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A HYBRID MONTE CARLO ACCELERATION METHOD OF PRICING BASKET OPTIONS BASED ON SPLITTING

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ABSTRACT. Pricing basket options has always been one of the key problems in financial engineering because of high dimensionality and low convergence rate. This paper proposes a hybrid Monte Carlo variance reduction method for pricing basket options. First, by splitting the payoff of the basket option into two parts, we can price basket options by value the two parts respectively. The first part has a closed-form expectation formula, the second part can be considered as a small probability event. To reduce variance for simulating the second part, the conditional Monte Carlo(CMC) method combined with the importance sampling(IS) method is adapted. Because these two methods are all effective to deal with small probability events. For IS method, it's a challenge to compute the optimal parameters with as little computational cost as possible. Therefore, an efficient prediction-correction(PC) iteration algorithm based on moment estimation is proposed to determine the optimal parameters in the importance sampling method. Some theoretical analyses for the existence and uniqueness of the optimal parameters in the IS method and the convergence of the PC method are also given. Numerical results show that the hybrid variance reduction method has great variance reduction effect and PC iteration algorithm can save a lot of computing costs comparing with the traditional Newton's iteration method.

Key words: Monte Carlo Method, Basket Option, Conditional Monte Carlo Method, Importance Sampling.

1. INTRODUCTION

Basket options are popular in financial market. The payoff of basket options is correlated with the arithmetic average prices or weighted arithmetic average prices of several assets at expired time. The basket options are widely used in index trading and foreign-exchange market. However they don't have a closed-form price formula, so many researching works have been done about pricing basket options by numerical methods, i.e. tree method, Fourier transform method and methods based on partial differential equation(PDE) like the finite element methods(FEM) and the finite difference methods(FDM). Topper[1] used FEM to price many kinds of exotic options including basket options. Lötstedt, Persson, Von Sydow, et al.[2] used the FDM to price basket options. Borovkova, Permana and Weide[3] used the binomial tree method to price and hedge basket options. Leentvaar and Oosterlee[4] used the fast Fourier transform(FFT) method

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