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The Valuation for the Options with Stochastic Volatilities by the Local Differential Quadrature Method

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Summary

In this work, the local differential quadrature (LDQ) method is proposed to solve the option-pricing model with stochastic volatility. The LDQ method is a newly developed numerical method that preserves the advantage of high accuracy from the differential quadrature (DQ) method and reduces the serious effect about ill-condition of the resultant matrix. Besides, compare to its predecessor, it offers a way to find the optimal order of polynomial approximation. We try to apply the LDQ method to solve the option-pricing model with stochastic volatility, which is an important financial-engineering topic and governed by the two-dimensional partial differential equation, namely Black-Scholes equation, on one hand based on its accuracy and efficiency, and on the other hand the appropriation for the regular-domain computation. These cases include two types of option problems - standard options and lookback options. For standard options, we test the effects of the final conditions, and for the lookback option case we show the good capability for evaluating the exotic options. Particular attention is paid to the Robin boundary conditions, and we further emphasize on the advantage of the LDQ method for easily selecting the order of approximation, including the numerical solutions about option price and its first-order derivative "delta". From the performances of these cases, the comparisons of the numerical results indicate that the LDQ method is an effective, stable and flexible numerical method for solving the option-pricing models with stochastic volatility.

keywords: LDQ; option-pricing model; stochastic volatility; DQ; Black-Scholes equation; standard European option; lookback option; Robin boundary condition.

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