, valuation is hard!!
- Particularly for stocks: DPV is very sensitive to slight changes in either growth of dividends or return on equity.

  As views on these two numbers change, stock prices fluctuate. This could happen in real-time.

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Observations about accounting valuation models

- Accounting valuation models are useful for pricing firms that are not listed. For example:
  - The P/E ratio of the firm can be derived as the inverse of the discount rate.
  - The P/E ratio across firms in a particular industry tend to be similar.

  Then stock price of a new company with E_j earnings at the end of the year, can be approximated as $P_j = E_j * (P/E)_{ind}$.
- There is a thriving industry of analysts whose make forecasts of earnings and the required rate of return, even for listed companies, in developed markets.
- The models are difficult to implement.
- Prices from these models are often $\neq$ traded market prices.

HW: Adopting a firm of your own

- Familiarise yourself with the CMIE Prowess database.
- Pick a non-financial firm with market value (market capitalisation) in excess of Rs.5000 crore.
  The firm should be a listed firm, with at least 85 percent trading frequency in the last two years.
- Make a simplified BS for 2014-15 and 2015-16.
- Make a simplified P&L for 2014-15.
- Trace the flow of resources between the two financial years.
- Create a time series of the dividend payout of your firm. Plot it as a PDF file using R.

Thank you.