IP0

SIAG/FME Junior Scientist Prize: Proving Regularity of the Minimal Probability of Ruin via a Game of Stopping and Control

We reveal an interesting convex duality relationship between two problems: (a) minimizing the probability of lifetime ruin when the rate of consumption is stochastic and when the individual can invest in a Black-Scholes financial market; (b) a controller-and-stopper problem, in which the controller controls the drift and volatility of a process in order to maximize a running reward based on that process, and the stopper chooses the time to stop the running reward and rewards the controller a final amount at that time. Our primary goal is to show that the minimal probability of ruin, whose stochastic representation does not have a classical form as does the utility maximization problem (i.e., the objective's dependence on the initial values of the state variables is implicit), is the unique classical solution of its Hamilton-Jacobi-Bellman (HJB) equation, which is a non-linear boundary-value problem. We establish our goal by exploiting the convex duality relationship between (a) and (b). Joint work with Jenny Young. Available at http://arxiv.org/pdf/0704.2244v13

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IP1

Title Not Available at Time of Publication

Abstract not available at time of publication.

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IP2

Does a Central Clearing Counterparty Reduce Counterparty Risk?

We show whether central clearing of a particular class of derivatives lowers counterparty risk. For plausible cases, adding a central clearing counterparty (CCP) for a class of derivatives such as credit default swaps reduces netting efficiency, leading to an increase in average exposure to counterparty default. Clearing two or more different classes of derivatives in separate CCPs always increases counterparty exposures relative to clearing the combined set of derivatives in a single CCP.

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IP3

Singular Forward-Backward Stochastic Differential Equations and Emissions Derivatives

We introduce two simple models of forward-backward stochastic differential equations with a singular terminal condition and we explain how and why they appear naturally as models for the valuation of CO_2 emission allowances. Single phase cap-and-trade schemes lead readily to terminal conditions given by indicator functions of the forward component, and using fine partial differential equations estimates, we show that the existence theory of these equations, as well as the properties of the candidates for solution, depend strongly upon the characteristics of the forward dynamics. Finally, we give a first order Taylor expansion and show how to numerically calibrate some of these models for the purpose of CO_2 option pricing.

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IP4

On Quasiconvex Dynamic Risk Measures and on Convex Approximations

We introduce the notion of conditional quasiconvex risk measures and we provide their dual representation, which generalizes the representation of quasiconvex real valued risk measures and of conditional convex risk measures. These results were inspired by the theory of dynamic measurements of risk and are applied in this context.

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IP5

Stochastic Expansions Applied to Fast Pricing

In this talk, we present a recent methodology based on stochastic analysis to derive tractable approximations of option prices in various models. Regarding the models, our results cover the case of local volatility models, including or not Gaussian jumps and Gaussian interest-rate models, Heston models. We also handle the case of stocks paying affine dividends at discrete times, Asian or basket options... Error estimates are provided. Numerical results illustrate the relevancy of the expansions. Applications to real-time pricing/calibration are discussed as well.

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IP6

Constant Proportion Debt Obligations: A Post-Mortem Analysis of Rating Models

In its complexity and its vulnerability to market volatility, the CPDO might be viewed as the poster child for the excesses of financial engineering in the credit market. This paper examines the CPDO as a case study in model risk in the rating of complex structured products. We demonstrate that the models used by S&P and Moody's fail standard in-sample specification tests even during the pre-crisis period, and in particular understate the kurtosis of spread changes. Model-implied probabilities of attaining high spread levels were biased downwards, which in turn biased the rating upwards. We conclude with larger lessons for the rating of complex products and for modeling credit risk in general.

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IP7

Variation Swaps on Time-Changed Levy Processes

For a family of functions G, we define the G-variation, which generalizes power variation; G-variation swaps, which pay the G-variation of the returns on an underlying share price F; and share-weighted G-variation swaps, which pay the integral of F with respect to G-variation. For instance, the case $G(x) = x^2$ reduces these notions to, respectively, quadratic variation, variance swaps, and gamma swaps. We prove that a multiple of a log contract prices a G-variation swap, and a multiple of an F log F contract prices a share-weighted G-variation swap, under arbitrary exponential Levy dynamics, stochastically time-changed by an arbitrary continuous clock having arbitrary correlation with the Levy driver, under integrability conditions. We solve for the multipliers, which depend only on the Levy process, not on the clock. Depending on the choice of G, these multipliers relate to other quantities of interest, such as jump skewness and various notions of hedge-risk.

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IP8

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Abstract not available at time of publication.

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IP9

Market Impact Modeling and Optimal Order Execution

Market impact refers to the adverse feedback effect on the price of a stock caused by one's own trading. It can lead to significant costs for the execution of sufficiently large orders. Due to the transience of market impact, the associated costs can be reduced by slicing the order in a sequence of small orders that are then distributed over a certain time interval. In practice the size of the individual slices is computed by optimizing a cost criterion within a mathematical model for market impact. In this talk, we discuss several market impact models that have been proposed in the literature. A particular question, which is similar to the question of characterizing the absence of arbitrage in a standard asset pricing model, is how one can exclude the occurence of certain model irregularities that can arise in market impact models. We also discuss optimization problems for order execution strategies with respect to various cost criteria.

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IP10

An Approximation Scheme for Investment Performance Processes in Incomplete Markets

An approximation scheme for the maximal expected utility in an incomplete market will be presented. The market incompleteness comes from a stochastic factor affecting the dynamics of the stock price. The scheme yields an intuitively pleasing decomposition of the value function process at each splitting step. Specifically, in the first sub-step, the current utility is being adjusted while the component of the investment opportunity set that is perfectly correlated with the stock remains unchanged. In the second sub-step the reverse happens. This orthogonal decomposition highlights how dynamic preferences and investment decisions behave in terms on the imperfect correlation and, moreover, explains some effects of the stochastic factors on the risk preferences and the investment decisions. This is joint work with Sergey Nadtochiy (University of Oxford).

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CP1

American-Style Options, Stochastic Volatility, and Degenerate Parabolic Variational Inequalities

Elliptic and parabolic partial differential equations arising in option pricing problems involving the Cox-Ingersoll-Ross or Heston stochastic processes are well-known to be degenerate parabolic. We provide a report on our work on the existence, uniqueness, and regularity questions for variational inequalities involving degenerate parabolic differential operators and applications to American-style option pricing problems for the Heston model. This is joint work with Panagiota Daskalopoulos (Department of Mathematics, Columbia University).

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CP1

Efficient Time Differencing Schemes for Pricing Exotic Options with Transaction Cost

A new second order exponential time differencing (ETD) scheme is developed to price exotic options using a Black-Scholes equation which incorporates transaction cost through a HWW nonlinear function. The scheme is compared with the ETD Crank-Nicolson method which does not incur unwanted oscillations. This will be demonstrated in numerical examples for a Butterfly Spread, and Digital call options. We also investigate American options using a penalty approach with transaction cost.

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CP1

Smoothing Effect of the Greens Function Approach to Terminal-Boundary Value Problems for the Black-Scholes Equation

A number of terminal-boundary value problems are considered for the Black-Scholes equation. A semi-analytical Greens function-based algorithm is developed for their solution. Closed analytical representations are obtained for required Greens functions. The procedure, which is im-

plemented for construction of the Greens functions, uses a combination of the Laplace integral transform with the method of variation of parameters. The latter is applied to the construction of Greens functions for resulting ordinary differential equations. Numerous graphical illustrations are presented justifying high accuracy level for settings with non-smooth and even discontinuous terminal and boundary data. The high accuracy is attained due to the integral feature of the approach where numerical differentiation is completely avoided. The proposed semi-analytical approach can be employed to accurately solve either European or American option problems simulated with the Black-Scholes equation. In the first case, our algorithm directly solves the problem, whereas for American option settings, an iteration procedure can readily be developed.

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CP1

Efficient Price Sensitivity Estimation of Financial Derivatives by Weak Derivatives

We present the stochastic gradient estimation method of weak derivatives (WD) with the aim of constructing efficient algorithms for the "Greeks" estimation of financial derivatives. The key idea is to replace the derivative of the probability measure of the underlying model by its WD. The WD method has the advantageous property that the form of the estimator does not depend on the details of the payoff but only on the density of the underlying model.

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CP1

A Toolbox for Option Pricing with Theta-Calculus Based on Sparse Grids

Theta-calculus is a mathematical modeling language for the description of sequential processes, financial contracts, and multi-period strategies. With the Theta-notation, it is possible to model financial products as sequences of operators. We combined the idea of Theta-calculus with an approach based on partial differential equations, such as the Black-Scholes equation, discretized with locally adaptive sparse grids. With this, we can handle various types of multi-dimensional option pricing problems numerically with one general technique, in a straightforward way.

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CP1

Exact Sampling of Jump-diffusions

Jump-diffusion processes are ubiquitous in finance and economics. They arise as models of security, energy and commodity prices, exchange and interest rates, and default timing. This paper develops a method for the exact Monte Carlo simulation of a skeleton and a hitting time of a one-dimensional jump-diffusion with state-dependent drift, volatility, jump intensity and jump size. The method requires the drift function to be C^1, the volatility function to be C^2, and the jump intensity function to be locally bounded. No further structure is imposed on these functions. The method leads to unbiased simulation estimators of derivatives prices, transition densities, hitting probabilities, and other quantities. Numerical experiments demonstrate its advantages over a conventional discretization scheme.

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CP1

A Projected Algebraic Multigrid Method for Pricing American Options

We adapt an algebraic multigrid (AMG) method for solving linear complementarity problems (LCPs) resulting from pricing American options using implicit finite difference discretizations. As an example we consider pricing American options under Heston's stochastic volatility model.

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CP1

Some Non-arbitrage Properties in Numerical Solutions for American Options

We first give a brief overview of American option pricing models and numerical methods. We treat American option models as a special class of obstacle problems. Finite element formulation is introduced together with error analysis of numerical solutions. Some interesting arbitrage properties about sensitivity of the option price to the payoff function are proved. We also give a criterion for the convergence of numerical free boundaries (optimal exercise boundaries) under mesh refinement. Some future research plans will be discussed.

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CP2

Controlling Portfolio Allocation Using a Kalman Filter and Multi-Factor Model Framework

Multi-factor models are developed and implemented into a Kalman filter to estimate portfolio states. The analytical framework of the state estimates combines the least squares models with classic mean-variance optimization. The multi-factor models include the CAPM, Fama-French, and other more diverse models to describe the behavior of various segments of the capital markets. A framework for filter tuning against expected process and plant noise is defined, and numerical results demonstrate effectiveness of

the approach.

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CP2

Risk Preferences and Their Robust Representation

To address the plurality of risk notions, we concentrate on setting invariant features: diversification and monotonicity. We introduce and study three key concepts, *risk order*, *risk measure* and *risk acceptance family* which allows us to provide a general robust representation of lower semicontinuous risk orders on convex subsets of locally convex topological vector spaces. This general approach is then illustrated in different setups (random variables, probability distributions, consumption streams...) allowing for different interpretations of risk.

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CP2

Entropy Approach to Incorporate Heavy Tailed Constraints in Financial Models

In the existing financial literature, entropy based ideas have been proposed in portfolio optimization and in model calibration for options pricing. The abstracted problem essentially corresponds to finding a probability measure that minimizes Kullbach- Leibler (KL) distance with respect to a known measure and satisfies certain moment constraints on functions of underlying assets. In this paper, we show that under KL distance, the optimal solution may not exist when constraints involve fat tailed distributions ubiquitous in financial practice. We note that this drawback may be corrected if 'polynomial-divergence' entropy distance is used. We discuss existence and uniqueness issues related to this new optimization problem as well as the nature of the optimal solution under different objectives. We also identify the optimal solution structure under KL distance as well as polynomial divergence when the associated constraints include those on marginal distribution of functions of underlying assets. These results are applied to portfolio modeling in Markowitz framework where we note that a reasonable view that a particular portfolio of assets has heavy tailed losses may lead to a more realistic tail distribution model of all assets.

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CP2

Portfolio Selection in a Market with Transaction Costs

In this paper we solve a portfolio optimization problem where the investor must pay transaction costs proportional to the size of the trade whenever the portfolio is reallocated. The risky asset is modeled as a geometric Brownian motion. There are no restrictions on short selling or borrowing. Despite this, the trading strategy is found analytically. The proof of our method relies on several conditions for the optimality of a portfolio choice problem.

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CP2

Optimal Investing with Reaping Losses in a Taxable Portfolio

Just as investors are best off deferring gains as long as possible, they are also best off realizing losses as soon as possible. We develop a PDE that corresponds to actively exploiting losses, but being passive otherwise. The PDE is determined from the adjoint of the formulation with the value function for the optimal expected utility at the time of portfolio liquidation. We show that finite difference methods for our PDE yield the optimal investing strategy in a fraction of the time needed by Monte Carlo methods, and with significantly more precision. Finally, we show how to account for wash sale constraints, transaction costs, and the $3000 annual limit on losses in the American tax code.

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CP2

Portfolio Management with Hyperbolic Discounting

This paper considers the Merton portfolio management problem. We are concerned with non-exponential discounting of time, which has received much attention lately, especially in the area of behavioural ?nance. It is a better description of the behaviour of investors, but it leads to problems of time inconsistency, so that the notion of optimal strategy no longer is appropriate. We introduce the notion of subgame perfect strategies, henceforth called policies, and for CARA preferences we characterize them by an integral equation.

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CP2

Market Models with a Stochastic Number of Assets

In equity markets the number of companies whose stock is tradeable changes over time as existing companies merge and split and new companies offer IPOs. To properly study the diversity and stability of equity markets over time, the number of assets being modeled must be allowed to vary stochastically in time. We present a mathematical framework for these models and study some of their basic properties.

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CP2

On a Hybrid Uncertain Market Model with Ran-

dom Interval Payoffs

A new hybrid uncertain market model, in which securities are modeled by random intervals, is proposed. New concepts, such as strong arbitrage opportunity, acceptable risk neutral measure, and weighted expected utility are proposed. Based on no strong arbitrage argument, the pricing rule for contingent claim and the problem of utility maximization are discussed, where weighted expected utility model is used to measure the utility towards random interval wealth.

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CP3

A Novel Modelling of Stochastic Skewness with Applications to Fitting and Hedging

[Carr, Geman, Madan and Yor, 2003] and [Carr and Wu, 2007] modelled stochastic skewness using a time-change, which corresponds to having stochastic intensity parameters of the Lévy measure. By calibrating to liquid vanilla options, we found evidence that a model with stochastic steepness parameters may be more appropriate. We develop a fast pricing algorithm for barrier options under stochastic steepness parameters by using an approximation with a regime-switching model, compare performance of the two models, and analyze implications for hedging.

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CP3

Asymptotic Approximations to Deterministic and Stochastic Volatility Models with Applications to High Frequency Trading

Asymptotic pricing formulas are derived for equity derivatives based on deterministic and stochastic volatility models. The formulas are valid near expiry and are derived using the ray method to first construct the density function. Next the risk-neutral integrals in the pricing formulas are expanded to obtain a uniform asymptotic approximation. The accuracy of the new formulas is demonstrated along with their usefulness for hedging and calibration in high frequency trading.

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CP3

The Contribution of Trader Interaction to Market Noise

We use limit theorems and the Cucker-Smale flocking idea to construct a dynamic asset price model that captures explicitly the impact of communication among market participants. Our results provide insights to various puzzling empirical properties (sometimes known as "stylized facts') of asset returns that have been observed in the market. This builds on work of Rama Cont, Jean-Philippe Bouchaud, Andrew Lo, and others. By modelling rates of communication among active traders in the spirit of Darrell Duffie for example, we are able to derive a mathematical structure existing in the limit that explains the inevitability of these stylized facts. In particular, among other things, we show that while asset returns over a longer period are indeed normally distributed, one can still observe leptokurtic distributions when the returns are calculated on smaller time scales.

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CP3

Efficient Valuation of Discrete Realized Variance Contracts

We value arbitrary contracts on discrete realized variance. The underlying follows a conditionally Gaussian process modulated by autonomous stochastic volatility. Euler schemes of the Heston, Hull-White and SABR models are special cases. We show that uncertainty in realized variance arises largely from the norm of the Gaussian shocks and the time average of volatility. We combine deterministic integration along privileged directions with exact Monte Carlo sampling in an algorithm that generates significant speed gains.

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CP3

On Refined Volatility Smile Expansion in the Heston Model

It is known that Heston's stochastic volatility model exhibits moment explosion, and that the critical moment s^* can be obtained by solving (numerically) a simple equation. This yields a leading order expansion for the implied volatility at large strikes: $\sigma_{BS}(k,T)^2T \sim \Psi(s^*-1)\times k$ (Roger Lee's moment formula). Motivated by recent "tail-wing' refinements of this moment formula, we first derive a novel tail expansion for the Heston density, sharpening previous work of Drăgulescu and Yakovenko [Quant. Finance 2, 6 (2002), 443–453], and then show the validity of a refined expansion of the type $\sigma_{BS}(k,T)^2T = (\beta_1 k^{1/2} + \beta_2 + \ldots)^2$, where all constants are explicitly known as functions of s^*, the Heston model parameters, spot vol and maturity T. In the case of the "zero-correlation' Heston model such an expansion was derived by Gulisashvili and Stein [Appl. Math. Opt., DOI: 10.1007/s002450099085]. Our methods and results may prove useful beyond the Heston model: the entire quantitative analysis is based on

affine principles; at no point do we need knowledge of the (explicit, but cumbersome) closed form expression of the Fourier transform of $\log S_T$ (equivalently: Mellin transform of S_T). Secondly, our analysis reveals a new parameter ('*critical slope*'), defined in a model free manner, which drives the second and higher order terms in tail- and implied volatility expansions.

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CP3

Potential PCA interpretation problems for Volatility Smile Dynamics

Abstract Principal Component Analysis (PCA) is a common procedure for the analysis of financial market data, such as implied volatility smiles or interest rate curves. Recently, Pelsser and Lord [11] raised the question whether PCA results may not be facts but artefacts. We extend this line of research by considering an alternative matrix structure which is consistent with foreign exchange option markets. For this matrix structure, PCA effects which are interpreted as shift, skew and curvature can be generated from unstructured random processes. Furthermore, we find that even if a structured system exists, PCA may not be able to distinguish between these three effects. The contribution of the factors explaining the variance in the original system are incorrect. Finally, for a special case, we provide an analytic correction that recovers correct factor variances from those incorrectly estimated by PCA.

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CP3

Most-Likely-Path Approximation of Option Prices on the Arithmetic Average in Local Volatility Models

We address the problem of approximating the price of options on the discrete arithmetic average of the underlying in local volatility models, specifically Asian options and variance options. We assume that such options are written on the average of the underlying sampled at equally spaced discrete time points before expiry. The application of the heat kernel expansion for the transition density between consecutive sampling time points with the aid of Laplace asymptotic formula leads to a "path-integral" type expression for option prices. In the limit as the sampling time window approaches zero under this formalism, we end up with a constrained variational problem of finding an optimal path in time-price space; an approximation of the option price is obtained once the variation problem is solved. This optimal path is reminiscent of, and actually inspired by, earlier most-likely-path approximations such as the one presented in Gatheral's book "The Volatility Surface". We will conclude by presenting results of numerical tests of our approximation.

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CP3

Fx Volatility Smile Construction

The foreign exchange options market is one of the largest and most liquid OTC derivative markets in the world. Surprisingly, very little is known in the academic literature about the construction of the most important object in this market: The implied volatility smile. The smile construction procedure and the volatility quoting mechanisms are FX specific and differ significantly from other markets. We give a detailed overview of these quoting mechanisms and introduce the resulting smile construction problem. Furthermore, we provide a new formula which can be used for an efficient and robust FX smile construction.

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CP4

Fair Value of Equity-Linked Polices with Stochastic Interest Rate

Pricing of an equity linked policy with surrender option before maturity date under stochastic interest rate is studied here by computation of a derived PDE model. The surrender option makes the policy American style. Pricing is conducted by method of lines with spatial discretization through finite difference and integration in time by ODE solver RK23. Early exercise of surrender option can be detected in the ODE solver and price can be evaluated then.

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CP4

Minimizing the Probability of Lifetime Ruin under Stochastic Volatility

We assume that individuals invest in a financial market

with one riskless and one risky asset, with the latter's price following a diffusion with stochastic volatility. In current financial market especially, including stochastic volatility in the risky asset's price process is important. Given the rate of consumption, we find optimal investment strategy for individuals who wish to minimize the probability of going bankrupt. To solve this minimization problem, we use techniques from stochastic optimal control.

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CP4

Bringing Focus to Fuzzy Real Options

Fuzzy numbers have recently been introduced in the real options literature as a simple alternative to option valuation. However, so far the assumption that the project value is a fuzzy number has not been put on solid theoretical ground. Here, we demonstrate how projects which are driven by a Geometric Brownian motion can lead to triangular profiles. The GBM acts as a market indicator is not directly traded, however, it is assumed strongly correlated to a tradable index. By utilizing the minimal entropy martingale measure, we value the real option in a theoretically sound manner.

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CP4

No-remorse Principles for Real Options

We give short proofs of general theorems about optimal entry and exit problems in Lévy models, when payoff streams may have discontinuities and be non-monotone. As applications, we consider exit and entry problems in the theory of real options, entry problem with an embedded option to exit, and problems with ambiguity and strategic interactions. We demonstrate a non-trivial impact of jump uncertainty and ambiguity on the investment threshold.

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CP4

Worst Case Scenario Portfolio Optimisation and Optimising Reinsurance

The worst–case scenario portfolio problem which has been introduced by Korn and Wilmott (2002) will be considered in this presentation. First, the portfolio optimisation problem will be introduced and the main results will be given. Second, the idea of the worst–case scenario will be applied to an insurance company who wants to optimise its reinsurance level. Usually, the reinsurance level will be determined by a ruin probability constraint. It will be discussed to which extend this constraint can be replaced by the worst–case scenario approach. This research is joint work with Ralf Korn (Kaiserslautern) and Mogens Steffensen (Copenhagen).

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CP4

Gambling When Broke: Optimal Risk-Taking Under Financial Distress

In this economy, it is anathema to say that is optimal for managers to un- dertake risky investments under financial distress. We show this by including distress costs into cash reserves represented by two different Brownian processes. Under arithmetic Brownian motion, it is optimal when distress costs are extremely high. Under a mixed geometric-arithmetic Brownian process, it is optimal when productivity of financial capital gets sufficiently large. Capital productivity is represented by an exponent to the multiplicative term appended to geometric Brownian motion.

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CP4

Maximizing the Utility of Consumption with Reversible Annuities

The purpose of this paper is to reveal the relation between the reversibility of annuities and retirees' reluctance to annuitize. To this end, we assume the existence of reversible annuities, whose surrender charges are a fixed proportion of their purchasing values. We model a retiree as a utility-maximizing economic agent who can invest in a market with a risky and a riskless asset and who can purchase and surrender reversible annuities. We define the wealth of an individual as the total value of her risky and riskless assets; this value is required to be non-negative during her lifetime. We solve this incomplete market utility maximization problem via duality arguments and obtain semi-analytical solutions. We find that the optimal annuitization strategy depends on the size of the proportional surrender charge and that a lower proportional surrender charge encourages annuitization. We also find that full annuitization is optimal when there is no surrender charge or when the retiree is very risk averse. More surprisingly, we find that in the case when the proportional surrender charge is larger than a critical value, an individual behaves as if annuities are not reversible at all. Numerical examples are given to illustrate our results.

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CP4

Optimal Non-Proportional Reinsurance Control

and Stochastic Differential Games

We study stochastic differential games between two insurance companies who employ reinsurance to reduce risk of exposure. We consider competition between two companies and construct a single payoff function of two companies surplus processes. We describe the Nash equilibrium of the game and prove a verification theorem for a general payoff function. For the payoff function being the probability that the difference between two surplus reaches an upper bound before it reaches a lower bound, the game is solved explicitly.

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CP5

Controlling Cascades on Dynamic Financial Networks

The network of financial exposures that arise among financial institutions is an important determinant of systemic risk. Real and idealized network structures can be analyzed to produce cascade statistics which quantify systemic risk, and to estimate the effects of certain mitigations in limiting the size of cascades. Such analyses take the network of institutional exposures as given: this assumption is especially limiting when evaluating the effectiveness of potential mitigations, because those mitigations may change the rules that govern network formation. A policy for managing systemic risk might operate in a way that invalidates the analysis upon which it was predicated. We examine the dynamics of the formation of exposures among financial institutions and their commercial customers by modeling the creation and trading of contractual linkages. Contracting entities adjust the terms of contracts based on their perceptions of market conditions and counterparty reliability. Over time the system adapts to engender and withstand episodic default cascades. We then examine the effect of parameters representing stabilization policies, such as countercyclical capital requirements and central bank lending terms, on the distribution of cascades and on the capital costs to commercial customers. This analysis creates a solid basis for policy recommendations by endogenizing feedback between the rules imposed on the financial system and the structure of financial interdependencies that emerge in consequence.

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CP5

A Non-Zero-Sum Game Approach to Convertible Bonds

Convertible bonds are hybrid securities that embody the characteristics of both straight bonds and equities. In this paper, we investigate how to use a non-zero-sum game framework to model the interaction between bondholders and shareholders and to evaluate the bond accordingly. Mathematically, this problem can be reduced to a system of variational inequalities. We explicitly derive a Pareto-optimal Nash equilibrium to the game.

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CP5

Gradient Estimation and Mountain Range Options

This application of gradient estimation drawns from financial engineering and explores several exotic derivatives that are collectively known Mountain Range options. We employ Monte Carlo simulation to price these options and developing gradient estimates to study the sensitivities to underlying parameters, known as "the Greeks'. We find that IPA and LR/SF methods are efficient methods of gradient estimation for Mountain Range products at a considerably reduced computation cost compared with the commonly used finite difference methods.

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CP5

The Impacts of Risk Aversion and Market Regimes on the Dynamic Hedging and Multiple Exercises of American Options

We study the problem of dynamically hedging a long position in American options written on a non-traded asset in a regime-switching market. The option holder faces the *idiosyncratic risk* from the non-tradability of the underlyer as well as the unhedgeable *regime-switching risk*. Applying the *utility indifference pricing* methodology, we determine the holder's optimal hedging and exercising strategies, and examine the non-trivial impacts of risk aversion and stochastic regimes on the holder's policy.

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CP5

Static Hedging of Barrier Options in Diffusion Models: An Explicit Exact Solution

We solve the problem of static hedging of (upper) barrier options (we concentrate on up-and-out put, but show how other cases follow from this one) in models where the underlying is given by a time-homogeneous diffusion process with, possibly, independent stochastic time-change. The main result of our paper includes analytic expression for the payoff of a (single) European-type contingent claim (which pays a certain function of the underlying value at maturity, without any path-dependence), such that it has the same price as the barrier option up until hitting the barrier. We then consider some examples, including the Black-Scholes, CEV and zero-correlation SABR models, and investigate an approximation of the exact static hedge with two vanilla

(call and put) options.

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CP5

Effect of Incorporating Correlation Structure on Pricing Mountain Range Options

This paper focuses on the effect of correlation on pricing an Everest option (pays based on the lowest performing stock) and an Atlas option (call on the mean of a basket from which best/worst performers are removed). We first price using independent Geometric Brownian Motions; we then re-price, modeling correlation based on historical returns using various decomposition methods to provide insight into the effect of including correlation structure in pricing mountain range options.

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CP5

Hedging under Arbitrage

It is shown that delta hedging provides the optimal trading strategy in terms of minimal required initial capital to replicate a given terminal payoff in a continuous-time Markovian context. This holds true in market models where no equivalent local martingale measure exists but only a square-integrable market price of risk. A new probability measure is constructed, which takes the place of an equivalent local martingale measure. In order to ensure the existence of the delta hedge, sufficient conditions are derived for the necessary differentiability of expectations indexed over the initial market configuration. The recently often discussed phenomenon of "bubbles' is a special case of the setting in this paper. Several examples at the end illustrate the techniques described in this work.

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CP5

A Hybrid Asymptotic Expansion Scheme: An Application to Long-Term Currency Options

This paper develops a hybrid asymptotic expansion scheme giving closed-form approximation for valuation of multi-factor European path-independent derivatives. We apply it specifically to pricing long-term currency options under a market model of interest rates and a stochastic volatility model with jumps of spot exchange rates. It also introduces a characteristic-function-based Monte Carlo simulation method with the expansion as a control variable. Finally, numerical examples shows effectiveness of our scheme.

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CP6

The Integrated Correlated Variance As a Statistical Inverse Problem

We consider the inverse problem of option implied integrated variance in a Bayesian framework. We present a method to estimate both the implied integrated variance and the correlation between stock price and volatility shocks, and discuss the problems and effect of noisy option price data. We suggest possible applications of the implied integrated variance: volatility derivatives, risk-neutral price densities and related option pricing, and hedging. The Bayesian approach provides not only estimates of the unknown of interest, but also information on the reliability of these estimates.

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CP6

Equilibrium Wind Hedge Contract Structures Through Stochastic Programming

Wind hedge contracts are a new way to help wind project developers secure financing and manage risks. In such a contract, a strike price of electricity and a quantity are specified. We use Nash bargaining solutions to capture the bargaining process between the two contract parties, and model it as a stochastic program, solved through the sample average approximation method. Sensitivity analysis is conducted with respect to volatility and parties risk averseness.

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CP6

Consistent Estimator of Covolatility

We introduce the random lead-lag estimator (RLL) for the integrated covolatility of a pair of assets traded nonsynchronously and observed with microstructure noise. We obtain expressions for bias and variance of RLL under general assumptions and demonstrate that RLL is $n^{1/3}$ consistent in the absence of noise. The rate is same if there is noise and we use a subsampled version of RLL with proper choice of sampling frequencies. Method is applied to NASDAQ data.

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CP6

Determining Clearing Prices for Coupled Day-Ahead Electricity Markets

The European power grid is divided into several market areas connected by power lines with restricted transmission capacity. Hence supply and demand of adjacent areas can not always be balanced. The goal of a day-ahead auction is to determine prices and cross border flow maximizing the economic surplus of all participants. In general electricity will be transmitted from a low price to an high price area. A MIQP is used to model this challenge.

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CP6

Time Series Analysis of Functional Data for Term Structure Modeling

We develop time series analysis of functional data, treating the whole yield curve as a random realization from a distribution on functions. The method consists of Principal Components Analysis of Functional data and subsequently modeling the principal component scores as vector ARMA. This provides a unified framework for studying the time and maturity components of interest rates under one set-up with few parametric assumptions. We compare our forecasts to Diebold and Li (2006).

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CP6

Hedge Funds Regulation and Systemic Risk Control

Contrast to regulated Mutual Funds, Hedge Funds are private and lightly regulated entities who are not obliged to disclose their activities to the general public. However, hedge funds risk taking activity using ways such as short selling and excessive leverage and their increasingly correlated strategies pose substantial threats to the financial stability of the great economy. We propose a simple framework which adopts the theory of acceptible risks and capital requirements using the limited available data on hedge funds, to control for risks at the fund level as well as on a systemic level. We model the risky cash ow assets less the liability (or Net Asset Value) directly using either a Gaussian process or a Variance Gamma process and apply the method to demeaned NAV data on 3622 hedge funds from Jan 2005 to April 2009. Funds are analysed for their required capital and the value of the option to put losses back to the taxpayer. A systemic approach with correlated largest market participants is also proposed. The 30 largest funds of April 2009 with total Asset Under Management over $620 Bn are studied with proposed systemic capital charges to be held by the broad economy and capital charges at the fund level accounting for the residual idiosyncratic risk component.

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CP6

A Unifying Approach to the Nonparametric Estimation of Risk Measures

This talk is concerned with the nonparametric estimation of risk measures. Fairly general results on the strong rate of convergence as well as on the asymptotic distribution of plug-in estimates will be given. The results are very flexible w.r.t. to both the underlying data and the estimator of the unknown distribution function. The statements on the asymptotic distribution rely on a version of the Functional Delta Method (FDM) which, in contrast to the classical FDM, is suitable also for weighted empirical processes.

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CP6

Challenges of Trading Illiquid Natural Gas Options

With the boom of natural gas market, more financial requests are imposed on various locations, which are off main hubs (e.g. Henry hub) and not tradable in exchange. Trading derivatives, especially high-risk options, brings us profitable opportunities bearing new challenges. After examining existing techniques to deal with non-liquid options, we will propose novel and practical solution for constructing the volatility surface and hedging options under the natural gas context.

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CP7

Pricing Cross-Currency Interest Rate Derivatives with Target Redemption Features on Graphics Processing Units via a PDE approach

We present a GPU-based parallel pricing via a PDE approach of exotic cross-currency interest rate derivatives, with strong emphasis on Power Reverse Dual Currency (PRDC) swaps with Foreign Exchange Target Redemption (FX-TARN) feature. The FX-TARN provision provides a cap on the FX-linked PRDC coupon amounts, and once the accumulated coupon amount reaches this cap, the underlying PRDC swap terminates. By introducing an auxiliary state variable to keep track of the total accumulated PRDC

coupon amount, over each period of the tenor structure, the valuation of a FX-TARN PRDC swap requires to solve a set of independent PDEs. Highly efficient GPU-based parallel ADI finite difference methods are used for the solutions of these PDEs. Numerical examples illustrating the convergence properties and the efficiency of the numerical methods are provided.

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CP7

Optimizing Market Value-at-Risk Computations on GPUs

The latest financial crisis has highlighted the need for more responsive market risk management systems and more pervasive stress testing. While the microprocessor industry has recently introduced transformative computing capabilities in the form of general-purpose graphics processing units (GPUs), its potential for quantitative risk estimation is currently under-realized. This presentation explains how Monte-Carlo simulation based estimation approaches such as Value-at-Risk (VaR) and Economic Capital (EC) can be optimized to take advantage of the widely available GPUs. We describe a three-phase optimization approach to leverage high performance numerical linear algebra routines, reduce standard error and maximize the utilization of the underlying resources of the GPU. We apply this approach to demonstrate (i) on-demand VaR estimation, scalable to the group-wise portfolios of even the largest financial institutions, and (ii) more pervasive stress testing by concurrent execution of batches of EC estimates under different modeling assumptions. A reoccurring theme throughout the talk will be the implications of the very latest advances in GPU technology on quantitative financial modeling.

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CP7

Price Sensitivity Estimation in the Hull-White Short-Rate Model

This paper extends the likelihood ratio and the weak derivative techniques for price sensitivity estimation to the short-rate model of Hull and White. Three problems arise: (1) non-differentiable payoff functions depend on model-parameters. (2) Exotic options break down payoff-independency of both methods. (3) In contrast to equity derivatives, the Delta and Gamma of an interest-rate derivative depend on the whole path. We propose solutions to all the items.

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CP7

A Robust Regression Monte Carlo Method for Pricing High-Dimensional American-Style Options

We present a new regression-based Monte Carlo method for pricing multi-asset American-style options. The key idea is to fit the model function for the continuation value by robust regression. Moreover, we suggest a new technique for calculating the coefficients of the model function to decrease the number of basis functions and to enable the parallelization of our approach. In addition, we extend earlier results for variance reduction via importance sampling. We can improve convergence significantly.

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CP7

Order Book Dynamics and Price Impact

We study the price impact of order book events using the TAQ database for a large set of stocks. Our study reveals a linear relation between order imbalance and price changes with a slope inversely proportional to the market depth. We argue that our linear price impact model, together with a scaling argument, implies the empirically observed "square-root" relation between price changes and aggregate traded volume measured in number of shares.

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CP7

Discontinuous Galerkin Methods for Elliptic Partial Differential Equations with Random Coefficients

This talk proposes two numerical methods for solving elliptic partial differential equations with random coefficients. The first approach transforms a stochastic problem into a parametrized one that is then discretized by the discontinuous Galerkin (DG) method. A priori error estimates in the energy norm and L2 norm are derived. The second approach utilizes the Monte Carlo Discontinuous Galerkin (MCDG) method. The error bound in the stochastic and space domain are both derived. Numerical simulations of

the MCDG method are tested on various meshes. Results show that the nonsymmetric MCDG method is stable independently of meshes and the value of the penalty parameter. Symmetric and incomplete MCDG methods are stable only when the penalty parameter is large enough. Comparisons with the Monte Carlo finite element method are presented for several test problems. As an application, the pricing of American options is discussed.

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CP7

Regularized Robust Optimization Approach for the Portfolio Execution Cost Problem

Execution cost problem minimizes total cost and risk of the execution of a portfolio of risky assets over a fixed number of periods. Execution cost is defined by (erroneously estimated) price impact functions. One practice to account for this uncertainty is to apply the robust optimization methodology. Under this worst-case approach, the investor accepts a suboptimal trading strategy for the nominal problem to ensure that the solution performs reasonably well, when the data varies in an uncertainty set. There are two main concerns with such an approach: (1) it might be very sensitive to the specification of the uncertainty set, (2) it might be too conservative. We propose a regularized robust optimization approach which has better stability properties, and attempts to rectify these two shortcomings; that is, given any uncertainty set for the parameters, we construct a regularized uncertainty set by including a regularization constraint. The regularization constraint is a matrix inequality of the Hessian of the objective function and a regularization parameter. An attractive aspect of our method is that the obtained solution is not only robust to the potential estimation errors in the parameters of the price impact functions, but also is robust to the possible changes in the specification of the uncertainty set. Regularization parameter controls diversity of the portfolio, degree of conservatism and the obtained objective value.

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CP7

Numerical Methods for Highly Non-Linear Financial Models

We are interested in strong convergence and almost sure stability of numerical approximations to the solution of stochastic differential equations (SDEs) with highly nonlinear coefficients. Our goal is to justify efficient Multi-level Monte Carlo simulations for many of stochastic volatility and interests rate models that do not satisfy standard assumptions required for strong convergence. In addition we examine global almost sure asymptotic stability in this non-linear setting for considered schemes.

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CP8

No-Arbitrage Pricing under Cross-Ownership

We generalize Merton's asset valuation approach to systems of multiple financial firms where cross-ownership of equities and liabilities is present. The liabilities, which may include debts and derivatives, can be of differing seniority. We derive equations for the prices of equities and recovery claims under no-arbitrage. An existence result and a uniqueness result are proven. Examples and an algorithm for the simultaneous calculation of all no-arbitrage prices are provided.

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CP8

Stylized properties and risk management of credit default swaps

We study the stylized facts of 5-year CDS spreads in 2005-09 and find that CDS spread returns exhibit positive autocorrelations, heteroscedasticity and heavy tails. We also find evidence of common jumps across obligors while those jumps do not necessarily relate to any credit events. Observing that the commonly used affine models are not capable to explain the stylized features, we propose an ARMA-GARCH type model which appears to have better risk management performance.

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CP8

American Options and Callable Bonds under Stochastic Interest Rates and Endogenous Bankruptcy

A new characterization of the American-style option is proposed under a very general multifactor Markovian and diffusion framework. The efficiency of the proposed pricing solutions is shown to depend only on the use of a viable valuation method for the corresponding European-style option and for the transition density of the model's state variables. Under a Gauss-Markov stochastic interest rates setup, these new American option pricing solutions are shown to be significantly more accurate than the approximations already available in the literature. This result is also used to price callable corporate bonds under an endogenous bankruptcy structural approach, by decomposing the option to call or default into a European put on the firm value plus two early exercise premium components.

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CP8

Pricing and Hedging in Affine Models with Jump

to Default

In this paper we analyze a general class of pricing models for European equity derivatives where the risk-neutral stock prices, interest rates and default of stock are jointly driven by an affine process. We extend the notion of a discounted moment generation function of the log stock price to the case when the underlying can default and show that it can be used for call option pricing using Carr-Madans method as well as for derivation of prices of power payoffs. Other European payoffs can be approximated using a mix of power payoffs and vanilla options. As we show the results are superior compared to using only power payoffs or only vanilla options. Moreover, within the class of such pricing models we determine those that are complete and discuss hedging by continuous trading in stock, corporate and government bonds as well as liquid vanilla options. The results are applied to the hedging of a variance swap. As a special case we consider Heston model with jump to default and stochastic interest rates.

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MS1

Credit Valuation Adjustment (cva) and Dynamic Hedging: Experience Through the Crisis

Abstract not available at time of publication.

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MS1

Resilience to Contagion in Financial Networks

Abstract not available at time of publication.

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MS1

Credit Default Swaps and Systemic Risk

Abstract not available at time of publication.

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MS1

Counterparty Risk Management for Central Clearing Counterparties

Abstract not available at time of publication.

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MS2

The Electricity Bid Stack: Linking Coal, Gas, Power and Emissions Prices

The observed bidding behavior of power generators illustrates the clear link between the dynamics of underlying fuel and emissions costs and resulting power prices. This relationship allows us to build a bid stack based structural model for both CO2 and electricity prices, which intuitively captures important effects such as merit order changes and fuel switching. We analyze the resulting dependence structure between the various energy prices, and the implications for derivative pricing in these markets.

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MS2

The Effect of Model Error on the Valuation and Hedging of Natural Gas Storage

We study the effect of model error on the valuation and hedging of the natural gas storage real option. The model error that we consider is due to the assumed number of factors in a multifactor futures price model differing from the true number of factors. We find that model error has a differential impact on the valuation and hedging of the real option to store natural gas.

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MS2

Inventory and Forward Dynamics

What can one expect from risk-neutral price processes in which inventory is explicitly included as a state variable? Inventory impact on commodity price dynamics has been a topic of discussion for many decades, and a set of stylized facts have emerged from empirical observation. A variety of modeling efforts have also been attempted to explain some of these stylized facts with varying degrees of success. Valuation and hedging of many structured commodities transactions, often in the near total absence of traded correlation products, requires that particular attention be paid to effects of inventory on volatility structure. Here we show how a simple inventory based forward model can yield a surprisingly wide variety of returns distributions, and contrast the implications of this model to both empirical observations and commonly used pricing models.

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MS2

Semi-Lagrangian Timestepping for Gas Storage

Problems

Stochastic dynamic programming approaches for the valuation of natural gas storage, and the determination of the optimal continuous-time injection/withdrawal strategy, give rise to HJB P(I)DEs which are typically solved using finite differences [Thompson et. al., 2009 and Chen and Forsyth, 2007] achieving first-order convergence to the viscosity solution. This talk will show how to formulate a semi-Lagrangian approach that can generate a second-order accurate discretisation, providing efficiency gains over existing approaches.

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MS3

Modeling Trade Duration and Price Innovations for High Frequency and Algorithmic Trading

Using a hidden Markov model to capture the dynamics of duration and price revisions, we argue that high frequency traders (HFT) profit from liquidity incentives (rebates) in certain regimes and from trading algorithms in others. Regimes are characterized by the duration between trades and the statistical properties of price revisions which are then used to drive a Marked Point Process for asset prices. Model parameters are estimated before and after HFTs came into the market.

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MS3

High Frequency Traders and Asset Prices

We derive the distribution of transaction prices in limit order markets populated by low frequency traders (LFT) before and after the entrance of a high frequency trader (HFT). In the presence of the HFT that distribution has more mass around the center and thinner far tails. We show that the HFT makes positive expected profits by "sniping' out LFT orders , and that the faster LFT's submit and vary their orders, the more profits the HFT makes. The model predicts that in the time of crisis the HFT provides less liquidity

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MS3

The Dynamic Mixed Hitting-Time Model for Multiple Transaction Prices and Times

We propose a structural model for durations between events and associated marks. We model the durations as the successive passage times of an underlying Brownian motion relative to in itself random boundaries. Multivariate Brownian motions allow us to incorporate a vector of asset returns (the marks) combined with a single duration generating process. Our model, applied to high-frequency financial data, embeds the standard autoregressive conditional duration models in a multivariate structural setting with GARCH effects.

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MS3

Estimation of Jump Tails

We propose non-parametric framework for estimating jump tails of discretely-observed Ito semimartingales. The approach is based on a set of estimating equations associated with the compensator for the jump measure that only utilizes assumption of regular variation in the jump tails, along with in-fill asymptotics for identifying the jumps. The estimation allows for general dynamic dependencies in the jump tails, and does not restrict the continuous part of the process.

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MS4

Investment Strategies Under Atlas Models

We study Atlas-type models of equity markets with local characteristics that depend on both name and rank, and in ways that induce a stability of the capital distribution. Ergodic properties are examined with reference to the theory of reflected Brownian motions in polyhedral domains and also of the corresponding adjoint differential operators. In the context of such models, we discuss various investment strategies, including the so-called growth-optimal and universal portfolios.

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MS4

Inferring Preferences from Agents' Choices

We pursue an inverse approach to utility theory: instead of specifying agent's utility function and deriving her actions, we assume we observe her actions (i.e. her consumption and investment strategies) and derive utility function for which the observed behaviour is optimal. This is done in a one-period model and in continuous time both in a deterministic and stochastic setting. We typically find that the consumption and investment strategies have to satisfy

a consistency condition (e.g. a PDE) if they come from a classical utility maximisation problem. We further show that agent's important characteristics such as attitude towards risk (e.g. DARA) can be directly deduced from her consumption/investment choices.

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MS4

Optimal Investment with High-watermark Performance Fee

We consider the problem of optimal investment and consumption when the investment opportunity is represented by a hedge-fund charging proportional fees on profit. The value of the fund evolves as a geometric Brownian motion and the performance of the investment and consumption strategy is measured using discounted power utility from consumption on infinite horizon. The resulting stochastic control problem is solved using dynamic programming arguments. We show by analytical methods that the associated Hamilton-Jacobi-Bellman equation has a smooth solution, and then obtain the existence and representation of the optimal control in feedback form using verification arguments. The presentation is based on joint work with Karel Janecek.

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MS4

Examples of Incomplete-market Equilibria in Continuous Time

Abstract not available at time of publication.

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MS5

Title Not Available at Time of Publication

Abstract not available at time of publication.

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MS5

The Brazilian Financial System: Network Structure and Systemic Risk Analysis

Using a unique data set of interbank exposures and capital levels of Brazilian financial institutions, we show that such banking networks may be modeled as *directed scale-free networks* with regularly-varying degree and exposure distributions. We define two indicators of the systemic risk generated by the failure of an institution - the *Default Impact* and the *Contagion Index* - and investigate the nature and magnitude of default contagion and systemic risk in the Brazilian financial system.

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MS5

The Most Likely Path to Systemic Failure

Abstract not available at time of publication.

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MS5

Entangled Financial Systems

This paper analyzes counterparty risk in systems where banks hedge risks using a network of bilateral over-the-counter contracts. If banks have large exposures to a few counterparties, they do not buy insurance against a low probability counterparty default even though it is socially desirable. This is because they do not take into account that their own failure also drags down other banks: a network externality. Mandatory counterparty insurance is welfare improving.

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MS6

A New Perspective on Commodity Market Models

Abstract not available at time of publication.

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MS6

Dynamic Bertrand Oligopoly

We study continuous time Bertrand oligopolies in which

a small number of firms producing similar goods compete with one another by setting prices. We analyze a static version of this game, then setup the nonzero-sum stochastic differential game and its associated system of HJB partial differential equations in the case of linear demand functions. We characterize certain qualitative features of the game using an asymptotic approximation in the limit of small competition. The equilibrium of the game is further studied using numerical solutions.

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MS6

Optimal Dynamic Hedging for a Large Investor in an Illiquid Market

The solution to Δdelta-hedging a European option in a complete, Black- Scholes market is well known. We present the solution in the incomplete case when the agent faces a liquidity cost that is proportional to the size of his trading. This is the situation faced by many large hedge funds whose trades adversely affect market prices ('slippage'). The trader's objectivebalances his mean expected cost of hedging against the variance of his mark-to-market portfolio at the end of a fixed trading horizon. This naturallyfalls within the mean-variance framework of a Quadratic Hamilton-Jacobi-Bellman Equation. In contrast to the complete case where the trader is ableto maintain a perfect Black-Scholes Hedge, an agent facing a proportional liquidity cost is generally mishedged and trades towards being hedged. We derive a simple analytic solution for the agent's trading intensity, which we and is proportional to the degree of mishedge, inversely proportional to the liquidity cost, and increases towards the end of the trading horizon. We describe the effectiveness of our strategy using numerical simulations with TAQ data and comment on its relation to a result of Garleanu and Pedersen on the Merton Problem in an illiquid market.

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MS6

Exploration and Exhaustibility in Dynamic Cournot Games

Motivated by oligopolies in oil markets, we study the effect of resource exploration in dynamic Cournot models. A producer may undertake costly exploration to replenish his exhaustible reserves. We assume that new discoveries occur according to a Poisson process with intensity given by the exploration effort. We treat both the case of a monopolist and a duopoly game between the producer and an inexhaustible competitor. This leads to a study of systems of nonlinear first order delay ODE's. We derive asymptotic expansions for the case of a small exploration rate and present numerical investigations.

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MS7

Conditional Certainty Equivalent

Abstract not available at time of publication.

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MS7

External Risk Measures and Basel II Accord

We propose new data-based risk measures called natural risk statistics that are characterized by a new set of axioms based on comonotonicity from decision theory. Natural risk statistics include VaR with scenario analysis, in particular Basel II risk measures, and other risk measures proposed to address the procyclicality issue in Basel II, as special cases; therefore, we provide a theoretical framework to understand and to extend Basel II, if needed.

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MS7

Risk Assessment for Cash Flows under Model and Discounting Ambiguity

We study the risk assessment of uncertain cash flows in terms of dynamic convex risk measures for processes as introduced in Cheridito, Delbaen, and Kupper (2006). These risk measures take into account not only the amounts but also the timing of a cash flow. We discuss their robust representation in terms of suitably penalized probability measures on the optional σ-field. This yields an explicit analysis both of model and discounting ambiguity. We focus on supermartingale criteria for time consistency. In particular we show how "bubbles" may appear in the dynamic penalization, and how they cause a breakdown of asymptotic safety of the risk assessment procedure.

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MS7

Dual Characterizations and Constructions for

Weakly Time Consistent Convex Risk Measures

We present characterizations of weak time consistency for convex risk measures in terms of their dual representations. Then we derive several guidelines for the construction of such risk measures. Forward in time, this involves a unique updating rule for obtaining ϕ_t from a given ϕ_s with $s < t$. Backward in time, we analyse the rules that the dual representation θ_s of ϕ_s must satisfy to guarantee weak time consistency, given a dual representation θ_t for ϕ_t.

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MS8

Strict Local Martingale Deflators and Pricing American Call-Type Options

We solve the problem of pricing and optimal exercise of American call-type options in markets which do not necessarily admit an equivalent local martingale measure. This resolves an open question proposed by Fernholz and Karatzas [Stochastic Portfolio Theory: A Survey, Handbook of Numerical Analysis, 15:89-168, 2009].

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MS8

Optimal Stopping with Irregular Reward Functions and Jumps

In this talk, we will examine optimal stopping problems with bounded Borel-measurable reward functions for one-dimensional diffusions with compound Poisson jumps. By identifying the value function as a limit of a sequence of value functions of optimal stopping problems for general diffusions, we extend recent results obtained for irregular reward functions on one-dimensional diffusions. Specifically, we show the value function is continuous and can be characterized as the unique solution of a variational inequality in the sense of distributions.

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MS8

On Valuation Equations for Stochastic Volatility Models

We study the valuation partial differential equation for European contingent claims in a general framework of stochastic volatility models, where the standard Feynman-Kac Theorem cannot be applied because the diffusion coefficients may degenerate on the boundaries of the state space and grow faster than linearly. We allow for various types of model behavior; for example, the volatility process in our model can potentially reach zero and either stay there or instantaneously reflect, and asset-price processes may be strict local martingales under a given risk-neutral measure. Our main result is an extension of the standard Feynman-Kac Theorem in the context of stochastic volatility models. Sharp results on the existence and uniqueness of classical solutions to the valuation equation are obtained using a combination of probabilistic and analytical techniques. The role of boundary conditions is also discussed.

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MS8

Optimal Stopping for Dynamic Convex Risk Measures

We use martingale and stochastic analysis techniques to study a continuous-time optimal stopping problem, in which the decision maker uses a dynamic convex risk measure to evaluate future rewards. We also find a saddle point for an equivalent zero-sum game of control and stopping, between an agent (the stopper) who chooses the termination time of the game, and an agent (the controller, or nature) who selects the probability measure.

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MS9

Riding on Smiles

This paper investigates the calibration performance of several multifactor stochastic volatility models. There is an empirical evidence that the dynamics of the implied volatility surface is driven by several factors. This leads to the extensions of the seminal Heston stochastic volatility model proposed by several authors. Using a data set of derivatives on the major indices we study the calibration properties of these models using the FFT as the pricing methodology.

We also study if adding jumps improves significantly the calibration accuracy of the models. We compare the calibration performance of those models over a large sample period. We also focus on basket option pricing models and more precisely on the WASC model (Wishart Affine Stochastic Correlation). We explain how to calibrate it and explain how it is related to the previous problem. Finally, we provide some price approximations for vanilla options that enlighten the properties of smile generated by the Wishart stochastic volatility and the WASC models. What is more, it provides a simple way to relate different models.

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MS9

Fast Calibration of Time Dependent Heston Model with Malliavin Calculus

Using a small volatility of volatility expansion and Malliavin calculus techniques, we derive an accurate analytical formula for the price of vanilla options for any time dependent Heston model (the accuracy is less than a few bps for various strikes and maturities). In addition, we establish tight error estimates. The advantage of this approach over Fourier-based methods is its rapidity (gain by a factor 100 or more) while maintaining a competitive accuracy. From the approximative formula, we also derive some corollaries related first to equivalent Heston models and second, to the calibration procedure in terms of ill-posed problems.

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MS9

Discretization of Lévy-Driven Stochastic Differential Equations with Applications to the Lévy Libor Model

We present new algorithms for weak approximation of stochastic differential equations driven by pure jump Lévy processes. The method is built upon adaptive discretization based on the times of large jumps of the driving process. Our technique avoids the simulation of the increments of the Lévy process, and in many cases achieves better convergence rates than the traditional Euler scheme. To illustrate the method, we discuss option pricing in the Libor market model with jumps.

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MS9

High Order Numerical Schemes for Affine Processes with Applications

We present several high order weak numerical schemes for affine processes (generalizing for instance the Ninomiya-Victoir scheme) which are derived by carefully considering approximations of the Riccati equations appearing in the Fourier transform. Several examples, in particular from the theory of covariance matrix valued affine processes, are considered.

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MS10

Stochastic Volatility and Path-dependent Options: the Asian Case

In this talk we review recent result on extending the notion of local volatility to handle path-dependent claims. We then specialize to the case of Asian options. In this context, we present new results on weak uniqueness for degenerate diffusions with coefficients which are merely continuous. These results combine tools from the theory of singular integrals on Lie groups with the localization machinery of Stroock and Varadhan.

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MS10

Recent Developments in Variance Contracts

Abstract not available at time of publication.

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MS10

Large and Small Strike Asymptotics of the Implied Volatility

Abstract not available at time of publication.

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MS10

Stochastic Volatility Modelling under Fast Mean

Reversion Regimes

Abstract not available at time of publication.

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MS11

An Efficient Unbiased SABR Model Simulation Scheme

The Stochastic Alpha Beta Rho (SABR) stochastic volatility model is widely used for the pricing of fixed income instruments. In this presentation we deal with the difficulties of the basic Euler scheme when simulating the SABR model, i.e. the possible negative rates, the martingale property and the discretization bias. We propose an unbiased time-discretization scheme for the SABR model based on careful analysis of its analytic properties. Experiments with realistic model parameters show that this scheme is robust.

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MS11

Reduced Basis for Solutions of Black-Scholes Equations with Jump Processes

We introduce a one dimensional Galerkin basis to numerically solve parabolic partial (integro-)differential equations which arise in option pricing theory. Basis functions are designed on Black-Scholes solutions and this choice is driven by the two main constraints: the numerical efficiency in the computation of the basis and of the Galerkin matrices and the suitable global shape and correct asymptotic behaviour for boundary condition. A convergence proof is given and numerical tests are performed. The basis is tried also for calibration of local volatilities.

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MS11

Pricing Inflation Products with Stochastic Volatility and Stochastic Interest Rates

In this presentation we consider a Heston type inflation model, where we model the nominal and real interest rates by a two-factor Hull-White model. We consider the case with all the correlations being non-zero. For pension funds such an inflation model is for example important to determine the value of conditional (future) indexations. Due to the presence of the Heston dynamics our derived inflation model is able to capture the implied volatility skew/smile which is present in inflation option market data. In particular, we derive an efficient pricing formula of inflation dependent plain vanilla options. Using these pricing formulas we perform a calibration of the inflation model and compare implied volatility surfaces.

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MS11

Quantization Methods for Multiple Exercise Options on GPGPU

The Quantization Tree algorithm has proven to be quite an efficient tool for the evaluation of financial derivatives with non-vanilla exercise rights as Bermudan- or Swing options. Since this approach involves compute-intensive Monte-Carlo simulations to estimate the transition probabilities for the underlying Markov process in the Quantization Tree, we present an efficient GPGPU implementation for this problem, which reduces the computational time dramatically.

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MS12

Liquidity and Risk Management: Crossing Networks Impact

It is generally acknowledged that a spiraling feedback between risk management and liquidity can arise: tighter risk management leads to more restricted portfolios, resulting in illiquidity because of the need to engage in increasingly larger transactions. In turn, the price impact of the latter induces changes in values at risk. As an alternative trading platform with lesser price impact risk, crossing networks (a.k.a. dark pools) have experienced rapid growth over the past few years. Though one of their disadvantages is longer time to execution, there is empirical evidence to suggest that they are particularly used when bid-ask spreads are very large. In this paper I present a stochastic control model that helps determine critical levels for bid and ask prices beyond which value-at-risk related transactions are routed through crossing networks that use the mid-points of national best bid and offer prices (NBBO).

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MS12

Optimal Liquidation in Limit Order Books with Stochastic Liquidity

We consider the problem of optimally placing market orders so as to minimize the expected liquidity costs from buying a given amount of shares over a fixed period of time. The limit order book approach suggested by Obizhaeva and Wang (2006) is used to model the liquidity price impact. We add the following feature: The liquidity supply and likewise the price impact coefficient are assumed to be described by a stochastic differential equation instead of being constant over time.

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MS12

Cetin-Jarrow-Protter Model of Liquidity in a Binomial Market

The binomial version of CJP model of liquidity is investigated. The discrete- time super replicating cost converges to the solution of a partial differential equa- tion derived by Cetin et al. in continuous-time. Hence, we show that the liquid- ity premium does not vanish in the limit. Moreover, efficient numerical methods are developed to compute the superreplicating cost and hedge. In particular, an up-and-out call option is studied.

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MS12

Continuous Equilibria with Heterogeneous Preferences and Unspanned Endowments

We present a class of Brownian based models which produce tractable incomplete equilibria. The models are based on finitely many investors with heterogeneous exponential utilities over intermediate consumption who receive partially unspanned income. The investors can trade continuously on a finite time interval in a money market account as well as a risky security. Besides establishing the existence of an equilibrium, our main result shows that if aggregate income is not continuous over time the resulting equilibrium can display a lower interest rate and a higher risk premium relative to the usual Pareto efficient equilibrium.

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MS13

Modeling the Forward Surface of Mortality

Longevity risk constitutes an important risk factor for insurance companies and pension plans. For its analysis, but also for evaluating mortality-contingent structured financial products, modeling approaches allowing for uncertainties in mortality projections are needed. One model class that has attracted interest in applied research as well as among practitioners are *forward mortality models*, which are defined based on forecasts of survival probabilities as can be found in generation life tables and infer dynamics on the entire age/term-structure – or forward surface – of mortality. However, thus far, there has been little guidance on identifying suitable specifications and their properties. The current paper provides a detailed analysis of forward mortality models driven by a finite-dimensional Brownian motion. In particular, after discussing basic properties, we present an infinite-dimensional formulation, and we examine the existence of finite-dimensional realizations for time-homogenous Gaussian forward models, which are shown to possess important advantages for practical applications.

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Abstract not available at time of publication.

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MS14

On the Least-Squares Monte Carlo Approach to Backward SDEs

Many option pricing and portfolio selection problems in

mathematical finance can be reformulated in terms of backward stochastic differential equations (BSDEs). As the corresponding BSDE can rarely be solved in closed form, numerical algorithms for BSDEs are of prime importance. In this talk we will review some results on the least-squares Monte Carlo approach for simulating BSDEs and discuss some practical matters such as choice of the basis functions, variance reduction, and how to check the 'quality' of the simulated solution.

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MS14
Adjoint Techniques in Financial Models

Abstract not available at time of publication.

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MS14
Numerical Speed-up Factors for Model Calibration in SDEs

Abstract not available at time of publication.

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MS14
Optimal Dynamic Hedging: A Double-Hedged Monte Carlo Method

The dynamic hedging of options with a bond and with the underlying asset has been extensively studied in the past. In practice, however, options are often dynamically hedged as well with some other financial instruments. We propose a least squares Monte Carlo method which allows to simulate this. The method provides very low variance by locally minimizing risk. Numerical results will be given. We hedge with vanilla puts respectively with variance swaps.

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MS15
Optimal Order Execution

In this talk, we review various models of market impact. We use variational calculus to derive optimal execution strategies, and show that in many conventional models, static strategies are dynamically optimal. We then present a model in which the optimal strategy does depend on the stock price and derive an explicit closed-form solution for this strategy by solving the HJB equation. We conclude by exploring the sensitivity of expected cost in this model to the execution strategy. This is joint work with Alexander Schied.

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MS15
On Credit Risk, First Passage Time Problems and Heat Polynomials

Motivated by a direct and inverse problem in credit risk, we relate the first hitting probabilities of diffusions to the so-called heat polynomials [Rosenbloom and Widder (1959)] and generalized Airy functions. We will present numerical examples.

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MS15
Optimal Liquidation in Dark Pools

We consider a finite time horizon, multi-asset optimal liquidation problem in discrete time for an investor having access to both a traditional trading venue and a dark pool. Our model captures the price impact of trading in transparent traditional venues as well as the execution uncertainty of trading in a dark pool. We prove existence and uniqueness of optimal trading strategies for risk averse mean-variance-like traders and find that dark pools change optimal trading strategies and can significantly reduce trading costs. Their effect can be reduced by adverse selection and trading restrictions.

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MS15
Price Volatility as a Limit of Queuing Systems

We present a stochastic model for the bid and ask quotes of a traded asset. We describe methods for computing the probability $p(x, y)$ that the next price move is up, conditional on the bid (x) and ask sizes (y). We then define the efficient price to be a weighted average of the bid and the ask prices, where $p(x, y)$ is the weight applied on the ask price. The instantaneous volatility of this efficient price may be interpreted as as a microstructure-adjusted volatility.

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MS16

A Fourier-Based Valuation Method of Bermudan and Barrier Options under Heston's Model

We present an efficient Fourier-based numerical method for pricing Bermudan and discretely monitored barrier options under the Heston stochastic volatility model. The two-dimensional pricing problem is dealt with by a combination of a Fourier cosine series expansion, and high-order quadrature rules in the other dimension. By a transformation from the variance to the log-variance domain, we deal with parameter sets that do not satisfy Feller's condition. Error analysis and experiments confirm a fast error convergence

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MS16

An Iterative Method for Pricing American Options Under Jump-diffusion Models

An implicit finite difference method for the linear complementarity problem (LCP) formulation of American options under jump-diffusion models leads to the solution of LCPs with full matrices at each time step. We propose an iteration which solves a sequence of LCPs with the corresponding model without jumps at each time step. As these LCPs are easier to solve and the iteration converges quickly this gives an efficient way to price American options under jump-diffusion models.

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MS16

A Front-fixing Finite Element Analysis of American Options

In this talk, I will present our recent work in front-fixing finite element methods for the valuation of American options. The free boundary problems on unbounded domains will be truncated to variable domain problems and then converted into nonlinear boundary value problems on rectangular domains. Finite element methods and Newton's method will be employed to solve the nonlinear problems numerically. Stability and solution nonnegativity are established under some appropriate assumptions. Numerical results are given to examine our methods and to compare them with the other methods.

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MS16

Finite Element Methods for Option Pricing

We are concerned with finite element approximations to the evaluation of American options. Following W. Allegretto etc, SIAM J. Numer. Anal. 39 (2001), 834–857, we introduce a novel practical approach to the discussed problem, on the basis of which the sharp error estimates and the superconvergence are presented. Moreover, the global superconvergence result can be used to generate an efficient a posteriori error estimator. Some numerical examples are provided to demonstrate our theoretical results.

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MS17

Calibration Problems in Option Pricing

We consider the problem of identifying volatility functions in Black-Scholes type equations from market data. Starting from an overview on different approaches, we focus on an optimal control approach in a Lagrangian framework. A regularized cost functional is minimized over a suitable set of admissible volatilities. We present analytical results on first- and second-order optimality as well as numerical results.

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MS17

Adjoint Based Calibration of Local Volatility Models

In the past the use of adjoints has been quite successful in the computation of Greeks. But adjoints are also very useful in the context of the calibration of various financial models using SDEs. However, in this talk we investigate the pros and cons of the adjoint approach in the PDE based calibration of financial models. As an example we consider the calibration of local volatility models applying Dupires equation in a least squares setting.

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MS17

On-the-fly Bid/Ask-Vol Fitting with Applications in Model Calibration

The fitting of market bid/ask-quotes is a prerequisite for any type of model calibration. Since the quotes differ in quality as well as quantity over timeslices and strikes, and are furthermore coupled by hundreds of arbitrage-constraints, the bid/ask-fitting is a nontrivial task. In this talk we will show that it is nevertheless possible to solve the associated optimization problem on-the-fly, and demonstrate the efficiency of the method in the calibration of local stochastic volatility models.

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MS17
Calibration with Model Reduction through POD

Option pricing models driven by Levy processes often lead to partial differential equations including an additional integral term. Usually the solution of the resulting systems of equation is quite expensive. In a calibration process many of these similar problems have to be solved. Here, proper orthogonal decomposition - embedded in a well-defined trust region algorithm - can be used as a method of model reduction with significant decrease of computing time.

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