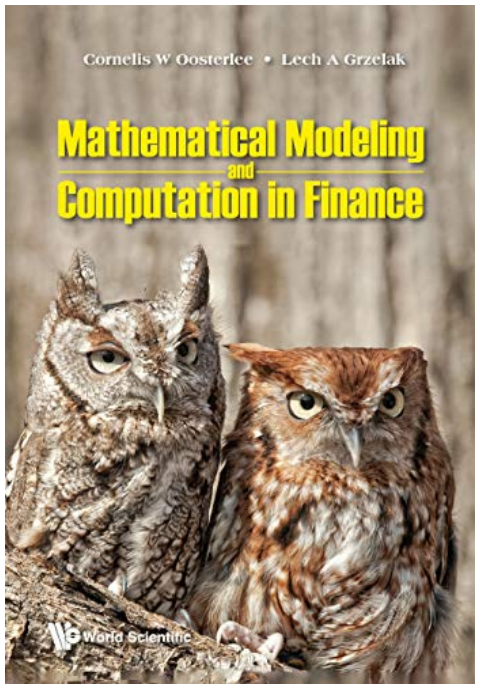
Materials for the course

The course is based on book "*Mathematical Modeling and Computation in Finance: With Exercises and Python and MATLAB Computer Codes*", by C.W. Oosterlee and L.A. Grzelak, World Scientific Publishing Europe Ltd, 2019. For more details go here.



- Youtube Channel with courses can be found here.
- Slides and the codes can be found here.

Course Objectives

- **Objectives**:
  The main focus of this course is the modelling of the interest rates while other asset classes like foreign exchange and inflation are also covered. Ultimately, after completing the course, the student should be able to build a multi-asset portfolio consisting of linear products and perform xVA (CVA, BCVA and FVA) and (H)VaR computations.
- **Expected prior knowledge:**
  Basic knowledge of stochastic differential equations (SDEs), numerical methods for Monte Carlo simulation, linear algebra. Prior to this course, it is highly recommended to follow the course of Computational Finance.
- **Workload:**
  The course consists of 14 lectures, and each lecture is divided into 45m-1h blocks. The whole course consists of 32 blocks. Homework assignments are given at the end of each lecture.
- **Programming Language**: Python.
- **Materials**: Links to slides + codes are in the description of this lecture.

Course road map

Understanding of Filtrations and Measures

Length: **2h40m**

The HJM Framework

Length: **2h**

Yield Curve Dynamics under Short Rate

Length: **2h10m**

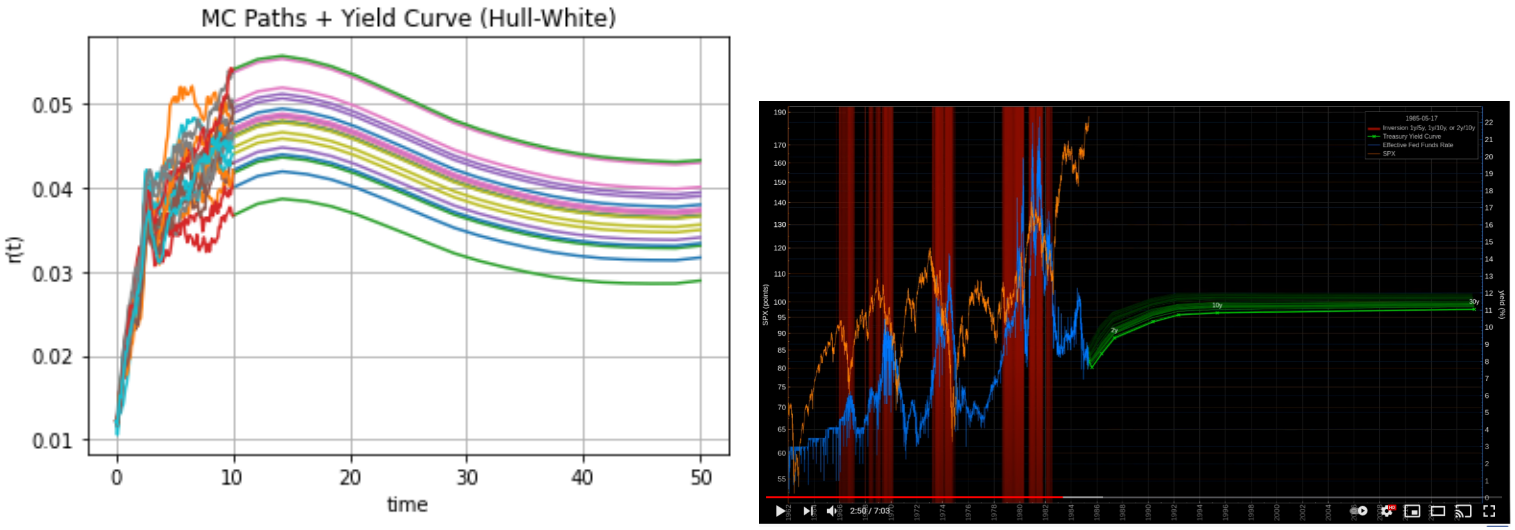
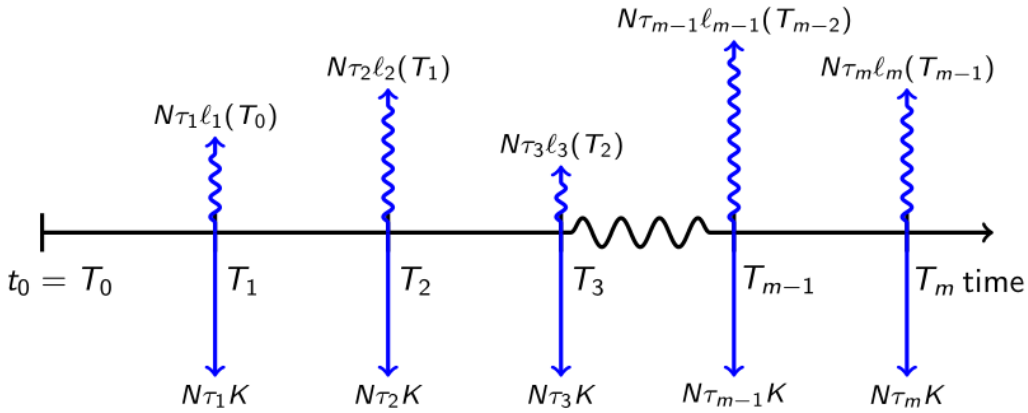


Figure: Dynamics of the yield curve for random market scenarios under the 1F Hull-White model.

Interest Rate Products

Length: **2h**



Construction of Yield Curve and Multi-Curves

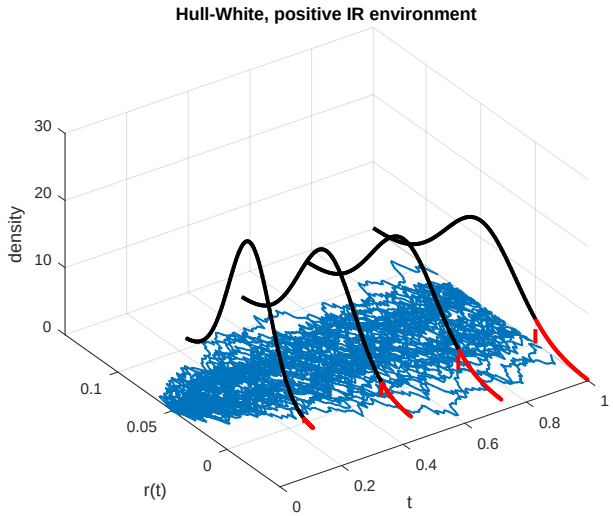
Length: **3h**

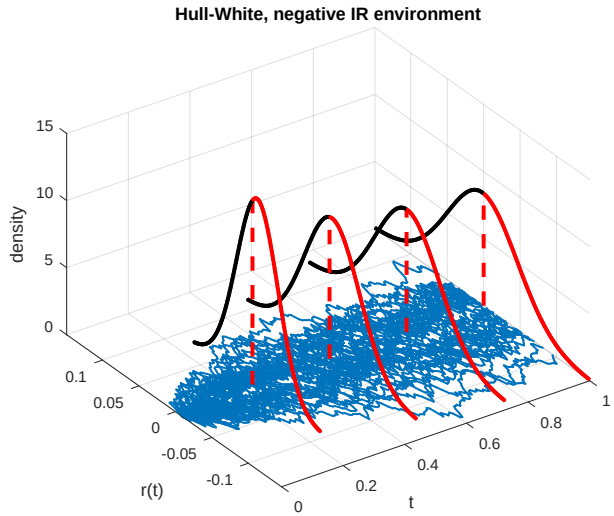
Date	1 Mo	2 Mo	3 Mo	6 Mo	1 Yr	2 Yr	3 Yr	5 Yr	7 Yr	10 Yr	20 Yr	30 Yr
06/01/21	0.01	0.01	0.02	0.04	0.04	0.16	0.31	0.81	1.28	1.62	2.22	2.30
06/02/21	0.01	0.01	0.02	0.04	0.05	0.13	0.30	0.80	1.26	1.59	2.21	2.28
06/03/21	0.00	0.01	0.02	0.04	0.04	0.16	0.34	0.84	1.30	1.63	2.22	2.30
06/04/21	0.01	0.02	0.02	0.04	0.05	0.14	0.32	0.78	1.23	1.56	2.16	2.24
06/07/21	0.01	0.02	0.02	0.04	0.05	0.16	0.33	0.79	1.24	1.57	2.17	2.25
06/08/21	0.01	0.02	0.02	0.04	0.05	0.14	0.32	0.77	1.20	1.53	2.13	2.21
06/09/21	0.01	0.02	0.03	0.04	0.05	0.16	0.31	0.75	1.17	1.50	2.10	2.17

Pricing of Swaptions and Negative Interest Rates

Length: **2h**

7.1. Pricing of Caplets/Floorlets
7.2. Pricing of Interest Rate Swaps
7.3. Pricing of Swaptions under the Black-Scholes Model
7.4. Jamshidian's Trick
7.5. Swaptions under the Hull-White Model
7.6. Negative Interest Rates
7.7. Shifted Lognormal, Shifted Implied Volatility
7.8. The Summary of the Lecture + Homework





Mortgages and Prepayments

Length: **4h**

Hybrid Models and Stochastic Interest Rates

Length: **2h20m**

Foreign Exchange (FX) and Inflation

Length: **2h50m**

Market Models and Convexity Adjustments

Length: **2h30m**

Valuation Adjustments- xVA (CVA, BCVA and FVA)

Length: **3h**

Value-at-Risk and Expected Shortfall

Length: **2h**

13.1. Value at Risk (VaR), Stressed VaR (SVaR)
13.2. Coherent Risk Measures
13.3. Expected Shortfall
13.4. Historical VaR (HVaR) and Python Experiment
13.5. Missing Data, Arbitrage and Re-Gridding
13.6. VaR Computation with Monte Carlo
13.7. Backtesting
13.8. The Summary of the Lecture + Homework

The Summary of the Course

14.1. The Summary of the Course.