

Semesterthesis

Implementation of multi-asset spread option pricing methods

ETH ZÜRICH

November 2015

Author:

Daniel Wälchli
wadaniel@student.ethz.ch

Examiner:

Prof. Dr. Erich FARKAS
PLE-H05
Plattenstrasse 22
8032 Zürich
farkas@math.ethz.ch

Supervisor:

Mrs. Fulvia FRINGUELLOTTI
PLE-G07
Plattenstrasse 22
8032 Zürich
fulvia.fringuelliotti@bf.uzh.ch

Abstract

Insert Abstract

Contents

1 Introduction

A hybrid European basket-spread option is a financial derivative, whose maturity is given by the difference (the so called spread) between two baskets of aggregated and weighted underlying asset prices. In mathematical terms its pay-off is given by the formula:

$$P(S, T) = \left(\sum_{i=0}^M w_i S_i(T) - \sum_{j=M+1}^{M+N} w_j S_j(T) - K \right)^+, \quad (1)$$

with $(x)^+ = \max(x, 0)$ and where S_i is the i th underlying asset price, w_i its weight and K is the strike price. Basket-spread options play an important role in hedging a portfolio of correlated long and short positions. Especially they are very common in commodity markets, as producers are exposed to risks arising from spreads between feedstock and end products. Basket-spread options are traded over-the-counter and on exchanges. Since there is no closed-form solution available for the fair price it is inescapable to have an accurate and fast approximation method at hand. The multi-dimensionality and hence the lack of a marginal distribution for the basket-spread makes it impossible to give an exact analytical representation for the price (even not in the simplest framework where the asset prices are driven by correlated geometric Brownian motions). Numerical approaches such as Monte Carlo simulations or PDE methods become very slow and hence impracticable as the number of underlyings increases. Therefore I closely look at two different basket-spread option pricing methods which have been introduced by S.Deng, M.Li, and J.Zhou [1] and by G.Deelstra, A.Petkovic and M.Vanmaele [2]. According to the authors both the second-order boundary approximation method [1,Chap.3,Prop.5] and the hybrid moment matching method associated to the improved comonotonic upper bound (HybMMICUB) [2,Chap.3,Prop.5] are considered to be extremely fast and accurate. Therefore I implement both methods in MATLAB and compare their numerical performances as a function of the basket spread characteristics. As a comparison benchmark I estimate the true prices with Monte Carlo simulations also implemented in MATLAB.

The paper is organized as follows.

2 Second-order Boundary Approximation

Insert text.

3 Hybrid Moment Matching associated with Improved Comontonic Upper Bound

Insert text.

4 Results and Future Work

Insert Results and other text.

References

- [1] S.J. Deng, M. Li, J. Zhou. *Multi-asset Spread Option Pricing and Hedging*. October 29, 2007. School of Industrial and Systems Engineering, Georgia Institute of Technology, Atlanta.
- [2] G. Deelstra, A. Petkovic, M. Vanmaele. *Pricing and Hedging Asian Basket Spread Options*. 2010. Journal of Computational and Applied Mathematics 233 2814-2830.