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A decomposition approach via Fourier sine transform for valuing American knock-out options with rebates

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Abstract

We present an innovative decomposition approach for computing the price and the hedging parameters of American knock-out options with a time-dependent rebate. Our approach is built upon: (i) the Fourier sine transform applied to the partial differential equation with a finite time-dependent spatial domain that governs the option price, and (ii) the decomposition technique that partitions the price of the option into that of the European counterpart and an early exercise premium. Our analytic representations can generalize a number of existing decomposition formulas for some European-style and American-style options. A complexity analysis of the method, together with numerical results, show that the proposed approach is significantly more efficient than the state-of-the-art adaptive finite difference methods, especially in dealing with spot prices near the barrier. Numerical results are also examined in order to provide new insight into the significant effects of the rebate on the option price, the hedging parameters, and the optimal exercise boundary.

Keywords. American barrier options, decomposition, Fourier sine transform, rebate, optimal exercise boundary, heat equation, time-dependent spatial domain.

1 Introduction

American vanilla options give the option holders the right to trade an underlying asset for a pre-determined strike price at anytime before and up to a pre-determined expiry date. American knock-out options are very similar to their vanilla counterparts, except that they are immediately terminated, i.e. knocked-out, as soon as the price of the underlying asset

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