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Abstracts

Session 25

Mathematical Methods in Finance and Risk Management

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Optimal Glider Flying

Robert Almgrem (Toronto University)

Problems of determining optimal strategies in random environments are the foundation of finance, but such problems are also characteristic of various sports activities. In cross-country soaring, for example, the pilot must make a continuous series of decisions about how best to exploit the local atmosphere, having only imperfect information about the conditions elsewhere. This is an optimal stopping problem: in the weak lift, the pilot may either stop to exploit it, or press on in the hope of finding stronger conditions later, taking the risk of being forced to land out. We write a stochastic model for the vertical lift in the atmosphere, which leads to a nonlinear and nonlocal Hamilton-Jacobi equation for the optimal strategy, with state constraints at the boundaries. Solutions are obtained numerically. [Joint work with A. Tourin.]

On risk management of portfolios of energy bilateral trading contracts

A. Alonso-Ayuso (Universidad Rey Juan Carlo)

José María Amigó García* (Universidad Miguel Hernández de Elche)

L.F. Escudero (Universidad Miguel Hernández de Elche)

We present a two-stage stochastic model with full recourse for structuring a portfolio of energy bilateral purchasing/selling contracts in the electric competitive market under uncertainty. The main uncertain parameters are the requirements and prices of the bilateral purchasing/selling contracts under consideration, the spot price and energy demand, the fuel cost and availability, and the water exogenous inflow to the reservoirs along the planning horizon. The benefit is given by the net income and expenses of the energy bilateral contracts and the spot market trading over the time horizon minus the fuel cost and the thermal-based production cost.

Projective systems of equivalent martingale measures

Alejandro Balbas de la Corte (Universidad Carlos III de Madrid)

The equivalence between the absence of arbitrage and the existence of an equivalent martingale measure fails when an infinite number of trading dates is considered. By enlarging the set of states of nature and the probability measure through a projective system of Radon martingale measures, we characterize the absence of arbitrage.

Portfolio optimization when asset returns have the Gaussian mixture distribution

Ian Buckley* (Imperial College, London)

Gustavo Comezaña (Sigmanalysis, Toronto)

Ben Djerroud (University of Toronto)

Luis Seco (University of Toronto)

Portfolios of assets whose returns have the Gaussian mixture distribution are optimized in the static setting to find portfolio weights and efficient frontiers using the probability of outperforming a target return and Hodges' modified Sharpe ratio objective functions. The sensitivities of optimal portfolio weights to the probability of the market being in the distressed regime are shown to give valuable diagnostic information. A two-stage optimization procedure is presented in which the high-dimensional non-linear optimization problem can be decomposed into a related quadratic programming problem, coupled to a lower-dimensional non-linear problem.

On the Zero Coupon Bond Pricing using Merton's Nonlinear Mean Reversion Interest Rate Model

Antonio Falcó* (Universidad Cardenal Herrera-CEU)

Juan M. Nave (Universidad de Castilla la Mancha)

The aim of this paper is to obtain a closed formula for a zero coupon $T-$ bond where the interest rate follows=20 a Nonlinear Mean Reversion Model=20 given by Merton in 1975. It is well-known that this model=20 has no closed–form transition density.=20 However, we will prove that the Partial Differential Equation governing the arbitrage–free bond values=20 has self–similar solutions. By using this fact, we will reduce the Partial Differential Equation down to the well-known Kummer's Differential Equation.=20 In consequence, the arbitrage–free price of a zero coupon $T-$bond=20 can be expressed by means of a Confluent Hypergeometric Function.

Hedging Simple Options with Transaction Costs

Charles Fefferman (Princeton University)

Alan Ho (University of Pittsburgh)

Not supplied.

Characteristics/finite elements method for pricing callable bonds with notice

Carlos Vázquez Cendón (Universidad de A Coruña)

The finantial product we price consists of an ordinary bond, coupon paying, which includes the call option with notice for the issuer. Discrete coupon payments lead to price discontinuities at the coupon dates, so that the numerical solution of the Black-Scholes type equation requires specific techniques. The bond value, $V = V(t, r)$, depends on time, t, and on stochastic interest rate, r, and verifies:

$$\frac{\partial V}{\partial t} + (u - \lambda w)\frac{\partial V}{\partial r} + \frac{w^2}{2}\frac{\partial^2 V}{\partial t^2} - rV = 0,\ t < T$$

plus the final condition $V(T, r) = 1$. The data for the model are the market price of risk, λ, and the functions u and w governing the stochastic model (Vasicek or CIR) for the interest rate:

$$dr\ =\ u(r,t)\,dt\ +\ w(r,t)\,dZ_t.$$

At the coupon payment date, t_n, the quantity, C_n, is received so that jump condition $V(r, t_n^-) = V(r, t_n^+) + C_n$ is imposed. Between notice and call dates, possible call or not call scenarios have to be considered (see D'Halluin and others(2001)). We propose the characteristics method for time discretization combined with finite elements for the interest rate variable, which has already been used for vanilla options in Vázquez (1998). The good performance of the method will be shown when approximating the analytic solutions in the noncallable case and when comparing the results with those obtained by finite volumes in D'Halluin and others (2001) for the call with notice case.

References

D'Halluin, Y. Forsyth, P.A., Vetzal, K.R. Labahn, G.: A numerical PDE approach for pricing callable bonds. *Applied Mathematical Finance,* **8**, pp. 49-87 (2001).

Vázquez, C. An upwind approach for an American and European option pricing model, *Applied Mathematics and Computation*, **97**, pp. 273-286, (1998).

Malliavin calculus for Levy processes and applications to jump-diffusion market models

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Recent works by D. Nualart and W. Schoutens have opened the possibility to developp a generalized Malliavin calculus (chaotic calculus) for Levy processes. In this work we developp this calculus for the so-called simple Levy processes and we obtain a complete jump-diffusion model that allows us to price and hedge european options. We will discuss also some generalizations to more complex Levy processes and as a consequence to more realistic market models.