

An Intuition-Based Options Primer for Financial Engineering

Model-independent relationships vs. Black-Scholes model

Topics Outline

1. European Options

- 1.1. Payoffs and payoff diagrams
- 1.2. Put-Call parity; Put-Call parity and forward contracts
- 1.3. No-arbitrage bounds for option prices
- 1.4. Put-Call parity arbitrage
- 1.5. Put-Call parity arbitrage with bid-ask spreads
- 1.6. Convexity of option prices and convexity arbitrage

2. Black-Scholes Framework

- 2.1. The lognormal model for the evolution of asset prices
- 2.2. Risk-neutral pricing. Black-Scholes formulas
- 2.3. Put-Call parity, option bounds, asymptotic values in the Black-Scholes framework
- 2.4. The three variables underlying the Black-Scholes formulas: log moneyness, total standard deviation, present value of the forward price

3. Greeks and Hedging

- 3.1. Greeks and model-independent relationships
- 3.2. The magic of Black-Scholes Greeks computations
- 3.3. No-arbitrage option bounds revisited. The time value of options
- 3.4. Delta- and Gamma-hedging. Dynamic hedging
- 3.5. Greeks dependence on spot price, volatility, maturity: Black-Scholes framework and intuition

4. Implied Volatility

- 4.1. Implied volatility and a pitfall of the Black-Scholes model
- 4.2. A model-independent relationship for the implied volatility of call and put options
- 4.3. Newton's method for implied volatility computations
- 4.4. Estimating dividend rates from market data using OLS
- 4.5. Numerical computation of implied volatility from market data

5. The Black-Scholes PDE

- 5.1. Portfolio hedging derivation of the Black-Scholes PDE. Boundary conditions
- 5.2. Financial interpretation of the terms in the Black-Scholes PDE
- 5.3. Black-Scholes PDE transformation to the Heat PDE
- 5.4. The fundamental solution of the Heat PDE
- 5.5. PDE derivation of Black-Scholes formulas

6. American Options

- 6.1. Early exercise region and option value plots

- 6.2. The Black-Scholes PDE for American options
- 6.3. American calls on non-dividend-paying assets

Materials: videos and additional notes will be provided.

Suggested Readings:

[A Primer for the Mathematics of Financial Engineering](http://www.fepress.org/primer-second-ed/), Second Edition, by Dan Stefanica. FE Press, 2011. <http://www.fepress.org/primer-second-ed/>

[Solutions Manual – A Primer for the Mathematics of Financial Engineering](http://www.fepress.org/sol-man-primer-second-ed/), Second Edition, by Dan Stefanica. FE Press, 2011. <http://www.fepress.org/sol-man-primer-second-ed/>

[150 Most Frequently Asked Questions on Quant Interviews](http://www.fepress.org/150iqs/), by Dan Stefanica, Rados Radoicic, and Tai-Ho Wang. FE Press, 2013. <http://www.fepress.org/150iqs/>

Principles of Financial Engineering, Third Edition, by Salih Neftci and Robert Kosowski. Academic Press, 2014. <https://www.amazon.com/dp/0123869684/>

About the Author:

Dan Stefanica has been the Director of the Baruch MFE Program since its inception in 2002, and is the author of the best-selling books on financial engineering education and quant interview questions. He teaches graduate courses on numerical methods for financial engineering, as well as pre-program courses on advanced calculus and numerical linear algebra with financial applications. His research spans numerical analysis, graph theory, and geophysical fluid dynamics. He has a PhD in mathematics from New York University and taught previously at the Massachusetts Institute of Technology.