Financial Mathematics
Mathématiques financières
(Org: **Cody Hyndman** (Concordia) and/et **Rogemar Mamon** (Western))

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Esscher Transforms and Consumption-Based Models

The Esscher transform is an important tool in actuarial science. Since the pioneering work of Gerber and Shiu (1994), this method has been used extensively for derivative valuation. However, the relationship between the asset pricing model based on the Esscher transform and some fundamental equilibrium-based asset pricing models, such as consumption-based models, has so far not been well-explored. In this paper we attempt to bridge the gap between consumption based models and asset pricing models based on Esscher-type transformations in a discrete-time setting. Based on certain assumptions for the distributions of asset returns, changes in aggregate consumptions and returns on the market portfolio, we construct martingale measures that are consistent with Esscher-type transformations. Relationships between the market price of risk and the risk preference parameters are derived for some cases.

DERVIS BAYAZIT, Florida State University, FSU Mathematics, 208 Love Building, 1017 Academic Way, Tallahassee, FL 32306-4510

Calculating sensitivities of options using Malliavin weights II

We use Malliavin weights to calculate sensitivities for option prices. We model assets using both a variance gamma process and a normal inverse Gaussian process. We use the fact that these processes are given by Brownian subordination. We calculate the Malliavin derivative in the direction of compound Poisson approximation of the subordinator. We use explicit Malliavin weights. In the case of calls and puts we calculate benchmark sensitivities using a fast Fourier transform and using simulations we compare the performance of the Malliavin approach with that of a finite difference method with respect to this benchmark. We then price Asians options, which cannot be computed by Fourier methods.

MARCOS ESCOBAR, Ryerson University, 350 Victoria Street, Toronto, Ontario, M5B 2K3

Quasi-closed-form solutions for some multidimensional derivatives

In this talk we present several results for path and non-path dependent financial derivatives in a multidimensional stochastic covariance setting. In particular we emphasize recent advances in the topic of closed-form expressions for n-dimensional Certificates and Barrier Options in cases with stochastic variance, simple stochastic covariances and stochastic interest rate. These solutions are found in terms of special well-known mathematical functions like Bessel, non-central Chi-Square and Confluent Hypergeometric.

ANDREW HEUNIS, University of Waterloo, 200 University Avenue West, Waterloo, Ontario, N2L 3G1

Mean-variance hedging with portfolio constraints and portfolio insurance

We study a problem of mean-variance hedging which includes a general convex constraint, together with "portfolio insurance" in the form of a guaranteed almost-sure lower bound on the wealth at close of trade. We use a conjugate duality approach, the essence of which is to appropriately "perturb" the problem, and calculate concave conjugates in terms of the perturbation in order to construct a Lagrangian function and a dual cost function, together with a set of Kuhn–Tucker optimality relations which effectively characterize the saddle points of the Lagrangian. Existence of a Lagrange multiplier is established subject to a natural Slater-type condition on the terminal-wealth constraint; the Lagrange multiplier comprises an Ito process paired with a member of the adjoint of the space of essentially bounded random variables measurable with respect to the event sigma-algebra at close of trade. The optimality relations are then used to synthesize an optimal portfolio in terms of the Lagrange multiplier.

CODY HYNDMAN, Concordia University, Montreal
Evaluation of insurance participating policies

In this talk, we consider the pricing of participating contracts using financial and actuarial approaches. Since these products involve mortality as well as financial risks, we compare both approaches using a mixed fund that reproduces typical investment instruments used in these policies. The financial framework of Vellekoop, Kamp and Post (2006) that is based on the duration of the bond portfolio is generalized to a non-gaussian interest rate model. Particularly, the financial framework is obtained under the physical and the risk-neutral probability measures. A detailed numerical analysis is performed using fixed premium and fully variable life insurance policies.

This is joint work with Patrice Gaillardetz.

NATASHA KIRBY, University of Western Ontario
Using Real Options to Value an Ethanol Plant

In this talk we discuss a real options approach to valuing a corn ethanol plant. Operators of these plants have optionality in making certain operating decisions based on the price of corn (input) and gasoline (output). A variety of valuation techniques are used in this study, including a retrospective analysis, bootstrapping and partial differential equations. We will focus on the PDE approach to solving the optimal control problem and draw conclusions from the numerical solution.

REG KULPERGER, University of Western Ontario
Smooth Baseline Hazard Modelling for Corporate Exits

There is a large amount of publicly available financial information on publicly traded corporations, usually on a quarterly year time period. These same corporations also undergo bankruptcy or acquisition through merger. It is natural to model these in a discrete time framework due to the nature of the data. We consider a bivariate discrete time hazard model. The framework is similar to that in classical biostatistics modeling, where one treats the two forms of exit from the system, namely bankruptcy and merger/acquisition, but with additional information on the type of exit. In biostatistics the cause of exit (usually death) is not known explicitly.

Such models are constructed and fit to a data base of some 12,000 publicly traded US corporations. With a large number of covariates some data reduction is needed. Both in and out of sample prediction is considered. A constant baseline hazard model does not fit well, so a smooth baseline hazard model is considered. This later model seems to give a reasonable fit in terms of prediction, and has a nice robustness property. Some tools for model assessment are developed. One useful tool for this is a limit theorem on rare multinomials which is originally due to McDonald (1980).

ALEXEY KUZNETSOV, York University, 4700 Keele Street, Toronto, ON
To what extent do marginal distributions and correlations determine the prices of basket credit derivatives?

A well established approach to pricing basket credit derivatives consists in using a copula model with the following input data:

(i) marginal distribution of default time for each company, and

(ii) one or several implied parameters, so-called "implied correlations", which are calibrated to the existing market data and are responsible for the dependence structure.

However, different choices of copulas often lead to dramatic changes in resulting prices, which is clearly a result of the incompleteness of credit risk models. We study the following question: what is the variability in arbitrage free prices if we fix all marginal distributions and also some parameters responsible for the dependence structure (such as the correlation between defaults). More specifically, we analyze the incompleteness of the market by computing the spread between buyer's and seller's price for "n-th to default" credit default swap in a dynamic lattice model. We will present results from several numerical experiments and some (preliminary) conclusions and conjectures.

CHANTAL LABBE, HEC Montréal
A simple discretization scheme for nonnegative diffusion processes, with applications in option pricing

The Cox–Ingersoll–Ross (CIR) process is broadly used in financial engineering, mostly since it assumes nonnegative values. Applying a standard Euler discretization scheme for simulations is problematic, as nothing prevents the simulated values to be negative. Several fixes are found in the literature, most involving the normal distribution. We propose a scheme producing nonnegative discrete approximations for nonnegative diffusions (e.g. CIR), in which nonnegativity is secured by sampling from a nonnegative distribution. We use the martingale problem to establish convergence of the approximating processes to the target diffusion. The proposed scheme is suitable for several applications in pricing derivative securities.

L'usage du processus de Cox–Ingersoll–Ross (CIR) est répandu en ingénierie financière, principalement parce qu'il est à valeurs non-négatives. L'utilisation d'un schéma de discrétisation standard de Euler pour le simuler est problématique, puisque rien n'empêche alors les valeurs simulées d'être négatives. Nous proposons un schéma produisant, pour des diffusions non-négatives (telles le CIR), des processus d'approximation discrets non-négatifs, la non-négativé de ces derniers résultant de l'emploi d'une distribution à valeurs non-négatives, plutôt que la loi normale sur laquelle repose la plupart des schémas présentés dans la littérature. Nous utilisons le problème de martingale pour établir la convergence des processus d'approximation vers la diffusion visée. Le schéma proposé est approprié pour la tarification de plusieurs produits dérivés.

CRAIG NOLDER, Florida State University, Tallahassee, FL, USA
Calculating sensitivities of options using Malliavin weights I

We use Malliavin weights to calculate sensitivities for option prices. We model assets using both a variance gamma process and a normal inverse Gaussian process. We use the fact that these processes are given by Brownian subordination. We calculate the Malliavin derivative only in the Brownian direction and use explicit Malliavin Brownian weights. In the case of calls and puts we calculate benchmark sensitivities using a fast Fourier transform and using simulations we compare the performance of the Malliavin approach with that of a finite difference method with respect to this benchmark. We then price Asians options, which cannot be computed by Fourier methods.

MARIANITO RODRIGO, Instituto Tecnologico Autonomo de Mexico (ITAM), Mexico City, Mexico
A unified approach to explicit bond price solutions under a time-dependent affine term structure modelling framework

We consider affine term structure models with time-varying parameters. Under this framework, we use an ansatz approach and a solution property of Riccati equations to provide exact and approximate explicit representations of the price of a zero-coupon bond. We demonstrate that our proposed methodology readily recovers certain well-known bond valuation formulae. For the short-rate process, we also put forward a stochastic differential equation capable of incorporating desired characteristics for an interest rate model. We address the feasibility of a practical implementation of our proposed methodology within the context of model calibration. Finally, we present an analytical solution, via a series expansion, to the Riccati equation involved under this extended setting. An approximation to this analytical solution, valid up to any desired degree of accuracy, is also given.

This is a joint work with Rogemar Mamon (Western).

FRANÇOIS WATIER, University of Quebec in Montreal
Mean-variance portfolio under a Heston volatility model

We study a mean-variance investment problem in a continuous-time brownian motion setting where the stock's volatility component is stochastic and driven by a mean-reverting Heston process. We construct an optimal strategy through the solutions of BSDEs (backward stochastic differential equations). We will also give sufficient conditions under which an explicit analytical expression is available for the optimal portfolio.