

# Seminar Finance: Derivatives & Risk Management

## Master Seminar

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Institute of Finance and Commodity Markets

Winter Term 2024/25

# Requirements

- Preparation of a seminar paper in groups of up to 2
- Scope: 15/20 pages (depending on group-size)
- Independently perform empirical / quantitative analysis
- Use of appropriate statistics software (R/Matlab/Python/etc.)
- Pure literature research is not sufficient
- Presentation of seminar paper in blocked seminar
- Assessment: 60 % written work and 40 % presentation

# Procedure

- 18.07.2024, Kick-off meeting in I-063
- 24.07.2024, submission of preferences (via e-mail)
- 25.07.2024, allocation of topics via email (I send you an e-mail)
- 29.07.2024, binding registration
- 18.11.2024, submission deadline
- Nov/Dec (TBA): presentation
- General information, registration form, grading specification form, guideline for writing seminar papers:  
<https://www.fcm.uni-hannover.de/de/lehre/seminare/>

# Valuation of American Options Using Monte Carlo Simulation

## Task:

- Describe the problems arising when pricing American options.
- Implement a Monte Carlo simulation technique to price American-style options.
- Perform further analyses, e.g., parameter sensitivity, application to real data, stochastic volatility/interest rates, multiple dimensions etc.

## Literature:

- Longstaff, F. A., & Schwartz, E. S. (2001). Valuing American Options by Simulation: A Simple Least-squares Approach. *Review of Financial Studies*, 14(1), 113-147.
- Broadie, M., & Glasserman, P. (1997). Pricing American-style securities using simulation. *Journal of Economic Dynamics and Control*, 21(8-9), 1323-1352.
- Glasserman, P. (2013). Monte Carlo methods in financial engineering (Vol. 53). Springer Science & Business Media.

# Option Pricing using Machine Learning

## Task:

- Describe, implement, and compare machine learning techniques w.r.t. their efficiency and accuracy for option pricing purposes.
- Which model is most effective at learning the Black-Scholes model?

## Literature:

- Chen, H., Cheng, Y., Liu, Y., & Tang, K. (2023). Teaching Economics to the Machines. *Working Paper*
- Hull, J. C. (2012). Options, Futures and Other Derivatives. Prentice Hall.

# Option Pricing Using Finite Differences

## Task:

- Describe (one of) these methods for (American) option pricing.
- Implement at least one method.
- Perform further analyses, e.g., introduce dividends, estimate greeks, compare to market data, etc.

## Literature:

- Seydel, R. U. (2009). Tools for computational finance (Vol. 4). Berlin: Springer.
- Hull, J. C. (2012). Options, Futures and Other Derivatives. Prentice Hall.

# Option Pricing with GARCH volatility

## Task:

- Describe and implement at least one method to price options whose underlying exhibits GARCH volatility.
- Perform further analyses, e.g., compare Monte-Carlo to analytic solutions, study the influence of different GARCH-processes

## Literature:

- Christoffersen, P., & Jacobs, K. (2004). Which GARCH model for option valuation?. *Management science*, 50(9), 1204-1221.
- Heston, S. L., & Nandi, S. (2000). A closed-form GARCH option valuation model. *Review of Financial Studies*, 13(3), 585-625.

# Option Pricing with Stochastic Volatility

## Task:

- Describe and implement at least one method to price options whose underlying exhibits stochastic volatility.
- Perform further analyses, e.g., compare Monte-Carlo to analytic solutions and study the influence of different stochastic volatility models

## Literature:

- Heston, S. L. (1993). A closed-form Solution For Options With Stochastic Volatility With Applications to Bond and Currency Options. *Review of financial studies*, 6(2), 327-343.
- Hagan, P. S., Kumar, D., Lesniewski, A. S., & Woodward, D. E. (2002). *Managing Smile Risk*. The Best of Wilmott, 1, 249-296.



# Option Pricing Using the Gram-Charlier Model

## Task:

- Describe and implement the Gram-Charlier Model.
- Compare it to the Black-Scholes-Merton model with respect to its ability to account for the volatility smile.
- Calibrate the model using a panel of option data.
- Create time-series of implied volatility, skewness, and kurtosis.

## Literature:

- Backus D., S. Foresi, and L. Wu. 2004. "Accounting for Biases in Black-Scholes." *Working Paper*.
- Rouah, F. D., & Vainberg, G. (2012). *Option Pricing Models and Volatility using Excel-VBA*. John Wiley & Sons.

# Option Pricing with Jumps

## Task:

- Describe and implement at least one method to price options whose underlying is governed by a jump diffusion process.
- Perform further analyses, e.g., compare Monte-Carlo to analytic solutions, study the influence of different parameterizations, or assess the resulting volatility skewness using market data

## Literature:

- Merton, R. C. (1976). Option Pricing When Underlying Stock Returns Are Discontinuous. *Journal of Financial Economics*, 3(1-2), 125-144.
- Madan, D. B., Carr, P. P., & Chang, E. C. (1998). The Variance Gamma Process and Option Pricing. *Review of Finance*, 2(1), 79-105.
- Bates, D. S. (1996). Jumps and Stochastic Volatility: Exchange Rate Processes Implicit in Deutsche Mark Options. *Review of Financial Studies*, 9(1), 69-107.

# Model-Free Implied Volatility

## Task:

- Estimate the model free implied volatility of an asset and compare it to its subsequently realized volatility.
- Perform further analyses, e.g., study conditional risk premia, compare it to Black-Scholes-Merton IV or historical forecasts (GARCH family), study the influence of discretization/truncation/interpolation, etc.

## Literature:

- Britten–Jones, M., & Neuberger, A. (2000). Option Prices, Implied Price Processes, and Stochastic Volatility. *Journal of Finance*, 55(2), 839-866.
- Jiang, G. J., & Tian, Y. S. (2005). The Model-Free Implied Volatility and its Information Content. *Review of Financial Studies*, 18(4), 1305-1342.
- CBOE (2019). VIX white paper.

# Interest Rate Derivatives

## Task:

- Describe at least one interest rate model, calibrate it, and use it to price an interest rate derivative.
- For example, short rate models like Vasicek and CIR, no-arbitrage models like Ho-Lee and Hull-White, or models of the forward curve like HJM or the BGM LIBOR market model.

## Literature:

- Hull, J. C. (2012). Options, Futures and Other Derivatives. Prentice Hall.

# Variance Reduction Techniques for Monte Carlo Simulation

## Task:

- Describe, implement, and combine variance reduction techniques like antithetic sampling, control variates, stratified sampling, importance sampling, moment matching, quasi-random sequences, etc.
- Quantify the impact on the trade-off between computational time and error rates by pricing a simple financial derivative using Monte Carlo simulation.

## Literature:

- Glasserman, P. (2013). Monte Carlo Methods in Financial Engineering (Vol. 53). Springer Science & Business Media.

# Estimation of Greeks for Hedging

## Task:

- Describe, implement, and compare methods to estimate the Greeks of an (exotic) option contract using Monte Carlo simulation.

## Literature:

- Glasserman, P. (2013). Monte Carlo Methods in Financial Engineering (Vol. 53). Springer Science & Business Media.