Accepted Manuscript

Fast computational approach to the Delta Greek of non-linear Black–Scholes equations

Miglena N. Koleva, Lubin G. Vulkov

PII: S0377-0427(17)30562-9

DOI: https://doi.org/10.1016/j.cam.2017.11.002

Reference: CAM 11374

To appear in: Journal of Computational and Applied

Mathematics

Received date: 22 May 2017 Revised date: 6 November 2017



Please cite this article as: M.N. Koleva, L.G. Vulkov, Fast computational approach to the Delta Greek of non-linear Black–Scholes equations, *Journal of Computational and Applied Mathematics* (2017), https://doi.org/10.1016/j.cam.2017.11.002

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

ACCEPTED MANUSCRIPT

Manuscript

Click here to view linked References

Fast Computational Approach to the Delta Greek of Non-linear Black-Scholes Equations

Miglena N. Koleva*

FNSE, Department of Mathematics, Ruse University, 8 Studentska St., 7017 Ruse, Bulgaria

Lubin G. Vulkov

FNSE, Department of Applied Mathematics and Statistics, Ruse University, 8 Studentska St., 7017 Ruse, Bulgaria

Abstract

In this paper, we consider a class of non-linear option pricing models. The focus is on the numerical investigation of Delta equation, where the unknown solution is the first spatial derivative of the option value. We construct and analyze monotone and sign-preserving finite difference schemes for the problems. Newton's and Picard's iterative procedures for solving the non-linear systems of algebraic equations are proposed. On this base, in order to improve the computational efficiency, we develop fast two-grid algorithms. Numerical experiments, using also Richardson extrapolation in time, are discussed in terms of accuracy, convergence and efficiency.

Keywords: Delta Greek, Delta equation, finite difference scheme, Newton method, Picard method, monotonicity, convergence, two-grid method, Richardson extrapolation

1. Introduction

The pricing and hedging of European options is a fundamental and relevant problem of modern finance. Following the classical theory due to Black, Scholes and Merton, see e.g. [27] an option in a stylized and idealized financial model can be priced by a solution V = V(S, t), to the linear Black-Scholes parabolic equation

$$\frac{\partial V}{\partial t} + \frac{1}{2}\sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} + (r - q)S \frac{\partial V}{\partial S} - rV = 0, \quad S > 0, \quad 0 \le t \le T.$$
 (1)

Here t is the time variable, r > 0 is the interest rate, $q \ge 0$ is the dividend yield rate, T is the maturity and $\sigma > 0$ is a constant historical volatility of the underlying asset price S. The linear Black-Scholes equation with a constant volatility σ has been derived under several restrictive assumptions, for example, zero transaction costs, perfectly replicated portfolio, frictionless, market completeness, etc. In the following years there have been several approaches to generalize this model, see e.g. [1, 2, 4, 5, 12, 13, 16, 20].

In this paper, we consider Black-Scholes equation (1), in which the volatility is assumed to be a function of the underlying asset S, the time t and Gamma of the option (the Greek Gamma is the second derivative V_{SS}) i.e

$$\sigma = \sigma \left(S, t, \frac{\partial^2 V}{\partial S^2} \right). \tag{2}$$

The motivation to target our research to solve the non-linear Black-Scholes equation (1) with the volatility of the form (2) arises from more realistic option pricing models in which one can take into account nontrivial

Email addresses: mkoleva@un-ruse.bg (Miglena N. Koleva), lvalkov@un-ruse.bg (Lubin G. Vulkov)

^{*}Corresponding author

Download English Version:

https://daneshyari.com/en/article/8901947

Download Persian Version:

https://daneshyari.com/article/8901947

<u>Daneshyari.com</u>