The research in this article is related to the important problem – constructing of efficient numerical methods for pricing American options under stochastic volatility. More precisely, the author presented the Runge-Kutta-Legendre (RKL) finite difference scheme, allowing for an additional shift in its polynomial representation. Compared to Runge-Kutta-Chebyshev (RKC) finite difference schemes, the RKL scheme stays stable without shift, and maintains the convex monotone property. This leads to a quadratic order of convergence on the problem of pricing American options. It is shown that a shift, which increases the damping at each time-step, may be necessary in order to obtain smoother Greeks, for example in the case of a low number of time-steps, or when the nonlinearity depends on the Greeks, such as in the case of the uncertain volatility model. The Greeks stability is discussed in Section 4. In Sections 5 and 6, the scheme is applied, respectively, to the Hamilton-Jacobi-Bellman (HJB) PDE of the uncertain volatility model of [M. Avellaneda et al., Appl. Math. Finance 2, No. 2, 73–88 (1995; Zbl 1466.91323)] and to American options under the Heston’s stochastic volatility model. A suitable example illustrates some intrinsic properties of the proposed model.

Reviewer: Nikolay Kyurkchiev (Plovdiv)

MSC:

91G60  Numerical methods (including Monte Carlo methods)
65M06  Finite difference methods for initial value and initial-boundary value problems involving PDEs
91G20  Derivative securities (option pricing, hedging, etc.)
60G40  Stopping times; optimal stopping problems; gambling theory

Keywords:
American options; stochastic volatility; uncertain volatility; Runge-Kutta-Legendre; Runge-Kutta-Chebyshev; finite difference method; quantitative finance; pricing

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References:


