Titles and Abstracts

Keynote Talks

Asymptotics for Merton problem with capital gain taxes and small interest rate

Min Dai
National University of Singapore, Singapore

We consider the Merton problem with capital gain taxes. Since closed-form solutions are generally unavailable, we provide asymptotic expansions with small interest rate and other parameters, and then obtain an explicit investment and consumption strategy that effectively approximates the optimal strategy. The expansions also offer qualitative and quantitative insights about the effects of various parameters on the optimal strategy. Moreover, we find that the optimal tax-deflated fraction of initial wealth in the risky asset is higher than the "Merton line" provided that there is a positive interest rate. This work is jointly with Xinfu Chen.

Better than pre-commitment mean-variance portfolio allocation strategies: a semi-self-financing Hamilton-Jacobi-Bellman equation approach

Peter Forsyth
Cheriton School of Computer Science, University of Waterloo, Canada

We present semi-self-financing mean-variance (MV) strategies which are superior to self-financing strategies for the pre-commitment optimal MV portfolio allocation problem. Our strategies are built upon a Hamilton-Jacobi-Bellman (HJB) equation approach for the solution of the portfolio allocation problem, and differ from self-financing strategies primarily in situations where the wealth of the portfolio exceeds a certain threshold. In such a situation, we extend the idea of the semi-self-financing approach originally developed in (Cui et al), Mathematical Finance 22 (2012) 346-378.
Under an HJB framework, our strategies have a simple and intuitive derivation, and can be readily employed in a very general setting, namely continuous or discrete re-balancing, jump-diffusions with finite activity, and realistic portfolio constraints. Moreover, under our strategies, the MV portfolio optimization problem can be shown to be equivalent to maximizing the expectation of a well-behaved utility function of the portfolio wealth. Numerical results confirming the superiority of the efficient frontiers produced by our strategies.

Valuing American options using fast recursive projections

Antonio Cosma, Stefano Galluccio,
Paola Pederzoli, Olivier Scaillet
GFRI Universite de Geneve and Swiss Finance Institute, Swiss

This paper introduces a new numerical option pricing method by fast recursive projections. The projection step consists in representing the payoff and the state price density with a fast discrete transform based on a simple grid sampling. The recursive step consists in transmitting coefficients of the representation from one date to the previous one by an explicit recursion formula. We characterize the convergence rate of the computed option price. Numerical illustrations with different American and Bermudan payoffs with discrete dividend paying stocks in the Black-Scholes and Heston models show that the method is fast, accurate, and general.

Arrow-Debreu equilibria for rank-dependent utilities

Jianming Xia
Academy of Mathematics and Systems Science, Chinese Academy of Sciences, China

We provide conditions on a one-period-two-date pure exchange economy with rank-dependent utility agents under which Arrow-Debreu equilibria exist. When such an equilibrium exists, we show that the state-price density is a weighted marginal rate of intertemporal substitution of a representative agent, where the weight depends on the differential of the probability weighting function. Based on the result we find that asset prices depend upon agents' subjective beliefs regarding overall consumption growth, and that there is a direction of thinking about the equity premium puzzle. (A joint work with Xun Yu Zhou)

Invited Talks

A comparative study on time-efficient methods to price compound options in the Heston model

Carl Chiarella, Susanne Griebsch, Boda Kang
School of Business, The University of Technology, Sydney, Australia

The primary purpose of this paper is to provide an in-depth analysis of a number of structurally different methods to numerically evaluate European compound option prices under Hestons stochastic volatility dynamics. Therefore, we first outline several approaches that can be used to price these type of options in the Heston model: a modified sparse grid method, a fractional fast Fourier transform technique, a (semi-)analytical valuation formula using Greens function of logarithmic spot and volatility and a Monte Carlo simulation. Then we compare the methods on a theoretical basis and report on their numerical properties with respect to computational times and accuracy. One key element of our analysis is that the analyzed methods are extended to incorporate piecewise time-dependent model parameters, which allows for a more realistic compound option pricing. The results in the numerical analysis section are important for practitioners in the financial industry to identify under which model prerequisites (for instance, Heston model where Feller condition is fulfilled or not, Heston model with piecewise time-dependent parameters or with stochastic interest rates) it is preferable to use and which of the available numerical methods.

Binomial tree Malliavin calculus and risk measures

Robert Elliott
University of Adelaide and University of Calgary
Tak Kuen Siu
Cass Business School, City University London, United Kingdom
Sam Cohen
Mathematical Institute, Oxford, United Kingdom

The classical familiar framework used to introduce financial pricing is the binomial model. The talk will discuss several more advanced concepts in this simple framework. These will include martingale representation, Malliavin derivatives, backward stochastic difference equations and dynamic risk measures. The latter are introduced using non linear expectations which are the solutions of backward stochastic difference equations.

Efficient Laplace and Fourier inversions and Wiener-Hopf factorization in financial applications

Sergei Levendorski
University of Leicester, UK

Appropriate conformal deformations increase the speed and accuracy of calculation of fairly complicated oscillatory integrals in option pricing formulas in many cases when standard approaches are either too slow or inaccurate or both. When several Laplace and Fourier inversions are needed it is necessary to use a family of contour transformations more flexible than Talbot's deformation of the contour in the Bromwich integral. Further step in a general program of study of the efficiency of combinations of one-dimensional inverse transforms for high-dimensional inversions [Abate- Whitt, Abate-Valko and others]. Among applications: pricing European options in L´evy models, Heston model and more general SV models, pricing options with barrier and lookback features and CDS in L´evy models.

Numerical valuation of derivatives in high-dimensional settings via PDE expansions

Christoph Reisinger
Mathematical Institute, University of Oxford, United Kingdom

In this talk, we propose a new numerical approach to high-dimensional partial differential equations (PDEs) arising in the valuation of exotic derivative securities. The proposed method is extended from Reisinger and Wittum (2007) and uses principal component analysis (PCA) of the underlying process in combination with a Taylor expansion of the value function into solutions to low-dimensional PDEs. We give a theoretical analysis as well as detailed numerical results of the accuracy and computational complexity compared to state-of-the-art Monte Carlo methods, on the example of Bermudan swaptions and Ratchet floors, which are considered difficult benchmark problems. We are able to demonstrate that for problems with medium to high dimensionality and moderate time horizons the presented PDE method delivers results comparable in accuracy to the MC methods considered here in similar or (often significantly) faster runtime. This is joint work with Rasmus Wissmann.

Ambiguous correlation in asset pricing

Hoi Ying Wong
Department of Statistics, The Chinese University of Hong Kong

Consider a continuous-time economy with a risk-free asset and two risky assets, where the two risky assets have an ambiguous correlation. In other words, investors have no confident on the correlation estimate. Such a situation occurs in practice when only implied volatilities of individual risk assets are observed but the market lacks of instruments to infer the correlation between them. Therefore, investors are interested in financial decision robust to the correlation estimate. In this talk, we apply the concept of ambiguous correlation to optimal asset allocation and option pric-ing problems. The portfolio selection robust to the ambiguous correlation is formulated as the utility maximization problem over the worst-case scenario with respect to the possible choice of correlation so that it becomes a maximin problem. We solve the problem under the Black-Scholes model for risky assets with an ambiguous correlation using theory of G-Brownian motions and then extend the result to stochastic volatility (SV) models for risky assets with an ambiguous correlation between their returns. Asymptotic solution of the deduced non-linear PDE is derived for a general class of utility functions, including CRRA and CARA utilities, when stochastic volatilities are fast mean-reverting. We offer a practical trading strategy, which combines information from option implied volatility surfaces of risky assets through the ambiguous correlation. When the concept of ambiguous correlation applies to option pricing on two risky assets, the option pricing PDE becomes an HJB equation. We solve the PDE in close-form for some specific popular options when volatilities follow the Heston model or the fast mean-reverting m odel. Our empirical study shows that the ambiguous correlation with SV model offers a realistic option pricing bounds for an FX option market. The empirical results also demonstrate the market price of ambiguous correlation risk. This talk is based on several joint papers with J.P. Fouque, M.H. Leung and C.S. Pun.

An arbitrage-pricing framework for CVA and FVA

Lixin Wu
Department of Mathematics, The Hong Kong University of Science and Technology

In a market completed by shares and credit default swaps (CDS), the payouts of a derivative subject to counterparty and funding risks can be replicated, which leads to the economic value of the derivative. In this talk, we will demon-strate the replication pricing of equity derivatives partially collateralized by cash and identify, on top of the classical risk-free value, credit valuation adjustment (CVA) and funding valuation adjustment (FVA) as price components. Our framework applies to pricing general derivatives, allows the presence of wrong-way/right-way risk, and can be used to study re-hypothecation risks. Our approach highlights the proper identification of the "risk-neutral measure", the central device for derivatives pricing which yet is overlooked in the currently ongoing FVA debate.

Pricing American-style Parisian options

Song-Ping Zhu1, Nhat Tan Le,
Wenting Chen, Xiaoping Lu
School of Mathematics and Applied Statistics, University of Wollongong, Australia

In this talk, we shall first discuss the pricing of various American-style Parisian options under the Black-Scholes mod-el. After pointing out the fundamental difference between American-style "in" and "out" Parisian options, we shall demonstrate how a closed-form analytic solution for American-style up-and-in Parisian options is worked out, which does not explicitly involve a moving boundary as far as the "mother option" is concerned. For American-style up-and-out Parisian options, we propose a very efficient numerical approach, based on the "moving window" technique developed in Zhu and Chen (2013), in order to simplify the solution procedure. Preliminary numerical results are presented to show some very interesting features of American-style up-and-out Parisian options.

Using a stochastic volatility model to forecast market volatility surfaces of illiquid currencies

Zili Zhu, Geoff Lee, Bowie Owen, Oscar Tian

CSIRO Division of Computational Informatics
Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia

In this paper, we will present our recent work on forecasting implied volatility surfaces for illiquid currencies. In particular, we have made substantial progress in using local stochastic volatility model (LSV) to forecast the implied vanilla volatility surfaces for illiquid currencies that are rarely traded in the market. The LSV model is calibrated to market traded vanilla volatility surfaces of liquid currencies, and we then generate the implied volatility surfaces for illiquid currencies as the crosses of liquid currencies. PDE solution procedures are developed to calibrate the LSV model, and the correlation between liquid currencies is generated by analysing historically traded spot data of the liq-uid currencies. For some currency crosses, e.g. KRW/BRL, there are no liquid market traded vanilla prices. However, over-the-counter (OTC) derivatives in such illiquid currencies are regularly transacted by major financial institutions. For initial pricing and mark-to-market purposes, these institutions need the implied vanilla volatility surfaces of these illiquid currencies on a daily basis. These forecasted implied volatility surfaces should be accurate and robust when tested in the market to prevent arbitrage opportunities due to significant inaccuracy in the forecast. Finally, in this paper, we will use the developed methodology to forecast the implied volatility surfaces of an illiquid currency pair and also to forecast the implied volatility surfaces of a liquid currency pair as benchmark to demonstrate the accuracy and robustness of the presented method.

Pricing interest rate derivatives in a multifactor HJM Model with Time dependent volatility

Ingo Beyna
Frankfurt School of Finance & Management, Germany
Carl Chiarella
UTS Business School, University of Technology, Sydney, Australia
Boda Kang
Department of Mathematics, University of York, United Kingdom

We investigate the partial differential equation (PDE) for pricing interest derivatives in the multi-factor Cheyette Mod-el, which involves time-dependent volatility functions with a special

structure. The high dimensional parabolic PDE that results is solved numerically via a modified sparse grid approach, that turns out to be accurate and e fficient. In addition we study the corresponding Monte Carlo simulation, which is fast since the distribution of the state variables can be calculated explicitly. The results obtained from both methodologies are compared to the known analytical solutions for bonds and caplets. When there is no analytical solution, both European and Bermudan swaptions have been evaluated using the sparse grid PDE approach that is shown to outperform the Monte Carlo simulation.

Analytical pricing European-style options under the modified Black-Scholes equation with a spatial-fractional derivative

Wenting Chen
School of Mathematics and Applied Statistics, University of Wollongong, Australia
Xiang Xu
Department of Mathematics, Zhejiang University, China
Song-Ping Zhu
School of Mathematics and Applied Statistics, University of Wollongong, Australia

In this talk, we investigate the option pricing under the FMLS (finite moment log stable) model, which can effective-ly capture the leptokurtic feature observed in many financial markets. However, under the FMLS model, the option price is governed by a modified Black-Scholes equation with a spatial-fractional derivative. In comparison with s-tandard derivatives of integer order, the fractional-order derivatives are characterized by their “globalness”, i.e., the rate of change of a function near a point is affected by the property of the function defined in the entire domain of definition rather than just near the point itself. This has added an additional degree of difficulty not only when a purely numerical solution is sought but also when an analytical method is attempted. Despite this difficulty, we have managed to find an explicit closed-form analytical solution for European-style options after successfully solving the FPDE (fractional partial differential equation) derived from the FMLS model. After the validity of the put-call parity under the FMLS model is verified both financially and mathematically, we have also proposed an efficient numeri-cal evaluation technique to facilitate the implementation of our formula so that it can be easily used in trading practice.

Interconnected balance sheets, market liquidity, and the amplification effects in a financial system

Nan Chen
The Chinese University of Hong Kong
David D. Yao
Columbia University
Xin Liu
The Chinese University of Hong Kong

This paper investigates how two important transmission channels of the financial s ystemic r isk i nteract t o develop individual defaults to a system-wide catastrophe. In our model, the balance sheets of financial institutions are inter-connected directly by holding debt claims against each other (the network channel). Meanwhile, they share the market liquidity to liquidate assets to meet debt liabilities when they face distress (the liquidity channel).

We formulate the model to an optimization problem with equilibrium constraints and develop an efficient partition-based algorithm to solve it. This method enables us to characterize explicitly how the topological structures of the system and asset liquidation interact with each other to amplify the systemic risk. Two multipliers, network multiplier and liquidity multiplier, are identified to capture the above amplification effects.
In addition to the significant computational advantage, our method reveals that the magnitude of a financial conta-gion highly depends on the market value of the institutions net worth. It can track down the value change of the net worth of every institution as the spillover effect spreads over the system, and thereby provide more accurate estimates for contagion probability than the other existing methods rely only on the book values of net worth. We finally illus-trate the significance of the liquidity channel with data on the European banking system.

Optimal dividend strategies with time-inconsistent preferences and transaction costs in Cram´er-Lundberg model

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Yan Zeng
Lingnan (University) College, Sun Yat-sen University, China
Zhifeng Hao
School of Applied Mathematics, Guangdong University of Technology, China

This paper considers the optimal dividend strategies for an insurance company with transaction costs and time-inconsistent preferences. In particular, we account for the fact that the manager, who represents the interest of share-holders, is impatient about choices in the short term but is patient when choosing between long-term alternatives. We assume that the surplus process is described by the classical Cram´er-Lundberg model, the manager's time preferences can be modeled by a quasi-hyperbolic discount function, and dividend payments are subject to both fixed and pro-portional transaction costs. It turns out that our problem is time-inconsistent with stochastic impulse control, and we tackle it in three ways by considering the manager of the company as pre-commitment, naive or sophisticated. By employing the dynamic programming approach, we derive explicitly the optimal dividend strategies and the optimal value functions. In addition, some numerical illustrations are presented to reveal the impact of time-inconsistency and transaction costs on the optimal dividend strategies. Moreover, our results show some interesting phenomena.

Asymmetric information and non-arbitrage

Jun Deng
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In economics and finance, asymmetric information arises quite naturally since individual's knowledge and availabil-ity of information varies from one agent to another. In this talk, we consider two economic agents, one possessing a public information and an insider obtaining some extra information that is characterized by a random time. This random time could represent the occurrence of bankruptcy, change of CEO board, insider information, et al. We aim at answering this fundamental problem: How would different non-arbitrage concepts be affected from the perspective of the insider. Precisely, we give the necessary and sufficient condition on the random time for which the first kind of no-arbitrage (also known as No-Unbounded-Profit- with-Bounded-

Risk) is preserved for any semi-martingale model. This no-arbitrage condition is also shown as the weakest markets viability in Choulli Deng and Ma (2014).

The least-squares Monte Carlo method for pricing options embedded in mortgages

Deng Ding, Wenfei Wang, Li Wang
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This paper studies the optimal stopping problems embedded in fixed rate mortgages. The prepayment and default options in mortgages are stated in the context of the optimal stopping theory. The Least-Squares Monte Carlo method, initiated by Longstaff and Schwartz in 2001, is applied to present a numerical method for pricing the mortgage pre-payment option. Then, this method is extended to price the mortgage default and prepayment options in a financial environment with two stochastic factors: house price and short term interest rate. Finally, the presented methods are numerically compared with the PDE method and the BTM method. The numerical results are given to show the effi-ciency of the presented method.

Corporate bond valuation under an infinite dimensional compound Poisson framework

Sheng Fan
School of Economic Mathematics, Southwestern University of Finance and Economics

This paper analyzes the firm b ond valuation a nd c redit s pread w ith a n e ndogenous m odel f or t he p ure d efault and callable default corporate bond. Regarding the stochastic instantaneous forward rates and the firm value as an infinite dimensional Poisson process, we provide some analytical results for the embedded American options and firm bond valuations.

Martingales with given marginals

Jie Yen Fan, Kais Hamza, Fima Klebaner
Monash University

Stochastic processes are not uniquely defined by their marginal distributions. Motivated by questions from finance, we are interested in constructing different processes (with a focus on martingales) that match the marginal distributions of a given process we call this mimicking process. There are several approaches to construct processes with given marginal distributions. In this talk, we give a construction that relies on the Markov property and the self-similarity of a given process, producing a family of martingales with the same marginal distributions. We also give some examples and attempt to extend this construction to a broader class of processes.

Canonical duality and triality: Unified understanding and global optimal solutions for challenging problems in nonconvex dynamic systems

David Y. Gao
Australian National University

Duality is a beautiful, inspiring, and fundamental concept that underlies all natural phenomena. In mathematical eco-nomics, dynamical systems, nonlinear analysis, global optimization, numerical methods and scientific computation, duality principles and methods are playing more and more important roles. The canonical duality theory is a newly developed, potentially powerful methodological theory, which can be used not only to model complex systems within a unified framework, but also for solving a wide class of challenging problems in discrete and continuous systems. The associated triality theory reveals an interesting multi-scale duality pattern in complex systems, which can be used to identify both global and local extrema and to design powerful algorithms for solving challenging problems.
In this talk, the speaker will first present some fundamental principles for modeling complex systems. From the traditional oriental philosophy and some basic rules in systems theory, he will show a unified framework in complex systems and fundamental reasons that lead to challenging problems in different fields, including chaotic dynamics, phase transitions of solids, multi-solutions in post-buckling analysis, NP-hard problems in global optimization, and the paradox of Buridans donkey in decision sciences. By a very simple one-dimensional bifurcation problem, the speaker will demonstrate that a class of nonlinear partial differential equations can be transformed to certain algebraic (tensor) equations, which can be solved completely to obtain all possible solutions. A movie will show that both global and local minimal solutions are usually nonsmooth and cant be captured by any Newton-type numerical approaches, which is one of reasons for NP-hardness. Finally, the speaker will show that by using least squares method, general nonlinear dynamical problems can be reformulated as a global optimization problem, which can be solved by the canonical duality theory to obtain the optimal solution. Applications will be illustrated.
The speaker hopes this talk will bring some new insights into complex dynamical systems.

Fast numerical pricing of barrier options under stochastic volatility and jumps

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We show how to achieve great computational savings and accuracy in the evaluation of barrier options through Bound-ary Element Method (BEM). The proposed method applies to quite general pricing models. The only requirement is the knowledge of the characteristic function for the underlying asset distribution, usually available under general asset models. We illustrate the implementation of BEM using numerical Fourier inverse transform of the characteristic function and show its numerical stability and efficiency u nder the simple Black-Scholes paradigm a nd under more sophisticated frameworks, such as Heston and Bates models.
A set of numerical simulations will be provided and analyzed, showing the efficiency and reliability of BEM either when the analytical expression of the Green fundamental solution is known and when a Fourier inverse transform has to be implemented. Suitable quadrature strategies will be suggested to perform the method without loosing efficiency.

The valuation of CCIRS with a special item

Huaying Guo
Tongji University, China

This paper presents a study of a particular credit derivatives- credit contingent interest rate swap (CCIRS) with a later cash flow item, which means the contract exist a cash flow clause when the default event happened. In this paper, we adapt the CIR model to describe the floating interest

rate. Under the framework of reduce form, we provide the pricing model for this derivative in three types of the default intensity relevant to interest rate respectively. Finally, numerical result and analysis have been carried on. Especially, we discussed the relationship between the initial insurance pre-mium and the later cash flow clause.

The pricing of credit default swaps under a generalized mixed fractional Brownian motion

Xinjiang He
Donghua University
Wenting Chen
University of Wollongong

In this paper, we consider the pricing of the CDS (credit default swap) under a GMFBM (generalized mixed frac-tional Brownian motion) model. As the name suggests, the GMFBM model is indeed a generalization of all theFB-M(fractional Brownian motion) models used in the literature, and is proved to be able to effectively capture the long-range dependence of the stock returns. To develop the pricing mechanics of the CDS, we firstly derive a sufficient condition for the market modeled under the GMFBM to be arbitrage free. Then under the risk-neutral assumption, the CDS is fairly priced by investigating the two legs of the cash flow i nvolved. The price we obtained involves elemen-tary functions only, and can be easily implemented for practical purpose. Finally, based on numerical experiments, we analyze quantitatively the impacts of different parameters on the prices of the CDS. Interestingly, in comparison with all the other FBM models documented in the literature, the results produced from the GMFBM model are in a better agreement with those calculated from the classical BlackScholes model.

A general Brownian bridge construction method in pricing American options with quasi-Monte Carlo

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The Brownian bridge (BB) is one of the dimension reduction approaches for the simulation using quasi-Monte Carlo (QMC). It can be applied with Least-Squares Method (LSM) and QMC to price American options, which outperforms the standard Monte Carlo. When using LSM with QMC, besides the dimension reduction, we should do the memory reduction. This paper considers the memory reduction solution from two aspects: real time construction and timely deletion. Following the principle of real time construction, we propose a general method for constructing different permutation-based BBs with LSM in a memory-efficient way. Our method is decoupled from the specific BB con-struction logic and it is simple, efficient and easy to implement. For the principle of timely deletion, we further look into two specific BBs and propose elegant memory reduction algorithms, which are superior to the existing algorithm both in performance and simplicity. Numerical results show that our construction method possesses the generality without losing any efficiency, and our specific algorithms for timely deletion are correct and efficient.

Option pricing using the fast Fourier transform under double exponential jump model with stochastic volatility and stochastic intensity

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This paper is based on the FFT (Fast Fourier Transform) approach for the valuation of options when the underlying asset follows double exponential jump process with stochastic volatility and stochastic intensity. Our model captures three terms structure of stock prices, the market implied volatility smile, and jump behavior. Via the FFT method, numerical examples using European call options show effectiveness of the proposed model. Meanwhile, numerical results prove that the FFT approach is considerably correct, fast and competent.

On estimating quantile sensitivities via simulation

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Chenglong Xu
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Michael C. Fu
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We present a simple framework for estimating quantile sensitivities by infinitesimal perturbation analysis (IPA) in both terminated simulation and steady-state simulation.Jackknife method is applied to reduce the bias of the estima-tion. We also compare our estimator with other estimators, and discuss the strengths and weakness of each method. Two simulation experiments, financial portfolio and M/M/1 queue, are used to show the effectiveness of our estimator.

Efficient simulation of Greeks of multi-asset European and Asian style options by Malliavin calculus and quasi-Monte Carlo methods

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This paper discusses simulation of sensitivities or Greeks of multiasset European and Asian style options by Malliavin calculus combined with Monte Carlo and quasi-Monte Carlo methods. By using the Malliavin calculus, we are able to express Greeks explicitly in terms of the expectations of the option payoff functions multiplied by the Malliavin weights for multiasset options in both path independent and path dependent cases. For European path independent multiasset options, these expectations are further converted to integrals over hypercubes in order to make use the better uniformity of low discrepancy sequences. Numerical results show the advantages of Malliavin calculus method to the finite difference method for options with nonsmooth payoffs. The superiority of the first method over the second one is even more significant when these methods are combined with quasi-Monte Carlo m ethods. For example, when simu-lating 1 of a basket type down-and-out option or a corridor option, the efficiencies reach up to tens of thousands with good lattice points sequences; and the efficiencies are up to tens of millions or higher with the same type of sequences when simulating 11 or 12 for the same type of options.

High order option convergence with CRR-type schemes

Guillaume Leduc
American University of Sharjah

We examine, in the Black-Scholes setting, the error resulting from approximating the underlying asset by random walks. Focusing on the classical CRR-type approximation, we prove that under these schemes, option values are sys-tematically underpriced when the spot if far enough from the money. Yet, we prove that with an appropriate volatility premium and with carefully chosen parameters of the approximating random walk, arbitrarily fast convergence can be achieved.

Asymptotic analysis for pricing vulnerable option under stochastic volatility

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Recently, the trade of financial derivatives in the over-the-counter markets has increased rapidly. Since there is no organized exchange to guarantee the promised payment in over-the-counter markets, the option holder is vulnerable to default risk. These options subject to the credit default risk are called vulnerable options. The value of a vulnerable option is less than a non-vulnerable option because of the possibility of default. Many researches subject to credit default risk have been studied extensively after Black and Scholes and Merton. Johnson and Stulz first proposed the option pricing formula for vulnerable European options, assuming that the option is the only liability of the counter-party. They assumed that an option holder receives all the assets of the option writer when the value of the option writer's assets is less than the value of the option. In the research of Hull and White, the other liabilities of the option writer were considered and the payment was determined by a proportion of the nominal claim when default occurs. But they did not consider the dependence between the value of the assets of the option writer and the asset underlying the option. Jarrow and Turnbull presented a new approach for pricing and hedging derivative securities with credit risk. Klein extended the study of Johnson and Stulz by allowing the counterparty to have other liabilities in the capital structure. Also, he obtained the formula under the assumption of recognizing the correlation between the option writ-er's asset and asset underlying the option, implying a payout ratio endogenous to the model is specified. He assumed that the option holder receives the proportion of nominal claim by the option writer in the event of financial distress and default boundary is fixed. In contrast to above assumptions, Klein considered the dependence of the total liabili-ties of the option writer on the value of the claim of the option holder. But the above papers assumed the volatility of the underlying asset is constant over the life of the vulnerable option. This simplified assumption is inappropriate to explain the volatility smile or skew of the implied volatility of the underlying asset. Hence a model must be developed to adapt to the real financial situation. Empirical evidence presents that volatility is a random process rather than a deterministic process. In the past two decades, many researches have been devoted to formulate these features of stochastic volatility models. For example, Heston model, the SABR model, the GARCH model and the Chen model. In this paper we consider the vulnerable option pricing with stochastic volatility extended the study of Klein to the case where the volatility of the underlying asset follows the mean-reverting OU process. The purpose of this paper is to provide asymptotic solutions of the vulnerable option pricing by applying singular perturbation method.

Valuation of American exchange options under jump diffusion models

Guanghua Lian
School of Commerce, University of South Australia
Robert Elliott
University of Adelaide and University of Calgary

This paper provides a pricing formula for American exchange options, where the dynamics of the underlying asset-s are driven by jump-diffusion processes. The American exchange option valuation problem is modelled as a free boundary problem, and is solved by decomposing the value function of an American exchange option into a European counterpart and an early exercise premium. These two components then are solved analytically. The early exercise boundary for an American exchange option proves to satisfy an algebra equation and can be solved efficiently. In this way, an asymptotic formula is derived for pricing an American exchange option. The numerical results reveal that our asymptotic pricing formula is robust and accurate.

Some development on modeling credit rating migration

Jin Liang
Tongji University

Some recent developments of modeling credit rating migration are introduced. They are including both using structure model and reduced form framework. In the first one, the problem turns to a PDE problem with a joint boundary which is migration boundary, while in the second one, a coupled PDE system is reduced. The applications such as a bond involving credit rating migration are discussed.

Asymptotic behavior of realised variations of semi-martingales with applications

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The realized power variations with even order of discretely observed semi-martingale have been widely studied in literature, due to some important applications in finance, for instance, the estimation of integrated volatility and in-tegrated quarticity. However, few works has paid attention to the realised power variations whose power index is odd. In this paper, we derive some limit theorems of realized variations of odd functions of an discretely observed Itoˆ semi-martingale on fixed time interval [0, T]. In the continuous case, unlike the realised power variations of even functions, for example the quadratic variation, the realised variations of odd functions tend to quantities only in distri-bution (stably) after multiplied by an appropriated factor related to the sample size, and the limiting process consists of a centered Wiener integral and a Riemann integral that plays a role as bias. The limit theorems for general case containing jumps has been also derived. Simulation studies for various models justify the theoretical results. Finally, we provide some application examples.

A semi-analytic method for the pricing of American options in a regime-switching economy

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In this study, we develop a semi-analytic method to evaluate American options in a regime-switching economy. The method is based on the works of Guo (2001), Buffington and Elliott (2002), and Zhu (2006). Under the assumption of a two-state regime-switching economy, there are two free boundaries which divide the pricing domain into two: common continuation region and transition region. Partial differential equation (PDE) systems are set up under the Black-Scholes framework for each region. Laplace transform method is used to obtain the formula to calculate the optimal exercise prices and the option values in the transformed space. Numerical inversion technique is then used to obtain results in the original time space. Numerical examples are provided to show the efficiency and accuracy of the method.

Pricing timer option with stochastic interest rate analytically

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A timer call option is similar to a vanilla call option with a random maturity date which is specified as the first time when the accumulated variance of the underlying stock reaches a given budget level. Since from 2007 when a timer call option was first traded by Societe Generale Corporate and Investment Banking (SG CIB), the timer options have been more and more widely sold. In the academia there are several papers studying the timer option pricing, e.g., Neuberger (1990), Bick (1995), Carr and Lee (2010), Li (2010), Bernard and Cui (2011). However these papers only consider the case of constant interest rate and the existent pricing methods can be hardly applied to the case of stochas-tic interest rate. In this talk I will present an analytical method for pricing time options with stochastic interest rates. The price of the timer option with Vasic´ek interest rate model is formulated as the solution of a four dimensional partial differential equation (PDE). Some dimension reducing techniques and a perturbation approach are developed to deal with the four dimensional PDE and then the analytical formula for the timer options is obtained. In particular the formulas for Heston model and Hull-White model are provided and implemented via numerical examples.

Robust investment-reinsurance optimization with multiscale stochastic volatility

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This paper investigates the investment and reinsurance problem in the presence of stochastic volatility for an ambiguity-averse insurer (AAI) with a general concave utility function. The AAI concerns about model uncertainty and seeks for an optimal robust decision. We consider a Brownian motion with drift for the surplus of the AAI who invests in a risky asset following a multiscale stochastic volatility (SV) model. We formulate the robust optimal investment and reinsurance problem for a general class of utility functions and a general SV model. Applying

perturbation techniques to the Hamilton-Jacobi-Bellman (HJB) equation associated with our problem, we derive an investment-reinsurance strategy that well approximates the optimal strategy of the robust optimization problem under a multiscale SV model. We also provide a practical strategy that requires no tracking of volatility factors. Numerical study is conducted to demonstrate the practical use of theoretical results and to draw economic interpretations from the robust decision rules.

Explicit formulas for pricing CLNs with counterparty risk under reduced-form framework

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A credit-linked note(CLN) is a type of credit derivatives, constructed with a bond and an embedded credit default swap, which allows the issuer to transfer a specific credit risk to credit investors. In this paper, we model CLNs with and without counterparty risk in the reduced-form framwwork. For CLNs with counterparty risk, we consider two different scenarios, that is, the issuer of CLNs and reference assets have positive correlation or negative correlation. Assuming the interest rate follows CIR model and the default events mainly depend on the interest rate, we model the two different correlations. Explicit formulas for value functions are obtained through PDE approach. In addition, counterparty valuation adjustment(CVA) and the dependence on related parameters are also investigated.

Valuation of American options with general payoffs

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In this talk we consider the valuation of American options with general payoffs, which can be formulated as a free boundary problem for the Black-Scholes partial differential equation with time-varying parameters. We provide an analytical valuation formula, that is, an exact formula for the option price and an exact first-order ordinary differential equation for the optimal exercise boundary. As special cases, we give valuation formulas for the American put and call options. Although analytically intractable, the ordinary differential equation can easily be solved numerically. Numerical simulations yield excellent agreement with the results via the binomial method. Our approach makes use of the Mellin transform for the option price and the Laplace transform for the ordinary differential equation.

An efficient methodology for portfolio selection models

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The fundamental goal of portfolio theory is to optimally allocate your investments between different assets. Mean variance optimization (MVO) is a quantitative tool which will allow you

to make this allocation by considering the trade-off between risk and return. Developed from the pioneering work of Markowitz, MVO has been widely rec-ognized as one of the milestones of modern portfolio theory. However, during the past 60 years, most people still think the model is difficult to solve and a few people can calculate efficient portfolios as their investment reference. In this talk, the speaker will present an exact solution algorithm for obtaining an optimal portfolio selection under cer-tain transaction cost. The method is based on the breakthrough canonical duality theory, which can be used not only for modelling complicated phenomena within a unified framework, but also for solving a large class of challenging problems in nonlinear dynamical systems and global optimization. Numerical results will be illustrated to show the efficiency of the proposed method for solving some classical portfolio selection problems.

Compound option approach for moment swaps pricing under a general L´evy model with stochastic volatility

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In this paper, we develop the exponential L´evy model in Fu and Yang (2012) and jump-diffusions model in Zhang, Zhao and Chang (2012) into a general L´evy model with stochastic volatility. Using general equilibrium framework method, we find the more general pricing kernel than previous researchers. Then, two European option pricing formu-las with different payoff functions are solved by general Fourier transformation and Feynman-Kac formula, respec-tively. As for moment swaps defined by Schoutens (2005) and Kyprianou, S choutens, Wilmott (2006), we employ Compound Option Approach introduced in Zhu and Lian (2011, 2012) to obtain innovative and elegant moment swap-s pricing formulas. In addition, the fair delivery prices of Variance Swap, Skewness Swap and Kurtosis Swap are achieved. Also, we study the moment risk premiums with three specialized moment risk premiums, that is variance, skewness and kurtosis risk premium. Finally, numerical experiments show our moment swaps pricing formulas are effective.

A simplified analytical approach for pricing discretely-sampled gamma swaps in the Heston stochastic volatility model and its application

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The main purpose of this paper is to extend an analytical approach proposed in a recent paper by Rujivan and Zhu (2012) for pricing discretely-sampled gamma swaps defined in terms of a weighted variance swap of the underlying asset based on the Heston's (1993) two-factor stochastic volatility model. The closed-form formula obtained in this paper is in a much simpler form than the one proposed by Zheng and Kwok (2013); the requirement of the parameter functions being twice differentiable in Zheng and Kwok (2013) has now been completely avoided. Moreover, the solution procedure presented in this paper can be adopted to price various types of generalized variance swaps such as self-quantoed variance and entropy swaps introduced by Crosby (2013).

A class of nonzero-sum stochastic differential investment and reinsurance games

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n this article, we provide a systematic study on the nonzero-sum stochastic differential investment and reinsurance game between two insurance companies. Each insurance company's surplus process consists of a proportional rein-surance protection and an investment in risky and risk-free assets. Each insurance company is assumed to maximize his utility of the difference between his terminal surplus and that of his competitor. The surplus process of each in-surance company is modeled by a mixed regime-switching Cramer-Lundberg diffusion approximation process, i.e. the coefficients of the diffusion risk processes are modulated by a continuous-time Markov chain and an independent market-index process. Correlation between the two surplus processes, independent of the risky asset process, is al-lowed. Despite the complex structure, we manage to solve the resulting non-zero sum game problem by applying the dynamic programming principle. The Nash equilibrium, the optimal reinsurance/investment, and the resulting value processes of the insurance companies are obtained in closed forms, together with sound economic interpretations, for the case of an exponential utility function.

Modeling and forecasting average temperature for weather derivative pricing

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Weather derivatives were first introduced in the USA in 1997. Their creation was driven by the need of departments to hedge the risk of abnormal weather conditions. Weather derivatives are different from traditional financial deriva-tives as their underlying assets cannot be traded in the market, such as temperature, humidity, precipitation and so on. Therefore, ordinary pricing models, such as the Black-Scholes formula, are not applicable in pricing weather deriva-tives, and the valuations of weather derivatives are widely studied in a lot of works. Taking the daily temperature of Zhengzhou as an observation, we construct a model to simulate daily average temperature in this paper. Considering the seasonal variation and long-term trends of temperature, we use the mean-reverting Ornstein-Uhlenbeck process to describe the dynamic variation. Then we provide the pricing equations for temperature futures on Cooling Degree Day index. In the end, the Monte Carlo simulations are proposed to price the CDD-based derivatives.

Funding liquidity and firm leverage ratio

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In this paper we analyse how the margin constraint (funding liquidity) in the short-term debt market interacts with insolvency risk and thereby complicates firm r isk m anagement a nd c apital s tructure. A b inding m argin constrain-t measured by margin requirement in the short-term debt market can lead to an early default while the firm is still considered to be solvent. The question how a firm can quantify and practically cope with the liquidity risks inherent in short-term debt market has been discussed much less though. We build a structure credit risk model in which two correlated defaults are considered: one is caused by insolvency risk that firm fundamental is too low and the one that margin requirement is too tight. A tight margin requirement indicates liquidity dry-ups in the short-term debt market such that short-term creditors stop lending and firm fails due to not being able to renew maturing short-term debt. We study the interaction between two correlated defaults. We derive the semi-analytic formulas for both debt value and equity value in this correlated default framework, which helps us evaluate them quickly and hence investigate how margin constraint affects the firm credit risk and capital structure (leverage ratio).

Asymmetric information response: New stylized facts in stock markets

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University of International Business and Economics

The distribution and dynamics of equity return series is of great significance for both asset pricing and risk manage-ment. This paper, by decomposing equity return with high and low prices into good news return and bad news return, investigates the distribution and the interaction of these two returns. Comprehensive empirical studies are performed on the main global stock market index using monthly and quarterly data, and some interesting stylized facts are ob-tained: 1) bad news return follow distribution different from the good news return, indicating that market responses differently from news to news; 2) bad news return almost unanimously Granger causes good news return while not vice versa, demonstrating strong evidence of asymmetric information response. These two stylized facts are of great significance as they hint that these news facts should be taken into consideration when modeling the distribution and dynamics of equity returns.

RNMs-constrained entropic least-squares valuation of American options

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Estimating the quadratic variation (QV) using high-frequency nancial data is studied in this article and this work makes two major contributions: First the fundamental Ito isometry $E\left[\left(\int_a^b f(t,\omega)dB_t\right)^2\right] \propto= E\left[\left(\int_a^b f^2(t,\omega)dt\right]$is generalized and then several application

examples are provided. This seems to be the rst time such generalization is achieved. Sec-ond, we intuitively establish two novel estimators of QV when the volatility varies with time, using realized volatility combined with realized bipower variation and realized quarticity respectively. To establish the estimators, the general-ized Ito isometry is employed. We prove that both estimators can converge to the quadratic variation with a higher rate O(1/n) than existing ones and the convergence is in mean square, not only in probability. Meanwhile the dierence between the QV and its estimator can be estimated for each estimation, in addition to that between QV and realized volatility.

Time-consistent investment-reinsurance strategy for mean-variance insurers with a defaultable security

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This paper considers an optimal investment and reinsurance problem involving a defaultable security for an insurer under the mean-variance criterion in a jump-diffusion risk model. The insurer is allowed to purchase proportional reinsurance or acquire new business and invest in a financial market consisting of a risk-free bank account, a stock and a defaultable bond. From a game theoretic perspective, the extended Hamilton-Jacobi-Bellman systems are es-tablished for the post-default case and the pre-default case, respectively. Furthermore, for the two cases, closed-form expressions for the optimal time-consistent investment-reinsurance strategies and the corresponding value functions are derived, and some special cases of our model are presented. Finally, some properties of the optimal strategies, value functions and efficient frontiers are discussed analytically or numerically.

Option pricing with ambiguous return rates and volatilities

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We consider the problem of option pricing when return rate and volatility are ambiguous. Firstly we illustrate how to describe this ambiguous option pricing models by using set-valued differential inclusion and how to change the discussion of pricing bound problems of options into that of maximal and minimal condition expectations. Secondly we use the backward differential equations to represent the maximal and minimal conditional expectations. Thirdly, as an example, we give the upper bound and lower bound formulae of European option pricing. Finally, we discuss the Quanto European option pricing with ambiguous return rates and volatility.

Time-consistent investment strategy for mean-variance portfolio selection with partially observable information

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Guangdong University of Finance

In this paper, we consider the time-consistent policy for the continuous-time mean-variance portfolio selection in the financial market with partially observable information. The investor can only observe the prices information of the assets in the financial market. The dynamics of the unobservable markets states is described by a hidden Markovian chain whose states represent the unobservable market states. Since the parameters of the financial market are unknown, the Kalman filter approach is used to estimate these parameters. By the estimation of parameter, the time-consistent investment strategy and the extended Hamilton-Jacobi-Bellman equation with partially observable information are de-rived by using the game approach presented by Bjork and Murgoci (2010).

A closed-form pricing formula for variance swaps with mean-reverting Gaussian volatility

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Jilin University

Although variance swaps have become an important financial derivative to hedge against volatility risks, closed-form formulas have only recently been developed when the realized variance is defined on discrete sample points and no continuous approximation is adopted to alleviate the mathematical difficulties associated with dealing with the dis-creteness of the sample data (cf. Broadie & Jain (2008); Zhu & Lian (2011); Rujivan & Zhu (2012); Zheng & Kwok (2012)). In this paper, a new closed-form pricing formula for the value of a discretely-sampled variance swap is pre-sented under the assumption that the underlying can be described by a mean-reverting Gaussian volatility model. With the newly found analytic formula, not only can all the hedging ratios of a variance swap be analytically derived, the numerical values of the swap price can be efficiently computed as well.

Pricing American-style Parisian up-and-out call options

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Wenting Chen, Xiaoping Lu
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In this talk, an integral equation approach for pricing American-style Parisian up-and-out call options under the Black-Scholes framework is presented for the first time. By applying the moving window technique developed in Zhu and Chen (2013), a three-dimensional pricing problem is reduced to a two-dimensional one, which can then be sim-plified further to an elegant pair of coupled integral equations by the Incomplete Fourier Sine transform technique. These equations can be numerically solved and our preliminary results reveal some interesting features about prices of American-style Parisian up-and-out call options and the behavior of the associated free boundaries.