Accepted Manuscript

A multiquadric quasi-interpolations method for CEV option pricing model

Shengliang Zhang, Hongqiang Yang, Yu Yang

PII: S0377-0427(18)30227-9
DOI: https://doi.org/10.1016/j.cam.2018.03.046
Reference: CAM 11629

To appear in: *Journal of Computational and Applied Mathematics*

Received date : 26 July 2017
Revised date : 26 September 2017

Please cite this article as: S. Zhang, H. Yang, Y. Yang, A multiquadric quasi-interpolations method for CEV option pricing model, *Journal of Computational and Applied Mathematics* (2018), https://doi.org/10.1016/j.cam.2018.03.046

A multiquadric quasi-interpolations method for CEV option pricing model ⋆

Shengliang Zhang [a,*], Hongqiang Yang [b], Yu Yang [c]

[a] *School of Applied Mathematics, Nanjing University of Finance & Economics*

[b] *College of Economics and Management, Nanjing Forestry University, Nanjing*

[c] *School of Science and Technology, Zhejiang International Studies University*

Abstract

The pricing of option contracts when the underlying process follows the constant elasticity of variance (CEV) model is considered. For CEV European options, the closed-form solutions involve the non-central chi-square distribution, whose computations by the current literatures are rather unstable and extremely expensive. Based on multiquadric quasi-interpolation methods, this study suggests a stable and fast numerical algorithm for CEV option pricing model. The method is confirmed to be a multinomial tree, in which the underlying variable moves from its initial value to an infinity of possible values of the next time step. The probabilities in the associated tree are ensured to be positive, which is a sufficient condition for stability and convergence. The method is flexible, since it is simple to implement with the nonuniform knots. Moreover, the method is easy to value the Greek letters which are important parameters in financial engineering, as the multiquadric function is infinitely continuously differentiable. Besides, the method does not require solving a resultant full matrix, the ill-conditioning problem arising when using the radial basis functions as a global interpolant can be avoided. Numerical experiments imply that the method is highly effective to calculate the stock options and its Greeks under the CEV model.

Keywords: Multiquadric quasi-interpolations; Option pricing; CEV model; Greek letters

AMS Subject Classifications: 91G20, 91G60, 65M20, 65M15, 41A05

1 Introduction

Black and Scholes presented an explicit formula for evaluating European option by assuming the underlying stock price follows a geometric Brownian motion [4]. Under this construction, the price distribution is lognormal, and ignoring the time effect, the volatility is constant. However, empirical evidence and theoretical arguments support the hypothesis that there is an association between stock price and volatility. To deal with this problem, Cox introduced the constant elasticity of variance model [8], in which the stock price change dS has volatility σS^{α} instead of σS in the Black-Scholes model, that is

$$dS = rS\,dt + \sigma S^{\alpha} dW,$$

⋆Supported by National Natural Science Foundation of China (No 11501519)

*Corresponding author.

Email address: `10110180035@fudan.edu.cn` (Shengliang Zhang).