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Option Pricing: Theory and Practice

FIN 890, Fall 2023 (Wednesdays, 2-4pm)

• Overview

- The class will start with an overview of the philosophies underlying the first-generation option valuation models and their contrasts with the valuation of primary securities. Then the class will introduce two general threads in the development of option pricing models. One is a general framework for designing and estimating second-generation bottom-up option pricing models based on time-changed Levy processes. The other is a more recent development in decentralized top-down option pricing.

There can be many different objectives for developing option pricing models. I will discuss the the modeling efforts from the perspective of option investments.

• Class formats and requirements

- In-person meeting classroom discussions: VC 10-210, Wednesdays 2-4pm.

Office hours: VC 10-247, Wednesday 1-2pm

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- I will make an overview discussion on each topic. Students are required to read the listed papers, implement a representative model in each category, analyze their pricing performance and their applications in option investments.
- Each student is required to write 2-3 term papers, one on each model/framework. Two students can work together on a given paper. The paper can be a replication or independent design and implementation of a particular model, with the ultimate objective of performing a particular type of option investments based on the model implementation.
- The empirical implementation can be done on options on any underlying securities. OptionMetrics (via WRDS) provides options data on individual stock options and options on stock indexes and ETFs. You can download OTC option implied volatility quotes from Bloomberg on currency options, swaptions, and interest rate caps/floors. You can also obtain data for commodity futures options from CME.

• Class outline

- [An overview of investment considerations](#)
 - Grinold and Kahn: *Active Portfolio Management*
 - Penaranda and Wu, 2022, [Targets, Predictability, and Performance](#), *Management Science*, 68(2), 1537--1555.
- [Introduction of option markets and valuation](#)
 - Hull: *Options, Futures, and Other Derivatives*
 - Statical arbitrage trading: [Goyal, Saretto\(2009\)](#).
 - Variance risk premium: [Carr&Wu\(2009\)](#)
 - Variance prediction: [Wu, Xu \(2021\)](#), [Bollerslev,Hood,Huss,Pedersen\(2018\)](#).

- [Second-generation bottom-up option pricing models](#)
 - Technical background: [From characteristic functions and Fourier transforms to densities and option prices](#)
 - Zemanian: *Distribution Theory and Transform Analysis*
 - Kendall's *Advanced Theory of Statistics*, Volume I, chapter 4
 - Sample code for [fft](#) and [Fourier-cosine series expansion](#)
 - Carr and Madan, 1999, [Option Valuation Using the Fast Fourier Transform](#), *Journal of Computational Finance*, 2(4), 61--73.
 - Chourdakis, 2005, [Option pricing using fractional FFT](#), *Journal of Computational Finance*, 8(2), 1--18.
 - Fang and Oosterlee, 2008, [A novel pricing method for European options based on Fourier-cosine series expansions](#), *SIAM Journal on Scientific Computing*, 31(2), 826-848.
 - [Levy process to model security returns](#)
 - Bertoin: *Levy Processes*
 - Sato: *Levy Processes and Infinitely Divisible Distributions*
 - Merton, 1976, [Option Pricing When Underlying Stock Returns Are Discontinuous](#), *Journal of Financial Economics*, 3(1), 125-144.
 - Carr, Geman, Madan, Yor, 2002, [The Fine Structure of Asset Returns: An Empirical Investigation](#), *Journal of Business*, 75(2), 305--332.
 - Madan, Carr, Chang, 1998, [The Variance Gamma Process and Option Pricing](#), *European Finance Review*, 2(1), 79--105.
 - Carr and Wu, 2003, [Finite Moment Log Stable Process and Option Pricing](#), *Journal of Finance*, 58(2), 753--777.
 - Wu, 2006, [Dampened Power Law: Reconciling the Tail Behavior of Financial Security Returns](#), *Journal of Business*, 79(3), 1445--1474.
 - [Stochastic time changes to capture stochastic volatilities and skews](#)
 - Jacod and Shiryaev: *Limit Theorems for Stochastic Processes*
 - Kuchler and Sorensen: *Exponential Families of Stochastic Processes*
 - Carr and Wu, 2004, [Time-Changed Levy Processes and Option Pricing](#), *Journal of Financial Economics*, 17(1), 113--141.
 - Heston, 1993, [A Closed-Form Solution for Options with Stochastic Volatility, with Application to Bond and Currency Options](#), *Review of Financial Studies*, 6(2), 327-343.
 - Bates, 1996, Jumps and Stochastic Volatility: Exchange Rate Processes Implicit in Deutsche Mark Options, *Review of Financial Studies*, 1996, 9(1), 69--107.
 - Huang and Wu, 2004, [Specification Analysis of Option Pricing Models Based on Time-Changed Levy Processes](#), *Journal of Finance*, 59(3), 1405--1439.
 - Carr and Wu, 2007, [Stochastic Skew in Currency Options](#), *Journal of Financial Economics*, 86(1), 213--247.
 - Bakshi, Carr, and Wu, 2008, [Stochastic Risk Premiums, Stochastic Skewness in Currency Options, and Stochastic Discount Factors in International Economies](#), *Journal of Financial Economics*, 87(1), 132-156.
 - [Model estimation and statistical arbitrage trading](#)
 - Simon: *Optimal State Estimation: Kalman, H Infinity, and Nonlinear Approaches*
- [Decentralized top-down option pricing](#)
 - Carr&Wu (2016): [Analyzing Volatility Risk and Risk Premium in Option Contracts: A New Theory](#)
 - Carr&Wu (2020): [Option Profit and Loss Attribution and Pricing: A New Framework](#)
 - Wu&Zhang (2022): [Common Pricing of Decentralized Risk: A Linear Option Pricing Model](#)

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