The Journal of Open Source Software

greeks: Sensitivities of Prices of Financial Options and Implied Volatilities

Anselm Hudde [1*]

1 University of Applied Sciences Koblenz, Germany * These authors contributed equally.

DOI: 10.xxxxxx/draft

Software

- Review
- Repository
- Archive

Editor: Charlotte Soneson

Reviewers:

- @lrnv
- @bahung

Submitted: 17 August 2023
Published: unpublished

Summary

greeks is an R package for calculating sensitivities of financial option prices for European, geometric and arithmetic Asian, and American options, with various payoff functions in the Black Scholes model, and in more general jump diffusion models. It includes a Shiny app to interactively plot the results. Furthermore, methods to compute implied volatilities are provided for a wide range of option types and custom payoff functions. Classical formulas are implemented for European options in the Black Scholes Model, as is presented in (Hull, 2022). In the case of Asian options, Malliavin Monte Carlo Greeks are implemented, see (Hudde & Rüschendorf, 2023). For American options, the Binomial Tree Method is implemented, as is presented in (Hull, 2022).

Statement of need

The accurate pricing of financial options and the computation of the Greeks, i.e., the sensitivities of option prices with respect to the input parameters, is of great theoretical and practical interest in finance. Several software packages exist, but a comprehensive framework including both exotic options and an interactive visualization tool is still missing.

For example, a widely known program to compute Greeks is the Excel Add-in `DerivaGem` which accompanies `Options, Futures and other Derivatives` (Hull, 2022). `DerivaGem` computes option prices, Greeks and implied volatilities and displays them interactively. The model selection is restrained to the Black Scholes and the Binomial Tree model. The framework `Quantlib` (Ametrano & Ballabio, 2003), which is ported to R via `RQuantLib` (Eddelbuettel et al., 2023), provides option prices and Greeks for American options in the Binomial Tree Model, and for European and geometric Asian options in the Black Scholes model. Yet, arithmetic Asian options are not considered, and no interactive visualization tool is provided.

Further packages on CRAN include `derivmkts` (McDonald, 2022) and `OptionPricing` (Dingeç & Hörmann, 2022), both without visualizations. `derivmkts` only computes Greeks for Binomial and European options. `OptionPricing` implements very efficient algorithms for arithmetic Asian call options, but not for put options, and only the Greeks Δ and Γ.

greeks is the most comprehensive R package for the computation of Greeks, i.e., the only one for European, American, and geometric as well as arithmetic Asian Greeks. In addition, Asian Greeks with digital payoff functions and second-order Greeks are computed. Also, it is the only R package with included interactive visualization in a Shiny app, and with the computation of Greeks in jump diffusion models.

greeks has been applied to investigate the performance of Monte Carlo Greeks for jump diffusion Models from (Hudde & Rüschendorf, 2023). Furthermore, greeks is used in graduate courses in financial mathematics to provide a better understanding of option prices and Greeks by interactive visualizations. greeks is also suited for financial risk management purposes.

References

Ametrano, F., & Ballabio, L. (2003). *QuantLib - a free/open-source library for quantitative finance*. http://quantlib.org/

Dingeç, K., & Hörmann, W. (2022). *OptionPricing: Option pricing with efficient simulation algorithms*. https://cran.r-project.org/web/packages/OptionPricing/

Eddelbuettel, D., Nguyen, K., & Leitch, T. (2023). *RQuantLib: R interface to the 'QuantLib' library*. https://cran.r-project.org/web/packages/RQuantLib/

Hudde, A., & Rüschendorf, L. (2023). European and asian greeks for exponential lévy processes. *Methodol Comput Appl Probab*, *25 (39)*. https://doi.org/10.1007/s11009-023-10014-5

Hull, J. C. (2022). *Options, futures, and other derivatives* (11th Edition). Pearson.

McDonald, R. (2022). *Derivmkts: Functions and r code to accompany derivatives markets*. https://cran.r-project.org/web/packages/derivmkts/