Market Risk & Counterparty Credit Risk

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1. Primer

1.1. Python Basics

The module contains Python basics to familiarize you with various data structures, functions and loops using Python. You will learn to write your own custom functions and develop your own classes using object-oriented programming to perform everyday tasks

Class Structure

- Introduction to Python
- Strings and Lists
- Tuples, Sets and Dictionaries
- If Else statements
- Loops (For, While)
- Functions
- Classes (Object Oriented Programming)

Assignment 	▶ **Exercise Set** ▶ **Develop Black-Scholes class for Option Pricing**

1.2. Python Advanced Modules

Learn a few essential Python modules to be able to perform financial data manipulation, visualization and vector algebra which are some key use cases in valuation and risk modeling

Class Structure

- NumPy – Vectorized calculations
- Pandas – 2D data reading, writing, cleaning
- Matplotlib – Basic visualization
- Seaborn and Plotly – for advanced visualization
- SciPy –probability, statistics and optimization
- Statsmodels – Regression and Timeseries analysis
- Scikit-Learn – Machine learning algorithms

Assignment	▶ **Problem Set on individual topics**
Project 	▶ **Develop Monte Carlo Class to handle pricing of options using simulation & calculating value at risk**

1.3. Risk Foundation

In this chapter, we will talk about the concept of market risk and regulatory capital basics. We will also cover two fundamental topics on Taylor Series and Expectation variance algebra which features massively in sensitivity and risk calculation. We will also cover both theory and practical exercises under Value-at-Risk and Expected-Shortfall calculations.

Class Structure

- Overview of Regulatory Capital
- Market Risk Terminologies
- Expectation and Variance Algebra
- Taylor Series expansion and Sensitivities
- Properties of Risk Measures
- Value-at-Risk & Expected Shortfall for various asset classes and portfolios

Assignment	▶ **Problem set on risk modelling**
Project 	▶ **Custom Class in Python for VaR and ES calculation under parametric, historical and Monte Carlo approach**

1.4. Additional reference

Some additional primer videos and excels are provided for deeper understanding of certain topics.

Class Structure

- Extreme Value Theory
- Copulas
- EWMA & GARCH volatility
- Advanced GARCH Models

2. FRTB Capital Charge (Standardized Approach)

In this module, we will do detailed theoretical and practical treatment for various capital charges under the FRTB framework standardized approach (SA).

2.1. Capital Charge for Equity Class

In this chapter, we will calculate the standardized capital charge for the Equity linear and non-linear products (options) as per the latest FRTB framework. All calculations include Excel implementations.

Class Structure

- Delta Risk Charge (Theory and Formula Derivations)
- End to End Delta Risk Capital Charge for an Equity Portfolio
- Curvature Risk Charge (Theory and Formula Derivations)
- End to End Delta Risk Capital Charge for an Equity Portfolio
- Default Risk Charge (DRC) / Jump-to-default (JTD) – theory and practical examples

Project 	▶ Custom Class in Python for Equity Capital Charge given sensitivity

2.2. Capital Charge for Rates

In this chapter, we will calculate the standardized capital charge for the Interest rate linear and non-linear products (options) as per the latest FRTB framework. All calculations include Excel implementations.

Class Structure

- GIRR (Delta, Vega, Curvature) Capital Charge
- CSR (Delta) Capital Charge

2.3. Capital Charge for FX & Commodity

In this chapter, we will calculate the standardized capital charge for the FX and Commodity linear and non-linear products (options) as per the latest FRTB framework. All calculations include Excel implementations.

Class Structure

- FX (Delta, Vega, Curvature) Capital Charge
- Commodity (Delta, Vega, Curvature) Capital Charge

3. FRTB Capital Charge (Advanced Approach)

In this chapter, we will calculate the market risk capital charge using IMA (Internal Models Method). All calculations include Excel implementations.

Class Structure

- Regulatory Requirements for IMA
- Internal Modellable Capital Charge (IMCC)
- Backtesting & PLAT (Theory)
- Backtesting & PLAT Implementation under FRTB

Assignment	▶ **FRTB Interview questions (MCQ and Risk Modelling)**
Project 	▶ **Custom Class in Python for Backtesting and PLAT tests**

4. Derivative Valuation

In this chapter, we study a bit of stochastic calculus and derivative pricing theory and formulas. Understanding Derivative valuation is key for risk management, trading and hedging. Also, some of the key metrics used in counterparty credit risk (EE, PFE) and xVA calculation rely heavily on derivative pricing distribution in a Monte Carlo routine. This module is a key steppingstone to understand advanced applications of pricing and risk.

All theory is supported by Excel examples and visuals.

4.1. Stochastic Processes and Applications

Class Structure

- The log Random Walk Process
- Ito Calculus
- Stock price Spot and Forward Dynamics
- Black Scholes PDE, Option Price & Greeks
- Volatility Surface
- Dupire Local Volatility
- Stochastic Volatility Models

4.2. Interest Rate Derivatives

In this chapter, we learn to value popular interest rate derivatives. All calculations include Excel implementations.

Class Structure

- Spot, Forward & Par rates
- Zero Coupon Bond Price Equation
- FRA, IRS and FRNs valuation
- Caps, Floors and Swaptions valuation
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4.3. Term Structure Models

In this chapter, we learn about interest rate term structure models which are essential for pricing linear and non-linear interest rate instruments and simulation of interest rate scenarios.

Class Structure

- Vasicek Model (dynamics, pricing and calibration)
- CIR Model (dynamics, pricing and calibration)
- Ho-Lee Model (dynamics, pricing and calibration)
- Hull-White Model (dynamics, pricing and calibration)

4.4. FX Derivatives

In this chapter, we learn about pricing Forex products. All calculations include Excel implementations.

Class Structure

- FX Forward
- Cross Currency Swap (xCCy)
- FX Option

4.5. Hedging

In this chapter, we learn about hedging various risk exposures such as Interest Rate Risk and FX Risk. Hedging is the most important application of Risk. All calculations include Excel implementations.

Class Structure

- Duration Vs PV01
- Hedging with IRS
- Hedging with Rate Options
- Hedging FX with Forwards & Swaps

4.6. Advanced Sensitivities

In this chapter, we learn about calculating tangent and adjoint mode of sensitivity calculations. These methods are extremely useful to calculate fast sensitivities in a Monte Carlo Environment. All calculations include Excel implementations.

Class Structure

- Likelihood Ratio & Pathwise Sensitivities
- Application of this for Vanila and Asian options

Project 	▶ Python & Excel implementation of pathwise sensitivities of Vanila and Asian options

5. Counterparty Credit Risk (CCR)

In this module, we will learn about modelling key exposure metrics such as EE, PFE of various derivatives and derivative portfolio, discuss about collateral, Netting and regulatory capital charges such as SA-CCR, IMM etc.

5.1. Exposure Basics

Class Structure

- Exposure for Equity Class (EE, PFE for forwards and options)
- Yield Curve Simulation
- Exposure for linear IR Derivatives (EE, PFE for Bonds, FRAs, Swaps)
- Exposure profile for non-linear IR Derivatives (Caplets, Swaptions)
- Exposure for linear FX Derivatives (EE, PFE for Forwards, Swaps)
- Netting and Collateral treatment

5.2. CCR and Regulatory Capital Charge

In this chapter, we will learn about calculating EAD under SA-CCR and IMM. We also learn to calculate CVA capital charge under BA-CVA and SA-CVA approach. All calculations include Excel implementations.

Class Structure

- SA-CCR (RC & PFE) – theoretical derivation of EAD formula
- SA-CCR addon calculations for (Credit, IR, FX, Equity and Commodity Asset classes)
- IMM – Alpha Factor
- IMM Modeling and Backtesting

Project 	▶ Excel implementation SA-CCR capital charge for sample portfolios

5.3. xVA and Regulatory Capital Charge

In this chapter, we will learn about various xVA calculations and their importance. We will also do detailed calculations for BA-CVA and SA-CVA capital charge calculations. All calculations include Excel implementations.

Class Structure

- xVA Overview
- CVA and DVA (theory and implementation)
- BA-CVA regulatory capital charge
- SA-CVA theory and implementation

Project 	▶ Excel implementation BA-CVA and SA-CVA for a sample portfolio of various asset classes

6. Model Validation

In this module, we will learn about model validation steps and the use of various statistical tests such as Kupiec, Christofferson etc. used in the industry

Class Structure

- Backtesting VaR Models
- Beyond Backtesting, Probability Integral Transform

Project 	▶ Excel implementation of various conditional, unconditional coverage tests and uniformity tests of PiT