Introductory Overview

- Investment mandate:
  - Investment universe
  - Investment theme
  - Portfolio implementation
    - Long only enhanced (better against benchmark)
      - If no view, can hold same weight as benchmark
    - Active extension (use the short money to go long)
    - Long short
      - Market neutral
      - Remove
      - systematic risk
    - Capacity
      - AUM
      - Rebalancing frequency
    - Investment preferences
      - Risk tolerance (moments)
      - Investment horizon
- Generate alpha signals
  - Multi asset beta (long only)
  - Multi asset risk premia (long-short)
  - Equity risk factors
    - Risk premia
    - Anomalies
  - Factor style timing (based on time want to go into certain strategies) vs multi factor model (don't care about timing, just want constant exposure to the factors)
    - Momentum vs value, regime switching VS
    - Priors vs statistical (linear vs non-linear models)
- Implement alpha views
  - Inputs
    - Alpha signals
    - Covariance matrix
    - Transaction cost
  - Objective
    - Max expected return
      - Risk budget target
      - Neutralize unintended risk factors
      - Turnover
- Tools
  - Quadratic programming
    - Mean-variance optimization
  - Non-linear programming
    - Non-linear objective function (log utility)
    - Non-linear constraints
  - Heuristics (blends picking stock and quant optimization)
- Risk Premia (premium expected to receive by taking risk)
  - Traditional
    - Long only (exposure to traditional asset bets
    - Commodities as a hedge
    - Is weighting scheme and choice of asset optimal??
      - Diversification
      - Equal exposure to beta?
      - Definition of exposure
  - Alternative risk premia
    - Long short
  - Linear relationships between sharpe ratio of risk premia and skewness
  - Option profile of risk premia
    - Long call (risk adverse)
    - Short call (market anomaly)
    - Long put (insurance)
- Strategies
  - Carry (like collecting rent/interest)
    - $Return = carry + E(price\ appreciation) + unexpected\ price\ shock$
    - $carry + E(price\ appreciation) = E(Return)$
    - Generally for currency (return on higher yielding currency against lower yielding currency)
      - Uncovered interest rate parity (low interest rate currency appreciate such that indifferent between investing in domestic interest rate market / investing in FX carry trade) does not hold for short horizons, making FX carry trades profitable
      - Long if foreign > domestic rate
    - Futures converging to spot
      - Long backwardation (futures below spot, will go up closer to maturity)
      - Long roll yield
      - Long +ve basis sign
      - Long disscount
      - Short contango (futures above spot, will go down closer to maturity)
    - Signal generation: cross-sectional signals (**relative** across n instrument) vs time series signals (historical data for each instrument)
    - Equity carry – dividend yield
    - Commodity carry – convenience yield
    - Can we predict expected return using carry
      - For equity its predictable
      - Commodities – predictability tainted by strong seasonal effects of carry
  - Liquidity (lower liquidity need liquidity premium)
  - Momentum
    - Time series momentum have net long / short bias (think about performance measure) but cross sectional momentum is dollar neutral (absolute return as the measure)
    - Momentum: Look at past 12 month excluding closest 1 month
    - Explanations
      - Macroeconomic variables driven by business cycle
      - Growth rate of industrial production
      - Overconfidence and biasedness
      - Investor under-reaction caused by gradual information diffusion
  - Reversal
  - Value
  - Volatility
  - Event
  - Growth
  - Low Volatility
  - Quality
  - Size

Bottom-up equity anomalies and risk premia

- risk factor – explains **cross section** of asset returns
- factor models
  - Used for
    - decompose risk and return attribution (systematic vs idiosyncratic)
    - estimates of abnormal returns
    - covariance matrix
  - Types
    - Macro factor model
      - observable economic / financial time series
      - regression
      - CAPM
    - Fundamental factor model
      - Returns are not observable but factor betas are (industry classification, market cap, style)
      - Returns are estimated based on betas
      - Opposite of macro
    - Statistical factor model
      - Everything not observable
      - PCA are usually used to extract factor realizations
- Estimation of fundamental factor models
  - Barra approach – z score each factor (except for binary ones)
- Factor investing
  - Fundamental law of active management
  - $E(R_A) = IC\sqrt{N}\sigma_A$,
  - $R_A = return\ over\ benchmark\ (long\ only)/absolute\ return(hedge\ fund)$
  - $N = number\ of\ bets\ (rebalancing\ frequency)$
  - $\sigma_A = active\ risk(concentrated/diversified)$
  - Risk premia => risk factor BUT risk factor !=> risk premia
- Risk factors
  - Understand cross section of expected returns
  - Common risk factors explain more variance than idiosyncratic risk in diversified portfolio
  - Risk premia are time-varying and low frequency mean reverting
  - Local not global
- Equity backtesting
  - Survivorship bias
  - Price adjustments (stock split)
  - Price return vs total return (incl. dividends)
  - Implementation lag
- SMB short big, HML short depressed stocks, difference in correlation because 1 is short big which is easy but short depressed stock have high borrow cost
- CTA makes money when theres a trend, doesn't matter, resembles a straddle
- WML makes money through out but loses when market rebound
- Volatility
  - Long low vol, short high vol = profit
- Low beta anomaly
  - Absence of leverage, use high beta stocks to compensate, expected return for high beta becomes lower
  - Not applicable for currencies and commodities because these classes can leverage for free

Bottom-up equity anomalies and risk premia II

- If risk factors are profitable over the long term = risk premia
- Anomalies cannot be explained by risk based rationales
- Factor timing works if there is factor persistence
  - Markov 2 state regime model (normal vs distressed)
- Illiquidity
  - Lower liquidity (measured by bid-ask spread), higher expected return
  - Premium for holding illiquid stocks
  - Illiquidity = daily ratio of stock return to dollar volume averaged across period
- Quality
  - Gross profitability
    - Cleanest accounting measure
    - Shows profitable firms generate higher returns despite having higher valuation (contradicts value investing, investing in cheap valuation)
  - Trend in gross profitability
  - Change in asset turnover
  - Accruals
    - Earnings can be divided into stable and transitory components
    - Everyone is focused on earnings but not accrual and cash flow components until future earnings is impacted
  - Share issuance
    - Real change in shares outstanding (accounting for stock splits and stock dividends)
    - Large firms issue fewer shares
    - High book to market (cheap) firms issue more shares and expensive firms buy back more shares
    - High momentum stocks issue more shares
- Weighting schemes
  - Value weighted
  - Equal weighted (perform better than value weight because more small cap exposure)
  - Rank weighted
- Fama Macbeth 3 step regression – determine persistence of the factor
  - Step 1: compute the betas against returns over time
  - Step 2: compute gamma of the betas against average return over T period by using betas in step 1 as the X
  - Step 3: compute t-stat, how significant is the slope
  - R-square only provide information of fraction of volatility explained **not predictive ability**
- Markov switching model
  - Look at mean and vol to determine the state
  - Probability of distressed given distressed is lower than that of normal given normal because there are more normal than distressed
  - Regime dependent weights and cov matrix
    - 2 state regime
      - 8X1 matrix of weights, state 1 and state 2
      - 8X8 cov matrix with diagonals = variances in state 1 and state 2, off diagonals bottom left and top right is 0
      - $\begin{bmatrix} variance\ state\ 1 & \cdots & cov \ldots 0 \\ \vdots & \ddots & \vdots \\ cov \ldots 0 & \cdots & variance\ state\ 2 \end{bmatrix}$

Risk management and investment management Based on FRM syllabus

- Hedge funds
  - Not open to public, less regulated
  - Profit from long/short
  - Ability to leverage
  - Incentive fee 2/20
  - Little transparency
- Hedge Fund database
  - Survivorship and self reporting bias => overstates actual
- Fund of hedge funds led to better disclosure
  - More institutional investors means more governance required
- Hedge Fund Strategies
  - Merger arbitrage
    - Betting on deal risk (completion of merger)
    - If market drops, mergers tend to be called off, merger arbitrage returns lesser
  - Equity long short
    - Tend not to be market neutral, usually net long because markets go up
  - Short bias

- Markt neutral
- Emerging market strategies

- Risk Management
  - Volatility targeting
  - Risk parity
  - Sufficient diversification
  - Non-linear risk
    - Split upside and downside beta
  - Liquidity and credit risk
    - Leverage exaggerate small profit / loss to large ones
    - Adverse changes in market prices => reduced value of collateral => credit withdrawn quickly => forced liquidation
    - Gauging liquidity risk – return's autocorrelation coefficient
      - The more efficient the market, more random price movements (lower autocorrelation)
      - LjungBox Q statistic
      - Mutual funds lower autocorrelation in returns, hedge funds more

- Portfolio performance
  - Time-weighted returns – adjust for cash flow effects, measure true performance of portfolio manager
  - Dollar-weighted returns – does not adjust for cash flow effects
  - Sharpe
  - Treynor
  - Jensen's Alpha
  - M-square – adjust portfolio by adding weights to RF such that volatility = market then compare the returns
  - Performance attribution
    - Contribution from asset allocation (difference between the weights to portfolio asset class vs benchmark weights * benchmark returns) + contribution from security selection (difference between performance of portfolio by asset class vs index performance * portfolio weights)

- Difficulties in measuring hedge fund performance
  - Dynamic risk profile, changing investment strategy
  - Invest in illiquid assets, how to MTM
  - Survivorship bias

Portfolio management I Review of portfolio theory

- Sigma problem = $argmax\left(x^T\mu - \frac{\phi}{2}x^T\sum x\right)$
  - when ϕ = 0, investor is risk loving, maximizing returns
  - when ϕ is large, minimize variance
- Analytical solution, $x = \phi^{-1}\Sigma^{-1}(\mu + \lambda\mathbf{1})$
- X will have high weights if the volatility of the asset is low and the covariance with other assets is low
- Mu problem = $argmin\left(\frac{1}{2}x^T\sum x - \gamma x^T\mu\right)$
- Separation theorem – alpha (proportion in risky assets) is driven by risk aversion, covariance and excess returns
- Market equilibrium and CAPM
  - At optimum, marginal change in portfolio expected return per unit change in portfolio variance must be equal for all risky assets
  - If not, investors will buy the higher expected return per unit risk and sell the lower expected return per unit risk until ratio is equalized
- Active return space
  - Delta weights = Portfolio weights – benchmark weights
  - Solving for delta weights, maximizing return $argmax(\Delta x^T\mu)$ subject to **sum of delta weights = 0 and tracking error = T**
  - Analytical solution, $\Delta x = \sqrt{\frac{T}{d}}\Sigma^{-1}\left[\mu - \frac{b}{c}\mathbf{1}\right]$
    - $a = \mu^T\Sigma^{-1}\mu, b = \mu^T\Sigma^{-1}\mathbf{1}, c = \mathbf{1}^T\Sigma^{-1}\mathbf{1}, d\ (information\ ratio) = a - \frac{b^2}{c}$
    - Δx proportional to mean, if return is positive, Δx positive
    - Δx proportional to T, tracking variance, larger risk willing to take, larger Δx
    - $\mu = \sqrt{Td}$, in unconstrained case (can short sell stocks and ignore the benchmark), excess returns is proportional to tracking error and information ratio
    - Solution is independent of the benchmark, by solving for delta weights, benchmark is taken out of the equation (**only for Unconstrained case**)
  - Considerations for delta weights
    - Limited short selling
    - Max / min weight differences due to mandate
    - Hedging along risk dimensions
    - Liquidity / turnover constraints
  - Constrained active return plateaus after certain point because at some point, underweighting the tail will lead to underweighting suboptimal alpha stocks in order to overweight the better performing stocks, increasing risk
- Markowitz pros and cons
  - Pros
    - Only require risk tolerance, expected return and covariance matrix
    - Numerical algorithms for finding solutions
    - Analytical solutions
  - Cons
    - Excessive weights on asset with large expected returns
    - Small change in input lead to large change in weights
    - Ignore higher moments

Portfolio construction I

- Alternative portfolio construction methods
  - Regularization of optimized portfolios
    - Introduce portfolio constraints
    - Shrinking covariance matrix (factorizing)
      - Non-negativity constraint for weights => reduction in variance by 2λ and covariance $\lambda_i + \lambda_j$
      - upper bound => increase in variance by 2λ and covariance $\lambda_i + \lambda_j$
      - Pros
        - Intuitive and computationally simple
        - Unbiased
      - Issues with sample covariance matrix
        - Imprecise for large number of assets
        - Difficult to estimate correlation
        - Not invertible when assets > periods
        - Highly sensitive to extreme elements (outliers)
  - Risk-based weighting schemes (**exam slide 49**)
    - Independent of expected returns
    - Equal weight portfolio
    - Minimum variance – equal marginal contributions across assets
    - Equal risk contribution (ignores expected returns)
      - higher volatility and higher correlation with asset that already have high weights => lower weights
    - Volatility ranking: MV < ERC < Equal weight
    - Volatility targeting
  - Black litterman
    - CAPM + reverse optimisation to provide equilibrium market portfolio as a starting point for estimating asset returns
      - Reverse optimisation: using market portfolio weights, solve for excess return by calibrating the risk aversion parameter
    - Clear way to specify investor views (partial / complete – don't need view on every asset, span arbitrary and overlapping) on returns (relative / absolute)
    - In absence of view, portfolio will be on CML
    - If 100% certainty then follow the view, omega -> 0, if 0% certainty then becomes market portfolio, omega -> inf
    - Absolute view leads to leverage
    - For relative view, look at reference point (implied equilibrium vector) vs the view to determine over/underweight
    - Weights changes only apply to assets with expressed view
    - Since confidence level is hard to quantify, show market weight vs 100% confidence weight and scale the weight accordingly to get a tilt factor added to market weight
  - Fundamental law of active management
    - IR = TC X IC X$\sqrt{N}$
    - $\sqrt{N}$: breath / n independent bets – if want more consistency in performance, higher N is better due to diversification benefits
    - IC: skill – how accurate is forecast vs realized excess returns
    - TC: friction between active weights vs forecasted excess returns
    - PC = TC X IC – correlation between active weights and realized excess returns
    - Higher tracking error => lower transfer coefficient
      - If lower tracking error -> closely following benchmark weights more closely, following forecast returns