Computational finance [no programming][Tuesday lecture 2-4 and Friday lec and 12-1 tutorial]:

* Lecture 1 [x is how much you have in the stock and y how much you have in the bank]:
  + Arbitrage [2 banks scenario one at lower interest rate than other, pointless]. The lower interest rate one would go bankrupt
  + Financial option pricing: coins example / EU call options
  + option value = S (stock price) – K (strike price) [S = price agreed on]
  + Note on 3 propositions: Linear combination [consider being given 6 make profit of 1] 🡪 combination of strategies
* Lecture 2:
  + Time value of money: cash flow stream today > cash flow stream in future
  + Define principal amount, interest (rent paid on investment) and interest rate (per unit currency) [I = W\*r] and initial wealth and terminal wealth
  + Text

    Description automatically generated with medium confidence
  + 
  + 7-10 rule [interest rates close to zero much better if you have loans not if you are saving]
  + Nominal interest rate is yearly
  + Effective interest rate [1 + r/m] ^m / [m is compounding period]
  + k = tm [m = frequency at which you compound, and t is the number of years] / for continuous compounding. Continuous compounding
  + Formulas dependent on convention (continuous(e^rt) or yearly (1+ r)^t or other combinations).
  + Discount factor (dk): recall k is the compounding period. Applied on the amount resulting after k compounding periods. FV\*dk = PV
  + Consider ideal bank: (same interest rate to deposits and loans), (no service nor transaction costs), (same interest rate for all principal sizes), (interest value independent of length of time applied)
  + Text, letter

    Description automatically generated with medium confidence
  + A picture containing diagram

    Description automatically generated
  + Used constant ideal bank to move all cash flows to end of period n or to present time
* Lecture 3:
  + x and y are cash flow streams [x’ and y’ equivalent only if their present values the same]
  + Calculate PV of cash flow stream [include all cash flow]
  + Time horizon matters
  + Interest rate term structure: [different rate for each maturity time] / spot rate is annualised interest rate [st vs t], varies over time but once you get it its fixed
  + Up to now risk-free interest rates
  + Normal market: long commitments higher I than shorter term ones [st curve normal]
  + Spot rate curve is smooth
  + Graphical user interface, application

    Description automatically generated
  + Text

    Description automatically generated with medium confidence
  + Table, Excel

    Description automatically generated
  + Above: bond paying 8% of principal. Get principal at maturity
  + Bond yield is coupon amount/price [remember under face value and over face value]
  + Always start from the spot rate curve
  + Forward rates: invest again and get forward rate at that time [use comparison principle to solve for the forward rate]
  + Text

    Description automatically generated
* Lecture 4:
  + Graphical user interface, text, application

    Description automatically generated
  + Remember it is the interest rate charged for borrowing money at t1 and repaid at t2
  + Fi, j = Ft1, t2
  + Borrow at i and repay at j
  + Forecasting spot rate: money loaned for a year a year from now. Expectation dynamics
  + Care with m periods for compounding
  + Text, letter

    Description automatically generated
  + PV(1) is the present value in year 1 [future value in year 1]
  + Diagram

    Description automatically generated with medium confidence
* Lecture 5:
  + Annuities and bonds
  + Fixed income securities: [fixed income over span of time is promised]. Usually depend on interest rates. Relationship between cash flow stream and interest rates. FIS could default, for example bonds
  + Annuity: Pension benefits are annuities [contract paying holder money periodically according to fixed schedule]
  + Text

    Description automatically generated
  + Bonds: **maturity date** [time of final payment], **face value, F** [par value, amount paid at maturity date], **coupon payment, rc\*F** [ % of face value] and m is the coupon payments per year
  + Bond terminology: corporate, municipal, treasure bond note and bill
  + Bonds 🡪 deterministic income stream [price determined by supply and demand]:
    - Quality ratings may be correlated with coupon rates [yield]. Ratings impact present value of bonds
    - YTM: bond’s yield is interest rate at which PV of payment streams is equal to current price [face value]
    - Diagram

      Description automatically generated
    - Generally, P and YTM inversely correlated
    - Chart, line chart

      Description automatically generated
    - For above chart think about par value of bond and you having paid less on more than this to acquire it [if less then YTM increases, if more then it decreases]. % of return you expect when you buy a particular bond at a specific price
    - Chart, line chart

      Description automatically generated
    - For above the face value is 1000
    - The longer the time to maturity the more sensitive is the price of the bond to the yield [higher curvature in plot]
    - Reversal in 2nd plot for rc > lambda explained by yield to maturity formula
    - For a fixed coupon rate and maturity date, supply and demand would influence YTM. The longer the product [ie date to maturity the higher the risk🡪 equations gets longer]
    - Macaulay Duration 🡪 weighted average of all payments [for sensitivity]
    - A picture containing text, clock

      Description automatically generated
    - 0 % coupon bond means maturity date = macaulay duration
    - Diagram

      Description automatically generated with low confidencerelative sensitivity
    - Immunisation: Diagram

      Description automatically generated
    - If convexity is introduced, then we must have at least 3 bonds to consider [for linear independence of systems]
  + Mean variance portfolio:
    - Optimal portfolio minimises risk and meets performance constraints
    - Need parameter estimation
    - Example on independent and identically distributed returns:
    - Text

      Description automatically generated
    - In graph below look at scenarios where ρ=1 and ρ=-1:
    - Chart

      Description automatically generated
    - Shorting not allowed portfolios are subset of shorting allowed [w unconstrained]
    - A picture containing diagram

      Description automatically generated
    - Text

      Description automatically generated with medium confidence
    - Text, letter

      Description automatically generated
    - Diagram, schematic

      Description automatically generated with medium confidence
  + Two fund theorem [market assumptions]: Assume all market players obey Markowitz
    - Text, letter

      Description automatically generated
    - Fund [multiple stocks], stock [single one]
    - Historically optimal strategy was to invest in indices [more you invest the more you minimise the variance in the Markowitz objective function]
    - One fund theorem:Calendar

      Description automatically generated with low confidencewhen borrowing and lending are allowed
    - Graphical user interface, application, Word

      Description automatically generated