MATH0113 Mathematical Climate Finance

Year	2024-25
Code	MATH0113
Value	UCL credits (=7.5 ECTS)
Term	2
Structure	On campus
Assessment	100% final examination. Overall mark of at least 50% for a pass.
Pre-requisites	MATH0085 Asset Pricing in Continuous Time, or similar/related material. Students may acquire relevant knowledge independently through self-study. The responsibility for ensuring knowledge of pre-requisite material, if not acquired by attending MATH0085, is the student's, in any case.
Lecturers	Prof. Andrea Macrina & Dr Chris Kenyon

Course description and objectives

This module focuses on climate change risk and its pricing and hedging, primarily in financial markets and wealth management, but may also adopt an insurance perspective. Climate scenarios and their use in mathematical finance are discussed. Along the concepts of the green label and ESG, the carbon equivalence principle (CEP) is introduced as a modern alternative on which carbon-linked project finance and the pricing and hedging of loans and derivatives are based.

In the context of the Black-Scholes framework, the so-called carbon valuation adjustment (CO2eVA) is considered for the re-valuation of financial hedging instruments subject to net-zero targets. The material taught on this module is selected from relevant areas of financial mathematics and industry practice. This will include, e.g., pricing and hedging in incomplete markets by (semi-)replication and associated equivalent martingale probability measures, PDEs arising in valuation adjustments, optimization (e.g., linear programming), Monte Carlo simulation, etcetera. Since carbon is treated on markets as a commodity, this module also includes taught material on commodities markets and related stochastic pricing models, e.g., the Schwartz and Gibson & Schwartz models.

This course on mathematical climate finance has as its objective to keep pace with research advancements in academia and the industry as these emerge in this field. This may include, for example, mathematical and statistical methods for the study of climate models, scenario design and generation on a probability space, stochastic models for carbon price dynamics and carbon-linked financial instruments, climate-change impact on credit risk, carbon offset mechanisms and permanence. This module aims at offering an introduction to mathematical, statistical and financial concepts, techniques and methods necessary in the nescient and fast-developing field of mathematical climate finance. The taught material is research-orientated.

References

1) T. Björk (2019) *Arbitrage Theory in Continuous Time*. Oxford University Press, 4th Edition.
2) H. Geman (2005) *Commodities and commodity derivatives.* Wiley Finance.
3) C. Kenyon, A. Macrina, M. Berrahoui (2023) *The Carbon Equivalence Principle: Methods for Project Finance*. Risk, Cutting Edge: Climate Finance, Risk.net May 2023. (Full version)
4) C. Kenyon, A. Macrina, M. Berrahoui (2023) *CO2eVA: Pricing the Transition of Scope 3 Emissions*. Risk, Cutting Edge: Climate Finance, Risk.net Oct. 2023. (Full version)