Available online at www.sciencedirect.com

ScienceDirect

Mathematics and Computers in Simulation 81 (2010) 568–577

MATHEMATICS AND COMPUTERS IN SIMULATION

www.elsevier.com/locate/matcom

Parallel pricing algorithms for multi-dimensional Bermudan/American options using Monte Carlo methods

Viet_Dung Doan [a], Abhijeet Gaikwad [a], Mireille Bossy [a], Françoise Baude [a,*], Ian Stokes-Rees [b]

[a] *INRIA Sophia Antipolis Méditerranée, I3S CNRS, Université de Nice Sophia-Antipolis, 2004, Route des Lucioles, BP93, 06902 Sophia-Antipolis Cedex, France*

[b] *Department Biological Chemistry & Molecular Pharmacology, Harvard Medical School, SGM-105, Harvard Medical School, 250 Longwood Ave, Boston, MA 02115, USA*

Received 2 April 2008; received in revised form 21 June 2010; accepted 4 August 2010

Abstract

In this paper we present two parallel Monte Carlo based algorithms for pricing multi-dimensional Bermudan/American options. First approach relies on computation of the optimal exercise boundary while the second relies on classification of continuation and exercise values. We also evaluate the performance of both the algorithms in a desktop grid environment. We show the effectiveness of the proposed approaches in a heterogeneous computing environment, and identify scalability constraints due to the algorithmic structure.

Keywords: Multi-dimensional Bermudan/American option; Parallel distributed Monte Carlo methods; Grid computing.

1. Introduction

Options are derivative financial products which allow buying and selling of risks related to future price variations. The option buyer has the right (but not obligation) to purchase (for a call option) or sell (for a put option) any asset in the future (at its exercise date) at a fixed price. Estimates of the option price are based on the well known arbitrage pricing theory: the option price is given by the expected value of the option payoff at its exercise date. For example, the price of a call option is the expected value of the positive part of the difference between the market value of the underlying asset and the asset fixed price at the exercise date. The main challenge in this situation is modeling the future asset price and then estimating the payoff expectation, which is typically done using statistical Monte Carlo (MC) simulations and careful selection of the static and dynamic parameters which describe the market and assets.

Some of the widely used options include American option, where the exercise date is variable, and its slight variation Bermudan/American (BA) option, with the fairly discretized variable exercise date. Pricing these options with a large number of underlying assets is computationally intensive and requires several days of serial computational

* Corresponding author. Tel.: +33 4 92 38 76 71.

E-mail addresses: Viet_Dung.Doan@sophia.inria.fr (V. Doan), Abhijeet.Gaikwad@sophia.inria.fr (A. Gaikwad), Mireille.Bossy@sophia.inria.fr (M. Bossy), Francoise.Baude@sophia.inria.fr (F. Baude), ijstokes@crystal.harvard.edu (I. Stokes-Rees).

0378-4754/$36.00
doi:10.1016/j.matcom.2010.08.005