An ETD-based numerical methods for multidimensional nonlinear pricing models

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Abstract: We introduce an approach for pricing American options within multidimensional nonlinear pricing models. One key aspect of our approach is the efficient elimination of cross-derivative terms through appropriate transformations[1], ensuring precise pricing in multidimensional scenarios. Our method is designed to tackle the complexities of pricing multi-asset options, employing a finite difference scheme combined with the exponential time differencing (ETD) technique[2]. By combining these methodologies, we achieve not only accuracy and efficiency but also streamlined implementation. Through exhaustive numerical experiments encompassing diverse option models, such as those with jumps and vulnerable options[3], we address as well the specific challenges inherent in pricing American options, such as early-exercise opportunities tackled by the penalty method. The proposed numerical algorithm is shown to be both accurate and efficient through numerical experiments, which also compare the results with existing methods and analyse the numerical stability and convergence rate.

References:

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