Mathematical Methods for Quantitative Finance

Cheat sheet for MITx 15.455x Mathematical Methods for Quantitative Finance.

Week 5: Continuous-Time Finance (contd.)

Black-Scholes equation

Summary of some key formulas

- Itô process: $\mathrm{d}X = a\mathrm{d}t + b\mathrm{d}B$
- Itô formula:

$$\begin{aligned}\mathrm{d}F &= \frac{\partial F}{\partial t}\mathrm{d}t + \frac{\partial^2 F}{\partial X^2}\mathrm{d}X + \frac{b^2}{2}\frac{\partial F}{\partial X}\mathrm{d}t \\ &= \left(\frac{\partial F}{\partial t} + a\frac{\partial F}{\partial X} + \frac{b^2}{2}\frac{\partial^2 F}{\partial X^2}\right)\mathrm{d}t + b\frac{\partial F}{\partial X}\mathrm{d}B\end{aligned}$$

- Stock price: $\mathrm{d}S = \mu S\mathrm{d}t + \sigma\mathrm{d}B \implies \mathrm{d}(\log S) = \left(\mu - \frac{\sigma^2}{2}\right)\mathrm{d}t + \sigma\mathrm{d}B$
- Black-Scholes: $\Delta = \partial V/\partial S$, $\mathrm{d}\pi = r\pi\mathrm{d}t$,

$$\frac{\partial V}{\partial t} + \frac{\sigma^2 S^2}{2}\frac{\partial^2 V}{\partial S^2} + rS\frac{\partial V}{\partial S} - rV = 0$$

Recommended Resources

- MITx 15.455x MITx 15.455x Mathematical Methods for Quantitative Finance [Lecture Slides] (`https://learning.edx.org/course/course-v1:MITx+15.455x+3T2020/home`)
- Tsay, Analysis of Financial Time Series (3e), Wiley. (Tsay)
- Capinski and Zastawniak, Mathematics for Finance, Springer. (CZ)
- Olver, Introduction to Partial Differential Equations (2016), Springer. (Olver)
- Campbell, Lo, and MacKinlay, Econometrics of Financial Markets (1997), Princeton. (CLM)
- Lang, Introduction to Linear Algebra (2e), Springer (Lang)
- Axler, Linear Algebra Done Right (3e), Springer (Axler)
- LaTeX File (`github.com/j053g/cheatsheets/15.455x`)

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