QF605 Fixed Income Securities

Course Summary

Bond Market

Concepts

- Compounding frequency
- Day count convention, day count fraction, business day convention
- Zero rate (aka spot rate)
- Yield to maturity (redemption yield, internal rate of return)
- Bootstrapping a bond curve

Products

- Zero coupon bond, fixed coupon bond, floating rate bonds
- Clean price vs Dirty price
- On-the-run vs off-the-run

Bond Risk Management

Concepts

- 1^{st} order: Modified duration, Macaulay Duration
- 2^{nd} order: Convexity
- Bond price change, viewed from Taylor expansion
- Hedging & Risk Management: Dollar Duration and Dollar Convexity
- DV01 (difference vs PV01?)
- Bond Portfolio Immunization

Models

- Not everything is linear

Products

- Bonds with negative yields

Interest Rate Derivatives & Swap Market

Concepts

- LIBOR and Term rate, (no-arbitrage) forward rate
- Fixed leg and floating leg, telescoping series for floating leg (single-curve)
- Par swap rate, swap pricing & valuation
- IR Delta of IRS: payers vs receivers
- LIBOR discount curve bootstrapping

Products

- LIBOR Replacement & Fallback
- Forward Rate Agreement (FRA)
- Interest Rate Parity
- Implied interest rates: SOR, MIFOR, THBFIX etc.
- Interest rate swaps (IRS)
- Rate convention: fixed-in-advance, paid-in-arrears

Multicurve Framework and OIS Discounting

Concepts

- Counterparty risk: Potential Future Exposure of forwards and swaps
- Collateralization: rationale, mechanism, impact on discounting
- Credit Support Annex (CSA): collateral, collateral rate
- Discounting framework: same vs. different currency collateral
- Two main guidelines
- Liquidity Value Adjustment
- Bootstrapping forward curve in collateralized swap market
- Floating leg no longer telescope with collateralization

Products

- Overnight Index Swaps
- SOFR & EFFR, secured vs unsecured, FOMC
- Overnight Index Futures, current vs deferred month, settlement
- Implied probability of rate change

LIBOR & Swap Market Models

Concepts

- Equivalent Martingale Measure
- Radon-Nikodym derivative and changing measure
- Choice of Numeraire
- Using $D(t,T)$ or $P_{n+1,N}(t)$ as numeraire
- $W^{i+1}(t)$ and $W^{n+1,N}(t)$, risk-neutral measure and the associated numeraire
- Implied volatility skew/smile (plotting implied vols vs. strikes)

Models

- Black Model: modeling forward
- LIBOR Market Model (Black)
- Swap Market Model (Black)
- Extension: Normal, Displaced-Diffusion, SABR

Products

- Caplet, Floorlet
- Payer Swaptions, Receiver Swaptions (swap-settled)

Constant Maturity Swap Payoffs

Concepts

- Implied risk-neutral density: Breeden-Litzenberger formula
- Static replication of European payoff: Carr-Madan
- Intuition behind static replication—payoff matching
- Why do we need IRR-settled swaptions?
- Radon-Nikodym revisited: changing numeraire within risk-neutral measures

Products

- IRR-Settled Swaptions
- Constant Maturity Swaps (CMS): rate, caplet, floorlet
- Constant Maturity Treasuries

Convexity Correction and Change of Numeraire Theorem

Concepts

- Convexity Correction: paid at wrong time, or paid in wrong denomination
- Single Currency Change of Numeraire Theorem
- Multicurrency Change of Numeraire Theorem
- Spot FX process has drift
- Forward FX process is a martingale
- Cholesky Decomposition

Models

- FX process under domestic/foreign risk-neutral measure

Products

- LIBOR-in-Arrears
- Quanto LIBOR

Short Rate Models: Ho-Lee & Hull-White

Concepts

- The need for term structure models
- Drift and volatility in short rate models
- Reconstructing zero-coupon bonds from short rate models
- Affine models: discount factor & spot rate representation
- Equilibrium models vs no-arbitrage models
- Ho-Lee Binomial Tree: fitting term-structure with $\theta(t)$
- Hull-White Trinomial Tree

Models

- Stylised short rate model: $dr_t = \mu dt + \sigma dW_t^*$
- Binomial tree for short rates
- Vasicek model (equilibrium)
- Cox-Ingersoll-Ross model (equilibrium)
- Ho-Lee model (no-arbitrage)
- Hull-White model (no-arbitrage)

Advanced Short Rate Modelling (No Exam)

- Instantaneous forward rates *vs* short rates
- Ho-Lee, Vasicek, Hull-White Models
  - Matching the initial term structure
  - Integrated short rate process & distribution
  - Girsanov and changing measure from $\mathbb{Q}^*$ to $\mathbb{Q}^T$
  - Zero-coupon bond process: SDE and solution
  - Instantaneous forward rate process
  - Zero-coupon bond options
  - Zero-coupon bond dynamics and volatility specification
  - One-factor *vs* two-factor model