The Second International Symposium
on Partial Differential Equations
& Stochastic Analysis in Mathematical Finance
6-10 January 2020

Tsinghua International Mathematics Conference Center (TSIMF)
Sanya, China

TSIMF
清华三亚国际数学论坛

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SOUTHWESTERN UNIVERSITY OF FINANCE AND ECONOMICS

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Welcome Message

We are delighted to welcome all of you to the 2nd International Symposium on Differential Equations and Stochastic Analysis in Mathematical Finance, from January 6 to 10, 2020, in Sanya, China.

Financial mathematics is a newly emerging area, in which mathematics can be beautifully applied to quantify some activities that were traditionally not quantifiable. These include, but not limited to, pricing financial derivatives, risk management, hedging and insurance. We are looking forward to an excellent symposium with researchers from different countries around the world, gathering together and sharing their latest exciting research results in financial mathematics, as well as encouraging young mathematicians to take up the challenges in this exciting area.

Songping Zhu

Senior Professor Song-Ping Zhu
On behalf of the Symposium Directors

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The 2nd International Symposium on Partial Differential Equations & Stochastic Analysis in Mathematical Finance, January 6-10, 2020										
Time\Date	**Monday (Jan. 6)**			**Tuesday (Jan. 7)**			**W**	**Thursday (Jan. 9)**		**Friday (Jan. 10)**
7:30-8:30	*Breakfast + **Opening Ceremony (8:40 – 9:00)***			*Breakfast*						
9:00-10:00	**K1: Peter Carr, P7**			**K2: Cornelis Oosterlee, P9**				**K3: Min Dai, P8**		**K4: Marek Rutkowski, P10**
10:00-10:30	*Group Photo Session (5 min)* *Coffee Break*			*Coffee Break*				*Coffee Break*		*Coffee Break*
	C1: Financial modelling	***C2: Numerical Methods***	***S1: Option pricing***	***C6: Portfolio selection***	***C7: Other derivatives***	***S2: Derivative pricing***		***C10: Other topics***	***S4: Other topics***	**I5: N. Chen, P12 10:30-11:20**
10:30-10:50	L. Wu, P55	G. Leduc, P30	C. Liu, P38	G. Ma, P42	X. Lu, P41	K. Chumpong, P23		J. Fan, P26	M. Wang, P51	
10:50-11:10	W. Jiang, P27	D. Tangman, P49	P. Nonsoong, P44	K. Li, P31	C. Chunhawiksit, P24	X. Jiang, P28		D. Lin, P35	N. Wang, P52	
11:10-11:30	J. Yue, P60	P. Li, P32	D. Yan, P56	S. Zhu, P66	X. Zang, P61	S. Liu, P39		C. Wen, P54	Y. Wang, P53	**IE4: Z. Zhou, P19 11:20-12:00**
11:30-11:50	K. Chong, P22	V. Shaydurov, P47	W. Yang, P58	B. Liu, P37	W. Zhang, P63	Y. Zou, P67			X. Zheng, P64	
12:00-13:30	*Lunch*							*Lunch*		
14:00-14:50	**I1: Lijun Bo, P11**			**I2: Jun Sekine, P14**				**I3: H.-Y. Wong, P15**		
14:50-15:30	**IE1: Xin-Jiang He, P16**			**IE2: Yingda Song, P17**				**IE3: C.-F. Sun, P18**		
15:30-16:00	*Coffee Break*							*Coffee Break*		
	C3: Bond pricing	***C4: Numerical methods***	***C5: Option pricing***	***C8: Insurance***	***C9: Other topics***	***S3: Asset management***		**I4: Lech A. Grzelak, P13**		Departure
16:00-16:20	J. Liang, P34	S. Sanfelici, P46	J. Cao, P21	Z. Yang, P59	M. Bhuruth, P20	X. Liu, P40				
16:20-16:40	S. Lin, P36	P. Li, P33	P. Pasricha, P45	Y. Shen, P48	N. Thakoor, P50	L. Mabitsela, P43				
16:40-17:00		Y. El-Khatib, P25	J. Zhang, P62	Z. Jin, P29	X. Zhou, P65	J. Yang, P57				
17:30-	*Welcome Banquet*			*Dinner*				*Conference Banquet*		

Discussion & Excursion

K: Keynote; I: Invited; IE: Invited ECR (Early Career Researcher); C: Contributed; S: Student; P: Page #

Women in Financial Mathematics (WiFM) Forum and Networking lunch

12:00 – 14:00

Tuesday January 7, 2020

Room TBA

The event is free to all participants of the 2nd International Symposium on Partial Differential Equations and Stochastic Analysis in Mathematical Finance, regardless of gender. The purpose of the lunch is to support women, and particularly early career researchers including PhD students, to enter and establish careers in mathematics, especially in financial mathematics. Come along to hear about the careers of our guest speakers (well established female researchers), to discuss issues concerning women in mathematics, and to network with fellow women researchers and supporters.

Guest Speaker

Professor Simona Sanfelici

University of Parma

Italy

Guest Speaker

Professor Jin Liang

Tongji University,

China

Facilitator:

Dr Xiaoping Lu

University of Wollongong

Australia

Sunday January 5, 2020

9:00-17:00	Registration Room: B200

Monday January 6, 2020

8:40-9:00	Opening Ceremony Room: A211

9:00 -10:00 Room: A211	K1: Keynote Speaker: **Peter Carr** Adding Optionality Session Chair: **Song-Ping Zhu**

10:00-10:30	Croup Photos and Coffee Break

	C1: Financial modelling Chair: **Guiyuan Ma** Room: A110	C2: Numerical methods Chair: **Yingda Song** Room: A115	S1: Option pricing Chair: **Jie Yen Fan** Room: A120
10:30-10:50	**Lixin Wu** The Equivalent CEV Volatility of the SABR Model	**Guillaume Leduc** Smooth Convergence in the CRR Model Obtained by Altering the Sibling Probabilities of One Single Penultimate Node	**Chunyang Liu** Option Pricing under Fractional Ornstein-Uhlenbeck Stochastic Volatility Model
10:50-11:20	**Wei Jiang** From Hotelling to Nakamoto: The Economic Meaning of Bitcoin Mining	**Désiré Yannick Tangman** Compact Implicit Radial Basis Functions Finite Difference for Option Pricing	**Piyapoom Nonsoong** An Analytical Option Pricing Formula for a Mean-Reverting Asset with Time-dependent Parameters
11:20-11:40	**Jia Yue** Asset Prices with Investor Protection in Approximate Fractional Economy	**Peng Li (NCWU)** Pricing Weather Derivatives with the Market Price of Risk Extracted from the Utility Indifference Valuation	**Dong Yan** Pricing European Options with Transaction Costs under the Heston Stochastic Volatility

11:40-12:00	**Kam Yoon Chong** Lie Symmetry Analysis of a Time Fractional Arbitrage-free Stock Price Model	**Vladimir Shaydurov** Numerical Methods for Mean Field Games with Restrictions	**Wensheng Yang** Analysis of Markov Chain Approximation for Asian Options and Occupation-time Derivatives: Greeks and Convergence Rates

12:00-13:30	Lunch

14:00-14:50 Room: A211	I1: Invited Speaker: **Lijun Bo** Relaxed Control and Gamma-Convergence of Stochastic Optimization Problem with Mean-Field Session Chair: **Junyi Guo**

14:50-15:30 Room: A211	IE1: Invited ECR: **Xin-Jiang He** A Revised Option Pricing Formula with the Underlying Being Banned from Short Sell Session Chair: **Yichun Chi**

15:30-16:00	Coffee Break

	C3: Bond pricing Chair: **Xin-Jiang He** Room: A110	C4: Numerical methods Chair: **Lijun Bo** Room: A115	C5: Option pricing Chair: **Guillaume Leduc** Room: A120
16:00-16:20	**Jin Liang** A Free Boundary Problem for Corporate Bond Pricing and Credit Rating under Different Upgrade and Downgrade Thresholds	**Simona Sanfelici** Computation of Greeks under Local Volatility Models	**Jiling Cao** Rough Stochastic Elasticity of Variance and Option Pricing
16:20-16:40	**Sha Lin** Pricing Resettable Convertible Bonds with the Integral Equation Approach	**Peng Li (NUFE)** Nested Monte Carlo Simulation in Financial Reporting: A Review and a New Hybrid Approach	**Puneet Pasricha** A Closed-form Pricing Formula for European Options with Market Liquidity Risk
16:40-17:00		**Youssef El-Khatib** On the Price Sensitivities of a Hybrid Stochastic Volatility Model in a Lévy Market	**Jichao Zhang** Timer Option on Finite Horizon Time under Hull-White Volatility Model

Tuesday January 7, 2020

9:00 -10:00 Room: A211	K2: Keynote Speaker: **Cornelis Oosterlee** Option Pricing and Calibration with Neural Networks Session Chair: **Lixin Wu**

10:00-10:30	Coffee Break

	C6: Portfolio selection Chair: **Vladimir Shaydurov** Room: A110	C7: Other derivatives Chair: **Jun Sekine** Room: A115	S2: Derivative pricing Chair: **Xin Zhou** Room: A120
10:30-10:50	**Guiyuan Ma** Optimal Portfolio Execution Problem with Stochastic Price Impact	**Xiaoping Lu** Finite-maturity Stock Loans under Regime-switching Volatility	**Kittisak Chumpong** Analytical Formulas for Pricing Discretely-sampled Skewness and Kurtosis Swaps Based on the Schwartz's One-factor Model
10:50-11:20	**Kai Li** Portfolio Selection under Time Delays: A Piecewise Dynamic Programming Approach	**Chonnawat Chunhawiksit** Valuation of Variance Swaps in Commodity Markets Based on Squared Percentage Returns under Stochastic Convenience Yields	**Xiaoying Jiang** On Implied Volatility Recovery of a Time-fractional Black-Scholes Equation for Double Barrier Options
11:20-11:40	**Song-Ping Zhu** An Analytical Series Solution for the HJB Equation Arising from the Merton Problem	**Xin Zang** Unspanned Stochastic Volatility Model for Variance Swaps	**Shuaiqiang Liu** Machine Learning to Compute Implied Information from American Options
11:40-12:00	**Bing Liu** Robust Portfolio Selection for Individuals: Minimizing the Probability of Lifetime Ruin	**Wenjun Zhang** Pricing VIX Derivatives with Infinite-activity Jumps	**Yihan Zou** American Real Option Pricing with Stochastic Volatility and Multiple Priors

12:00-13:30	Lunch/WiFM Forum

14:00-14:50 Room: A211	I2: Invited Speaker: **Jun Sekine** Remarks on Arbitrages in Bilateral Derivative Trading with Repo Markets Session Chair: **Guojing Wang**

14:50-15:30 Room: A211	IE2: Invited ECR: **Yingda Song** Irreversible Investment with Random Delay Session Chair: **Xiaoping Lu**

15:30-16:00	Coffee Break

	C8: Insurance Chair: **Lech A. Grzelak** Room: A110	C9: Other topics Chair: **Sanae Rujivan** Room: A115	S3: Asset management Chair: **Chuanfeng Sun** Room: A120
16:00-16:20	**Zhou Yang** Optimal Retirement in a General Market Environment	**Muddun Bhuruth** A Bivariate Hull-White Tree for Pricing Convertible Bonds	**Xiaotao Liu** Equilibrium Asset-liability Management Policy under the Constant Elasticity of Variance Model
16:20-16:40	**Yang Shen** Stackelberg Mutual Fund Management Game	**Nawdha Thakoor** Option Valuation under No-arbitrage SABR Using Meshfree Methods	**Lesedi Mabitsela** Representation of BSDE-based Dynamic Risk Measures and Dynamic Capital Allocations
16:40-17:00	**Zhuo Jin** A Hybrid Deep Learning Approach for Optimal Dividend Problems	**Xin Zhou** Risk Neutral Skewness, Risk Aversion and Learning Theory: Evidence from SSE 50ETF Option	**Jingyue Yang** Optimal Pairs Trading under Multi-assets CEV Models

Wednesday January 8, 2020

9:00-17:00	Excursion

Thursday January 9, 2020

9:00 -10:00 Room: A211	K3: Keynote Speaker: **Min Dai** Non-concave Utility Maximization without the Concavification Principle Session Chair: **Jingtang Ma**

10:00-10:30	Coffee Break

	C10: Other topics Chair: **Hoi-Ying Wong** Room: A110	S4: Other topics Chair: **Zhou Zhou** Room: A115
10:30-10:50	**Jie Yen Fan** Local Brownian Motions	**Ming-Hui Wang** Optimal Consumption and R&D Investment for a Risk-averse Entrepreneur
10:50-11:20	**Dung-Cheng Lin** Asymptotically Optimal Importance Sampling for Lower Tail Probability Estimation under Matrix Valued Stochastics	**Ning Wang** Robust Reinsurance Contracts with Mean-variance Criteria in a Three-factor Interest Rate Model
11:20-11:40	**Conghua Wen** Does VPIN Provide Predictive Information for Realized Volatility Forecasting: Evidence from Chinese Stock Index Futures Market?	**Yongjie Wang** Longevity Risk Hedging for Pension Schemes in Decumulation Phase
11:40-12:00		**Xiaoyu Zheng** Pricing Option of Credit Spread Based on the Equilibrium Model of Term Structure of Interest Rates

12:00-13:30	Lunch

14:00-14:50 Room: A211	I3: Invited Speaker: **Hoi-Ying Wong** Portfolio Selection with Rough Volatility through Volterra Processes Session Chair: **Muddun Bhuruth**

14:50-15:30 Room: A211	IE3: Invited ECR: **Chuanfeng Sun** Generalized Neyman-Pearson Lemma for Convex Expectations on $L^{\infty}(\mu)$-spaces Session Chair: **Désiré Yannick Tangman**

15:30-16:00	Coffee Break

16:00-16:50 Room: A211	I4: Invited Speaker: **Lech A. Grzelak** Collocating Local Volatility: A Competitive Alternative to Stochastic Local Volatility Models Session Chair: **Simona Sanfelici**

18:00-21:00	Conference Dinner

Friday January 10, 2020

9:00 -10:00 Room: A211	Keynote Speaker: **Marek Rutkowski** Recent Advances in Nonlinear Finance and Imperfect Markets Session Chair: **Song-Ping Zhu**

10:00-10:30	Coffee Break

10:30-11:20 Room: A211	Invited Speaker: **Nan Chen** Dynamic Investment and Financing with Internal and External Liquidity Management Session Chair: **Jiling Cao**

11:20-12:00 Room: A211	Invited ECR: **Zhou Zhou** Time-inconsistent Stopping Problems under Non-exponential Discounting Session Chair: **Xiao-Song Qian**

12:00-12:10	Closing Remarks

12:10-13:30	Lunch

Biographies of Keynote Speakers

PETER CARR

Prof. Peter Carr serves as the Chair of the Finance and Risk Engineering Department at NYU Tandon School of Engineering. Prior to joining NYU 3 years ago, He headed various quant groups in the financial industry for twenty years. He also presently serves as a trustee for the National Museum of Mathematics and WorldQuant University. Prior to joining the financial industry, Prof. Carr was a finance professor for 8 years at Cornell University, after obtaining his Ph.D. from UCLA in 1989. He has over 85 publications in academic and industry-oriented journals and serves as an associate editor for 8 journals related to mathematical finance. He was selected as Quant of the Year by Risk Magazine in 2003 and Financial Engineer of the Year by IAQF/Sungard in 2010. From 2011 to 2014, Prof. Carr was included in Institutional Investor's Tech 50, an annual listing of the 50 most influential people in financial technology.

MIN DAI

Prof. DAI Min is currently Professor of Mathematics and Director of the Centre for Quantitative Finance at the National University of Singapore (NUS). Before joining NUS, he taught at Peking University. His research focuses on quantitative finance and FinTech. He has published over 40 papers in peer-review journals such as Journal of Economic Theory, Journal of Financial and Quantitative Finance, Management Science, Mathematical Finance, Review of Financial Studies, SIAM Journals, etc. Currently he is in the editorial board of some journals, including Journal of Economic Dynamics and Control, SIAM Journal on Financial Mathematics, Mathematics and Financial Economics, Digital Finance, etc.

CORNELIS OOSTERLEE

Prof. Kees Oosterlee is part-time full professor at Delft University of Technology in Applied Numerical Mathematics. He is also senior scientist at CWI (Centrum Wiskunde & Informatica) and member of CWI's management team. He was the editor-in-chief of the Journal of Computational Finance, between 2013-2018, and the Chair of the Dutch-Flemish Society for Computational Sciences (SCS), which has 400 members, from 2014-2019. He has also been coordinator of various EU Marie Curie projects on financial risk management. His research focus is on developing and analysing novel, robust and efficient algorithms, with a particular interest in computational finance. He has written two textbooks, the most recent one is "Mathematical Modeling and Computation in Finance" with Lech A. Grzelak, and approximately 150 research articles.

MAREK RUTKOWSKI

Prof. Marek Rutkowski is currently Professor in Financial Mathematics at the University of Sydney. Prior to this he held faculty positions at the University of New South Wales and Warsaw University of Technology. He published several research papers on stochastic analysis and financial mathematics, as well as three monographs on mathematics of finance. The monograph ``Martingale Methods in Financial Modelling" co-authored by Marek Musiela was first published in 1997 and its second edition appeared in 2005. The book ``Credit Risk: Modeling, Valuation and Hedging" co-authored by Tomasz Bielecki was published in 2002 and the book ``Credit Risk Modeling" co-authored by Tomasz Bielecki and Monique Jeanblanc was published in 2009. His recent research interests include valuation adjustments in imperfect markets, the pricing and hedging of American and game options in nonlinear market models and optimisation problems for financial derivatives related to pension funds.

Biographies of Invited Speakers

LIJUN BO

Prof. Lijun Bo's research focuses on theory of stochastic analysis and application to mathematical finance. For the stochastic analysis, he mainly worked on reflected SDEs and SPDEs arising from physics and chemistry (e.g. Cahn-Hilliard SPDE) since he was pursing master degree of probability in Nankai University under the supervision of Prof. Yongjin Wang . Currently he is working on stochastic control & game and mathematical finance. He has published papers on Math. Finan., SIAM J. Control & Optim., SIAM J. Finan. Math., Math. Opers. Res., Queueing Syst., J. Banking & Finan., Electronic. J. Probab., J. Theoret. Probab.

NAN CHEN

Nan Chen is Professor of Systems Engineering and Engineering Management at the Chinese University of Hong Kong. His research interests are quantitative methods in finance and risk management, Monte Carlo simulation, and applied probability. He has published in top journals and referred conference proceedings in the fields of operations research and quantitative finance, such as Review of Financial Studies, Journal of Econometrics, Operations Research, Mathematics of Operations Research, Mathematical Finance, Finance and Stochastics, Journal of Economic Dynamics and Control. The previous research topics included credit spread modeling, stochastic differential game in convertible security pricing, Monte Carlo methods in American option pricing and the related sensitivity analysis, simulation of stochastic differential equations, and exotic option pricing under jump diffusion models. Currently, he is mainly focusing on modeling of systemic contagion and liquidity risk, complex social and financial network, and Monte Carlo method in stochastic control and learning. Part of his research is supported by the scheme of General Research Fund, Hong Kong Research Grant Council.

Prof. Chen received his Ph.D. in operations research from Columbia University in 2006, and M.S. and B.S. in probability and statistics from Peking University, Beijing, China in 2001 and 1998, respectively. He was a second place price recipient of the Best Student Research Paper Award, Financial Services Section, INFORMS, 2006. He served as associate editor for Operations Research Letters from 2007-2008. He is now an associate editor of Mathematical Finance, International Review of Finance, Digital Finance and has chaired/been a member of the program committees of several international conferences on quantitative finance and Monte Carlo simulation.

Prof. Chen now serves as director of the Bachelor of Engineering Program in Financial Technology at CUHK. The program is the first of its kind in Hong Kong to offer comprehensive undergraduate education in FinTech. He is also director of Master of Science Program in Financial Engineering at CUHK Shenzhen. For public service, Prof. Chen is now a member of the Payment Systems and Stored Value Facilities Appeals Tribunal in Hong Kong.

LECH A. GRZELAK

Dr. Lech A. Grzelak is a front office Sr. Quantitative Analyst at the Financial Engineering team at Rabobank in the Netherlands. At the same time, he holds a lecturer position at the Delft University of Technology where he teaches a course on Financial Engineering. Lech received his Ph.D. in Numerical Analysis at Delft University of Technology in 2011. His main areas of research are computational finance, numerical analysis, scientific computing and high-performance computing methods. Recent work has focused on efficient numerical methods for stochastic and local volatility models, cross-asset hybrid models and xVA. Lech is the editor of the Journal of Computational Finance and the Journal of Applied Mathematics and Computation. Lech has published several research articles on quantitative finance in multiple prime journals.

JUN SEKINE

Prof. Jun Sekine is a professor of Graduate School of Engineering Science, Osaka University. Concurrently, he is working as (i) the director of MMDS (Center for Mathematical Modeling and Data Science), Osaka University, and (ii) an adviser of Mitsubishi UFJ Trust Investment Technology Institute Co., Ltd. As an associate editor, he is working for several international academic journals such as Finance and Stochastics, Quantitative Finance, Japan Journal of Industrial and Applied Mathematics, and Asia-Pacific Financial Markets. Mathematical finance and related stochastics (including stochastic control and related numerical issues) are his main research interests.

HOI-YING WONG

Prof. Hoi-Ying Wong is Professor in Department of Statistics of the Chinese University of Hong Kong (CUHK) and CUHK outstanding fellow of Science. His research interest focuses on Mathematical Finance, including derivatives pricing, portfolio selection, big data analytics, and risk management. He has published over 75 journal articles and serves as associated editor of journals: International Journal of Theoretical and Applied Finance, and SIAM Journal on Financial Mathematics.

Biographies of Invited ECRs

XIN-JIANG HE

Dr. Xin-Jiang He received the confirmation of his Ph.D. from the University of Wollongong in Aug. 2017. He initially worked as an Associate Lecturer in the School of Mathematics and Applied Statistics, University of Wollongong from Jan. 2017 to Jun. 2018. It took only 1.5 years before he was promoted to a tenured Lecturer position in the School of Mathematics and Applied Statistics, University of Wollongong. His research covers a wide range of topics in the derivative pricing area, ranging from theory and computation to model calibration and empirical studies. He has an outstanding track record with twenty-five journal papers already accepted or published in international journals including Journal of Economic Dynamics and Control, Quantitative Finance and Journal of Futures Markets.

YINGDA SONG

Dr. Yingda Song is an associate professor at the Antai College of Economics and Management, Shanghai Jiao Tong University. He obtained his bachelor degree from Tsinghua University and Ph.D. degree from Hong Kong University of Science and Technology. His research interests focus on financial engineering, stochastic models, applied probability and computational methods. His work has been published on Operations Research and INFORMS Journal on Computing.

CHUANFENG SUN

Dr. Chuanfeng Sun graduated from Shandong University, Jinan, China in June of 2008 with a Bachelor of Applied Mathematics and got his Ph.D. in Financial Mathematics from Shandong University in December of 2014. His dissertation entitled "Some Optimization Problems under Sublinear Expectations" was completed under the supervision of Prof. Shaolin Ji. Now he is a lecturer at University of Jinan. His research interests include convex analysis and nonlinear expectations, such as minimax problem and constrained optimization problem for g-expectations and convex risk measures. He has published papers on international journals such as Journal of Convex Analysis, Journal of Optimization Theory and Applications, Systems & Control Letters and is supported by the National Natural Science Fund of China. One of his main jobs is to extend the classical Mazur Orlicz theorem to the convex case, which is considered as a surprising result.

ZHOU ZHOU

Dr. Zhou Zhou received B.S. in Mathematics from Nankai University in 2010, and Ph.D. in Applied and Interdisciplinary Mathematics from the University of Michigan in 2015. He was a Postdoctoral Fellow at the Institute for Mathematics and its Applications in the University of Minnesota during 2015–2017. He joined the School of Mathematics and Statistics in the University of Sydney as a Lecturer in Financial Mathematics in 2018. His research interests include mathematical finance, stochastic control, and optimal stopping. He has published a number of papers in leading journals, such as Annals of Applied Probability, Mathematical Finance, and SIAM Journal on Control and Optimization.

Keynote Speeches

Adding Optionality

Peter Carr

New York University, USA

Abstract:

It is well known that adding an opportunity to exercise an option adds value to the option. We explore the consequences of treating optionality as a non-classical addition. In particular, we explore the pricing of a financial structure called a covered Bermudan crash put. This structure allows its holder to protect against an adverse price change in some underlying reference index over some finite period at most once. We develop a closed form formula for the value assuming Markovian dynamics with exponentially heavy tails.

Authors:

Peter Carr

Non-concave Utility Maximization without the Concavification Principle

Min Dai

National University of Singapore, Singapore

Abstract:

The problems of non-concave utility maximization appear in many areas of finance and economics, such as in behavior economics, incentive schemes, aspiration utility, and goal-reaching problems. Existing literature solves these problems using the concavification principle. We provide a framework for solving non-concave utility maximization problems, where the concavification principle may not hold and the utility functions can be discontinuous. In particular, we find that adding bounded portfolio constraints, which makes the concavification principle invalid, can significantly affect economic insights in the existing literature. Theoretically, we give a new definition of viscosity solution and show that a monotone, stable, and consistent finite difference scheme converges to the solution of the utility maximization problem.

Authors:

Min Dai

Steven Kou

Shuaijie Qian

Xiangwei Wan

Option Pricing and Calibration with Neural Networks

Cornelis Oosterlee

Delft University of Technology, Netherlands

Abstract:

We will outline the calibration of a financial asset price model in the context of financial option pricing. Particularly, to provide an efficient calibration framework, a data-driven approach, by means of an Artificial Neural Network (ANN), is proposed to learn the solutions of financial option pricing models and to reduce the corresponding computation time significantly. This ANN-based method is extended to calibrate financial models. Specifically, fitting model parameters is formulated as training hidden neurons within a machine-learning framework. The rapid on-line computation of ANNs combined with a flexible global optimization method (i.e. Differential Evolution) provides us fast calibration without getting stuck in local minima.

Authors:

Cornelis Oosterlee

Shuaiqiang Liu

Anastasia Borovykh

Sander Bohte

Lech Grzelak

Recent Advances in Nonlinear Finance and Imperfect Markets

Marek Rutkowski

University of Sydney, Australia

Abstract:

A nonlinear approach to risk management in finance, which consistently accounts for imperfections arising from real-world features such as: multiple funding sources, default risk, collateralisation and optional cancellation of contracts, was actively studied during the recent years. We present general results regarding unilateral valuation problems for American and game options within the framework of a general nonlinear market by extending results from Bielecki and Rutkowski (2015) who examined the case of contracts of European style. A BSDE approach is used to establish more explicit pricing, hedging and exercising results when solutions to reflected or doubly reflected BSDEs enjoy additional desirable properties. To this end, we employ results on reflected BSDEs driven by RCLL martingales obtained recently by Nie and Rutkowski (2019). We also address the issues of pricing and exercising of American and game options with extraneous risks. General results are illustrated by examples of valuation adjustments in both linear and nonlinear markets.

Authors:

Marek Rutkowski

Invited Speeches

Relaxed Control and Gamma-convergence of Stochastic Optimization Problem with Mean-Field

Lijun Bo

University of Science and Technology of China, China

Abstract:

We study the relaxed control and Gamma-convergence of a class of mean field stochastic optimization problems arising from systemic risk of inter-banking system. We establish existence of optimal relaxed solutions to such a class of mean field optimization problems when the number of banks is finite. The core of this talk is to show that, when the number of banks is large, the minimizer of the finite-dimensional relaxed optimization problem converges to the minimizer of the limiting relaxed optimization problem. To prove the Gamma-convergence of finite-dimensional objective functionals, we establish general convergence properties of empirical measure-valued processes arising from the finite-dimensional controlled model. Then, we connect the limit of the large dimensional objective functional to the unique solution of a nonlinear Fokker-Planck-Kolmogorov (FPK) equation in a random environment. We prove the uniqueness of solutions to the FPK equation in the trajectory sense.

Authors:

Lijun Bo

Dynamic Investment and Financing with Internal and External Liquidity Management

Nan Chen

Chinese University of Hong Kong, China

Abstract:

We develop a theoretical model of dynamic investments, dividend payouts, debt borrowing, external equity financing, and bankruptcy for financially constrained firms. The model characterizes the central importance of liquidity management in corporate decision making in the presence of external financing costs. Mathematically, to solve for the recursive equilibrium of the problem, we formulate it as an optimal stopping problem with a fixed-point structure embedded. Our model can generate rich implications. Particularly, we find that the debt may yield two opposing effects to the firm's investment decisions if it has limited liquidity. On one hand, debt issuance may enhance the size of current investment; on the other hand, debt may reduce the actual profit to the firm. Our model characterizes quantitatively how these two effects, interacting with the cash management, will shape up the firm's investment, financing, bankruptcy, and payout decisions. The paper also discusses the implications of liquidity and leverage requirements in the current banking regulatory framework.

Authors:

Nan Chen

Jiahui Ji

Yuan Tian

Collocating Local Volatility: A Competitive Alternative to Stochastic Local Volatility Models

Lech A. Grzelak

Delft University of Technology, Netherlands

Abstract:

We discuss a competitive alternative to stochastic local volatility models, namely the Collocating Local Volatility (CLV) model, introduced in Grzelak (2018). The CLV model consists of two elements, a 'kernel process' that can be efficiently evaluated and a local volatility function. The latter, based on stochastic collocation – e.g., Babuska et al. (2007), Ganapathysubramanian and Zabaras (2007), Witteveen and G. Iaccarino (2012), Xiu and Hesthaven (2005) – connects the kernel process to the market and allows the CLV model to be perfectly calibrated to European-type options. In this article we consider three different kernel process choices: the Ornstein-Uhlenbeck (OU) and Cox-Ingersoll-Ross (CIR) processes and the Heston model. The kernel process controls the forward smile and allows for an accurate and efficient calibration to exotic options, while the perfect calibration to liquid market quotes is preserved. We confirm this by numerical experiments, in which we calibrate the OU-CLV, CIR-CLV and Heston-CLV models to FX barrier options.

Authors:

Lech A. Grzelak

Anton V.D. Stoep

Kees Oosterlee

Remarks on Arbitrages in Bilateral Derivative Trading with Repo Markets

Jun Sekine

University of Osaka, Japan

Abstract:

Inspired by Bichuch et al. (2018) and Nie and Rutkowski (2018), among other related studies, we consider an OTC-derivative pricing/hedging model, where non-defaultable/defaultable risky assets and cash accounts with various interest rates, i.e., risk-free rate, funding rates, repo rates, and collateral rates, each of which has a borrowing-lending spread. We focus on the following issues: i) Describing suitable sufficient conditions to ensure the existence of no arbitrage price of derivative. ii) Constructing arbitrage opportunities by violating the NA condition, iii) Understanding xVA (x=C, D, F, and Col) formulas as approximations of the correction terms of the arbitrage-free price.

Authors:

Jun Sekine

Akihiro Tanaka

Portfolio Selection with Rough Volatility through Volterra Processes

Hoi-Ying Wong

Chinese University of Hong Kong, China

Abstract:

Rough volatility refers to the empirical fact that the time series of volatility exhibits a rough sample path. In other words, the Hurst parameter from the realized volatility series is tested to be significantly less than 1/2, which corresponds to that of the standard Brownian motion. Volterra process becomes a popular model for the rough volatility. However, the Volterra processes are non-Markovian and non-semimartingale processes in general, making the corresponding portfolio optimization a challenge problem. This talk introduces important toolkit to solve various portfolio selection or hedging problems when the risky asset has a rough volatility. Analytical trading strategies are obtained for Merton's problem, mean-variance problem (MVP), time-consistent MVP and utility maximization with a non-exponential discounting. Through some of these examples, we address the impact of the volatility roughness to portfolio policies.

Authors:

Hoi-Ying Wong

Bingyan Han

Invited ECR Speeches

A Revised Option Pricing Formula with the Underlying Being Banned from Short Sell

Xin-Jiang He

University of Wollongong, Australia

Abstract:

An important issue in derivative pricing that hasn't been explored much until very recently is the impact of short sell to the price of an option. This paper extends a recent publication in this area to the case in which a ban of short sell of the underlying alone is somewhat less “effective” than the extreme case discussed by Guo and Zhu (2017). The case presented here is closer to reality, in which the effect of a ban on the underlying of an option alone may quite often be ``diluted" due to market interactions of the underlying asset with other correlated assets. Under a new assumption that there exists at least a correlated asset in the market, which is allowed to be short sold and thus can be used by traders for hedging purposes even though short sell of the underlying itself is banned, a new closed-form equal-risk pricing formula for European options is successfully derived. The new formula contains two distinguishable advantages; a) it does not induce any significantly extra burden in terms of numerically computing option values, compared with the effort involved in using the Black-Scholes formula, which is still popularly used in finance industry today; b) it remains simple and elegant as only one additional parameter beyond the Black-Scholes formula is introduced, to reflect the dilution effect to the ban as a result of market interactions.

Authors:

Xin-Jiang He

Song-Ping Zhu

Irreversible Investment with Random Delay

Yingda Song

Shanghai Jiao Tong University, China

Abstract:

We study the problem of irreversible investment when the payoff is delayed for a random period after making the investment decision. We develop a general framework for the problem in which the delay can be either a known function of the value of the underlying process or an independent random variable with arbitrary distribution. Based on our method, we make a thorough analysis on the impact of the delay on the optimal decision.

Authors:

Yingda Song

Pengzhan Chen

Generalized Neyman-Pearson Lemma for Convex Expectations on $L^{\infty}(\mu)$-spaces

Chuanfeng Sun

University of Jinan, China

Abstract:

As known, the Neyman-Pearson lemma is a useful result in hypothesis testing, which tells us, for discriminating between two probability measures, the most powerful test not only exists but also satisfies some specific form. It has important applications in statistics and financial mathematics. In this topic, we show a generalized Neyman-Pearson lemma for convex expectations, which extends previous results. The existence of the optimal test function has been given and we also show the optimal test function has the reminiscent form as in classical cases.

Authors:

Chuanfeng Sun

Shaolin Ji

Time-inconsistent Stopping Problems under Non-exponential Discounting

Zhou Zhou

University of Sydney, Australia

Abstract:

We study infinite-horizon optimal stopping problems under non-exponential discounting both in discrete and continuous time. A new method, which we call the iterative approach, is developed to find subgame perfect Nash equilibria. When the discount function induces decreasing impatience, we establish the existence of an equilibrium through fixed-point iterations. Moreover, we show that there exists an optimal equilibrium, which generates larger values than any other equilibrium does at all times. In addition, we compare different notions of equilibria in continuous time. When the state process is a continuous-time Markov chain, we completely show the relations between these equilibria, and we also provide a new iteration method that can directly construct an optimal equilibrium.

Authors:

Zhou Zhou

Contributed Talks

A Bivariate Hull-White Tree for Pricing Convertible Bonds

Muddun Bhuruth

University of Mauritius, Mauritius

Abstract:

A convertible bond (CB) is a corporate bond which, in addition to entitling investors to coupons and the face value, allows the conversion of the bond to a preset number of shares of stock of the company. The pricing of convertible bonds is a challenging task since they are subject to default risk and most often, have embedded call and put features.

As most convertibles have long maturities, two-factor models which treat such bonds as derivatives of both the underlying equity and the interest rate are of most practical importance.

A two-factor tree model for pricing convertibles under the Hull-White model is proposed in this work. The framework allows correlation between the stock price and the interest rate and permits the modelling of default risk.

Comparisons against some existing tree-models indicate moderate pricing differences. The effects of the various contractual features on the convertible bond price are also studied. Numerical tests indicate that doubling the recovery fraction has a more pronounced effect on the price than doubling the default probability.

Authors:

Radhakrishn Coonjobeharry

Muddun Bhuruth

Rough Stochastic Elasticity of Variance and Option Pricing

Jiling Cao

Auckland University of Technology, New Zealand

Abstract:

This study is concerned with the elasticity of variance for risky assets. We show that the elasticity of variance for S&P500 exhibits short-range correlations. By using asymptotic and martingale methods, we obtain a semi-analytical expression for the option price in the two-scale regime where the constant elasticity of variance is perturbed by a smooth and bounded function of a rapid fractional Ornstein-Uhlenbeck process with Hurst exponent within (0; 1/2). The associated implied volatility is presented and discussed. As a result, the scope of Markov stochastic elasticity of variance model is extended to a non-Markov case.

Authors:

Jiling Cao

Lie Symmetry Analysis of a Time Fractional Arbitrage-free Stock Price Model

Kam Yoon Chong

Tunku Abdul Rahman University College, Malaysia

Abstract:

Bell and Stelljes (2009) described a method for constructing a class of solvable arbitrage-free models for stock price. They started with the stochastic Bernoulli equation of Stratonovich type which its solution does not generally satisfy the arbitrage-free condition. Bell et al. then constructed a function that satisfies the condition and a second-order partial differential equation that is similar to the classical Black-Scholes equation was yielded. Two solutions of the equation were suggested at the end of the work.

Winter (2016) completed this result in his work and gave a comprehensive invariant solution of the partial differential equation by using the Lie symmetry analysis.

Our interest is to extend Winter's work to a Riemann-Liouville type of time fractional arbitrage-free stock price model using Lie symmetry analysis. Using the prolongation formula suggested by Gazizov et al. (2007) and simplified by Huang and Zhdanov (2014), we gave the symmetry group of the equation. Examples of exact solutions of the fractional arbitrage-free stock price model are suggested.

Authors:

Kam Yoon Chong

J.G. O'Hara

Analytical Formulas for Pricing Discretely-sampled Skewness and Kurtosis Swaps Based on the Schwartz's One-factor Model

Kittisak Chumpong

Chulalongkorn University, Thailand

Abstract:

In this talk, we present analytical formulas for pricing discretely-sampled skewness and kurtosis swaps based on the Schwartz's one-factor model. Our results would be beneficial for market practitioners who adopt the model to describe commodity prices and require analytical pricing formulas for the two types of commodity derivatives in order to hedge against price volatility risks in commodity markets.

Authors:

Kittisak Chumpong

Khamron Mekchay

Nopporn Thamrongrat

Valuation of Variance Swaps in Commodity Markets Based on Squared Percentage Returns under Stochastic Convenience Yields

Chonnawat Chunhawiksit

Walailak University, Thailand

Abstract:

In this research, we derive a closed-form pricing formula for discretely-sampled variance swaps when the underlying asset regards a commodity with the realized variance defined in terms of squared percentage returns. The Schwartz (1997)'s two-factor model is used to describe the stochastic behaviors of commodity prices and convenience yields. The validity of the closed-form formula is discussed in terms of its financially meaningful. Monte Carlo simulations are conducted to illustrate the efficiency and accuracy of the current closed-form formula. We also investigate the impact on the fair strike prices of the variance swaps with respect to different sets of model parameter values.

Authors:

Chonnawat Chunhawiksit

Sanae Rujivan

On the Price Sensitivities of a Hybrid Stochastic Volatility Model in a Lévy Market

Youssef El-Khatib

United Arab Emirates University, United Arab Emirates

Abstract:

This paper deals with the pricing and the hedging of financial options in a hybrid stochastic volatility model with jumps. We propose a hybrid Heston-CEV model driven by a Lévy process. Under these settings the market is in-complete, which leads to the existence of infinitely many risk-neutral measures. In order to price the option, the set of all risk-neutral measures is determined. Moreover, the PIDE of the option price is derived using Itô formula. Further-more, Malliavin-Skorohod Calculus is utilized to hedge the portfolio and to compute the price sensitivities. The obtained results generalize the existing pricing and hedging formulas for the Heston as well as for the CEV stochastic volatility models.

Authors:

Zororo S. Makumbe

Youssef El-Khatib

Josep Vives

Local Brownian Motions

Jie Yen Fan

Monash University, Australia

Abstract:

In this talk, I will introduce local Brownian motions, which are processes that behave like a Brownian motion locally (within a proximity of any time). Constructions of such processes will be given. Despite the strong connection between local Brownian motions and Brownian motions, there are significant differences between the two classes of processes. In particular, a local Brownian motion may not be a martingale, not even a semimartingale. Some other properties of local Brownian motions will also be given. Potential applications in financial mathematics will be discussed.

Authors:

Eduard Biche

Jie Yen Fan

Kais Hamza

Fima Klebaner

From Hotelling to Nakamoto: The Economic Meaning of Bitcoin Mining

Wei Jiang

The Hong Kong University of Science and Technology, China

Abstract:

Although Bitcoin mining activities are widely discussed in the media, as miners attempt to profit from transaction fees, there are few academic papers studying the transaction fees. We proposed a model for Bitcoin transaction fees from the miners' perspective. The model is rich enough to incorporate both inventory and demand levels. The model is calibrated to the empirical data and dynamics of the average transaction fees are discussed. The model is made possible by significantly extending the classical Hotelling model for exhaustible natural resources, via the addition of both feedback supply and an S-shaped stochastic demand function.

Authors:

Min Dai

Wei Jiang

Steven Kou

Cong Qin

On Implied Volatility Recovery of a Time-fractional Black-Scholes Equation for Double Barrier Options

Xiaoying Jiang

Zhejiang University, China

Abstract:

This paper investigates a time-fractional Black-Scholes equation with an implied volatility which is assumed to be associated with underlying price. Two aspects are considered. One is for the forward problem, i.e., a robust L_1-CDIA (L_1-central difference implicit approximation) scheme is utilized to solve the initial boundary value problem effectively. Remarkably, convergence analysis for the forward problem solver is also given. The other is for the inverse problem, i.e., recovery of the implied volatility via additional data. By linearization which is similar as Bouchouev et al. (2002), a Fredholm integral equation of the first kind for the unknown volatility is obtained. Based upon the integral equation, a uniqueness of the recovery is shown under some assumptions and an efficient numerical reconstruction algorithm is proposed to reconstruct the coefficient. Numerical results for both direct problem and inverse problem are presented to illustrate the validity and effectiveness of the proposed schemes.

Authors:

Xiaoying Jiang

Xiang Xu

A Hybrid Deep Learning Approach for Optimal Dividend Problems

Zhuo Jin

University of Melbourne, Australia

Abstract:

This work studies a deep learning approach to find optimal reinsurance and dividend strategies for insurance companies. Due to the randomness of the financial ruin time to terminate the control processes, a Markov chain approximation-based iterative deep learning algorithm is developed to study this type of infinite-horizon optimal control problems. The optimal controls are approximated as deep neural networks in both cases of regular and singular types of dividend strategies. The framework of Markov chain approximation plays a key role in building the iterative equations and initialization of the algorithm. We implement this self-learning approach to approximate the optimal strategies and compare the learning results with existing analytical solutions. Satisfactory computation efficiency and accuracy are achieved as presented in numerical examples.

Authors:

Zhuo Jin

Smooth Convergence in the CRR Model Obtained by Altering the Sibling Probabilities of One Single Penultimate Node

Guillaume Leduc

American University of Sharjah, United Arab Emirates

Abstract:

In the n-period Cox, Ross, and Rubinstein (CRR) model we achieve smooth convergence of American and European put and call options to their Black-Scholes limits by altering the up and down probabilities of the penultimate node whose siblings are on each side of the strike. We call this method the terminal probability method. We define high order smooth convergence and show that it can be achieved via the terminal probability method. With Richardson extrapolation, we obtain convergence of order n^2 in the European case. We illustrate our results with examples and show numerically that smooth convergence extends to the American case, allowing to reach higher convergence with Richardson extrapolation.

Authors:

Guillaume Leduc

Kenneth J. Palmer

Portfolio Selection under Time Delays: A Piecewise Dynamic Programming Approach

Kai Li

Macquarie University, Australia

Abstract:

This paper solves the portfolio selection problems when the price process explicitly depends on historical information with time delays. New path-induced state variables characterizing the delayed information are constructed, together with the original state variables, to constitute a sufficient statistic of the dynamic portfolios. State variables are different for different investment horizons. As horizon increases, the number of state variables increases without bound. Thus, the optimal portfolio weight depends not only on the current values of the original state variables, but also on their historical paths. The method developed in the paper has many potential applications for important problems in economics and finance.

Authors:

Kai Li

Jun Liu

Pricing Weather Derivatives with the Market Price of Risk Extracted from the Utility Indifference Valuation

Peng Li

North China University of Water Resources and Electric Power, China

Abstract:

A PDE (partial differential equation) based approach is presented to price weather derivatives with the market price of risk extracted from the utility indifference valuation. Assuming that the underlying temperature follows an Ornstein-Uhlenbeck process, the PDEs associated with the utility indifference valuation are established and then solved numerically using a one-sided finite difference scheme. The solution procedure is validated through numerical experiments for the utility indifference future prices, and then applied to price more complicated weather derivatives such as options.

Authors:

Peng Li

Xiaoping Lu

Song-Ping Zhu

Nested Monte Carlo Simulation in Financial Reporting: A Review and a New Hybrid Approach

Peng Li

Nanjing University of Finance and Economics, China

Abstract:

Risk assessment on stochastic basis has become prevalent in financial reporting due to increasingly sophisticated regulatory requirements. Some changes require nested stochastic projections, for which crude Monte Carlo can be too costly and time consuming to perform to reach a reasonable degree of accuracy. While there has been ample literature on nested simulation methods in the area of portfolio management, less is known in the literature regarding nested simulation for financial reporting and internal risk management. There has been little research dealing with unique challenges arising from the structure of insurance liabilities. This paper intends to fill the gap in the literature by providing an overview of the use of nested stochastic modeling for different regulatory purposes and investigating the multi-period nested stochastic model, common in insurance products. The paper reviews a variety of so-called "stochastic-on-stochastic" methods to speed up nested simulations. In addition, the paper presents a new hybrid "deterministic-on-stochastic" method based on partial differential equation (PDE). To the best knowledge of authors, this is the first time that a PDE method has been introduced for the purpose of nested stochastic projection. A numerical example is provided to show the high efficiency of the hybrid PDE method in a multi-period nested model for financial reporting.

Authors:

Peng Li

Runhuan Feng

A Free Boundary Problem for Corporate Bond Pricing and Credit Rating under Different Upgrade and Downgrade Thresholds

Jin Liang

Tongji University, China

Abstract:

In this talk, a new model for corporate bond pricing and credit rating is proposed. In this model, credit rating migrations are assumed to depend on the ratio of debt and asset value of the underlying company where debt is assumed to be a zero coupon corporate bond and asset value follows a geometric Brownian motion with volatility depending on credit rating. There is a buffer zone (called deadband in engineering) in credit rating migration, so upgrade and downgrade thresholds are different. Mathematically, this model is a system of partial differential equations with two free boundaries that correspond to the hitting boundaries in state space to upgrade and downgrade credit rating respectively. The existence, uniqueness, regularity and asymptotic behavior of the solution and free boundaries are obtained.

Authors:

Jin Liang

Xinfu Chen

Asymptotically Optimal Importance Sampling for Lower Tail Probability Estimation under Matrix Valued Stochastics

Dung-Cheng Lin

National Taiwan University, China

Abstract:

The tail probability of a high dimensional distribution is the basic quantity to measure a joint event occurred within a system. In case of rare events, importance sampling is considered an efficient simulation method. Given any finite dimensional Gaussian distribution such as matrix valued normal and Brownian motions, we prove that our proposed importance sampling schemes are asymptotically optimal. Moreover, the rate function of multivariate normal converges to that of Brownian motions via an error analysis. ΔCoVaR is employed for the demonstration to measure the financial stability by our proposed importance sampling under a dynamic volatility matrix model.

Authors:

Chuan-Hsiang Han

Dung-Cheng Lin

Pricing Resettable Convertible Bonds with the Integral Equation Approach

Sha Lin

Zhejiang Gongshang University, China

Abstract:

In this paper, the fair price of an American-style resettable convertible bond under the Black-Scholes model with a particular reset clause is calculated. This is a challenging problem because an unknown optimal conversion price needs to be determined together with the bond price as well as an additional complexity that the value of the conversion ratio will change when the underlying price touches the reset price. Because of the additional reset clause, the bond price is not always a monotonically increasing function with the underlying price, which is impossible for other types of the convertible bonds. Of course, the problem can be dealt with using the Monte-Carlo simulation. But, PDE (partial differential equation)/integral equation approach is far superior in terms of computational efficiency. Fortunately, after establishing the PDE system governing the bond price, we are able to present an integral equation representation by applying the incomplete Fourier transform on the PDE system.

Authors:

Sha Lin

Song-Ping Zhu

Robust Portfolio Selection for Individuals: Minimizing the Probability of Lifetime Ruin

Bing Liu

Nanjing University of Finance and Economics, China

Abstract:

Robust portfolio selection has become a popular problem in recent years. In this paper, we study the optimal investment problem for an individual who carries a constant consumption rate but worries about the model ambiguity of the financial market. Instead of using a conventional value function such as the utility of terminal wealth maximization, here, we focus on the purpose of risk control and seek to minimize the probability of lifetime ruin. This study is motivated by the work of Bayraktar and Zhang (2015), except that we use a standardized penalty for ambiguity aversion. The reason for taking a standardized penalty is to convert the penalty to units of the value function, which makes the difference meaningful in the definition of the value function. The advantage of taking a standardized penalty is that the closed-form solutions to both the robust investment policy and the value function can be obtained. More interestingly, we use the "Ambiguity Derived Ratio" to characterize the existence of model ambiguity which significantly affects the optimal investment policy. Finally, several numerical examples are given to illustrate our results.

Authors:

Bing Liu

Ming Zhou

Option Pricing under Fractional Ornstein-Uhlenbeck Stochastic Volatility Model

Chunyang Liu

Jilin University, China

Abstract:

In this paper, we investigate the pricing of European call option under fractional Ornstein-Uhlenbeck stochastic volatility model. We obtain the analytical solution of European style option by Itoˆs formula with respect to fractional Brownian motion, Malliavin calculus, portfolio replication and fundamental solution method. We give the numerical simulations to illustrate the main results.

Authors:

Yuecai Han

Zheng Li

Chunyang Liu

Machine Learning to Compute Implied Information from American Options

Shuaiqiang Liu

Delft University of Technology, Netherlands

Abstract:

Computing American-style option prices is generally more expensive than pricing European-style options, due to single (or even multiple) early exercise regions. The inverse problem, i.e. extracting implied information from observed prices, which traditionally requires solving the pricing model many thousands of times, is a highly challenging task in finance.

We will employ a data-driven machine learning approach to estimate implied information (i.e. the Black-Scholes implied volatility and/or dividend yield) for American options in a fast and robust way. First of all, for the implied volatility from American options, the inverse function is approximated by an artificial neural network, which decouples the offline (training) and online (prediction) phases and thus eliminates the iterative process. Additionally, a dividend yield is also important within the American-style Black-Scholes world. However, the put-call parity, which can easily be used to compute European-style implied dividend, does not hold for American options. To address this issue, we formulate the inverse problem as a calibration procedure to determine simultaneously the implied volatility and the implied dividend yield. Then, a generic and robust calibration framework which we call the Calibration Neural Network (CaNN) is introduced to estimate multiple parameters. It is shown that machine learning is an efficient numerical technique to deal with implied information for American options.

Authors:

Shuaiqiang Liu

Cornelis W. Oosterlee

Equilibrium Asset-liability Management Policy under the Constant Elasticity of Variance Model

Xiaotao Liu

Shanghai Jiaotong University, China

Abstract:

This paper investigates the equilibrium strategy of the asset-liability management (ALM) problem under the mean-variance criterion. The price process of the risky asset is described by the constant elasticity of variance (CEV) model, and the liability process is assumed to follow a geometric Brownian motion whose risk is partially correlated with the Brownian motion driving the price process of the risky asset. By the theory of stochastic optimal control, we first establish the associated extended Hamilton-Jacobi-Bellman (HJB) system of equations, and then simplify it into a system of parabolic partial differential equations (PDEs) via the variable change techniques. By the Feynman-Kac formula, we further derive the explicit solutions of the value function and the equilibrium investment policy. Closed-form solutions are obtained under some special cases and the economic meanings are discussed as well. Finally, several numerical examples are provided to illustrate effects of parameters on the equilibrium investment policy.

Authors:

Xiaotao Liu

Finite-maturity Stock Loans under Regime-switching Volatility

Xiaoping Lu

University of Wollongong, Australia

Abstract:

In this work, we study finite maturity stock loans under a two-state regime-switching economy. A thorough semi-analytic analysis of the optimal redeeming prices, the values and the fair service fees of the stock loans is presented, under the assumption that volatility of the underlying is in a state of uncertainty. Numerical examples are presented to show the effects of the volatility regimes and other loan parameters.

Authors:

Xiaoping Lu

Endah Putri

Optimal Portfolio Execution Problem with Stochastic Price Impact

Guiyuan Ma

Chinese University of Hong Kong, China

Abstract:

In this paper, we provide a closed-form solution to an optimal portfolio execution problem with stochastic price impact and stochastic net demand pressure. Specifically, each trade of an investor has temporary and permanent price impacts, both of which are driven by a continuous-time Markov chain; whereas the net demand pressure from other inventors is modelled by an Ornstein-Uhlenbeck process. The investor optimally liquidates his portfolio to maximize his expected revenue netting his cumulative inventory cost over a finite time. Such a problem is first reformulated as an optimal stochastic control problem for a Markov jump linear system. Then, we derive the value function and the optimal feedback execution strategy in terms of the solutions to coupled differential Riccati equations. Under some mild conditions, we prove that the coupled system is well-posed, and establish a verification theorem. Financially, our closed-form solution shows that the investor optimally liquidates his portfolio towards a dynamic benchmark. Moreover, the investor trades aggressively (conservatively) in the state of low (high) price impact.

Authors:

Guiyuan Ma

Chi Chung Siu

Song-Ping Zhu

Robert J. Elliott

Representation of BSDE-based Dynamic Risk Measures and Dynamic Capital Allocations

Lesedi Mabitsela

University of Pretoria, South Africa

Abstract:

We derive a representation for dynamic capital allocation when the underlying asset price process includes extreme random price movements. Moreover, we consider the representation of dynamic risk measures defined under Backward Stochastic Differential Equations (BSDE) with generators that grow quadratic-exponentially in the control variables. Dynamic capital allocation is derived from the differentiability of BSDEs with jumps. The results are illustrated by deriving a capital allocation representation for dynamic entropic risk measure and static coherent risk measure.

Authors:

Lesedi Mabitsela

Calisto Guambe

Rodwell Kufakunesu

An Analytical Option Pricing Formula for a Mean-Reverting Asset with Time-dependent Parameters

Piyapoom Nonsoong

Chulalongkorn University, Thailand

Abstract:

In this paper we present an analytical option pricing formula for European options in which the price dynamics of a risky asset follows a mean-reverting process with time-dependent parameters. The process can be adapted to describe seasonal variation in price such as in agricultural commodity markets. Our solution shows that a European option price can be decomposed into two terms, the payoff of the option at the initial time and time-integral over the lifetime of the option derived by using the time-dependent parameters. Finally, we investigate some properties of the integral term and provide some numerical examples and discussion.

Authors:

Piyapoom Nonsoong

A closed-form pricing formula for European options with market liquidity risk

Puneet Pasricha

University of Wollongong, Australia

Abstract:

In this article, a closed-form pricing formula for liquidity-adjusted European options is derived in the form of an infinite series using Karhunen-Love expansion for Ornstein-Uhlenbeck process. The impact of the liquidity on the underlying asset is considered via a discounting factor which is assumed to be a function of two factors; market liquidity risk modeled as a mean-reverting stochastic process and the sensitivity of the underlying to the market liquidity process. The convergence of the series solution is theoretically proved to guarantee closed-ness so that market practitioners can adopt the new formula when they need to account in market liquidity risk. The speed of convergence is demonstrated through numerical experiments. Finally, the accuracy of the newly derived formula is shown by comparing option prices calculated with our formula and those obtained from Monte-Carlo simulation, and various properties of our formula are also investigated.

Authors:

Puneet Pasricha

Song-Ping Zhu

Xinjiang He

Computation of Greeks under Local Volatility Models

Simona Sanfelici

University of Parma, Italy

Abstract:

We present an alternative method for the numerical calculation of Greeks based on Malliavin calculus. Assume a general local volatility model for the underlying and suppose the option price is expressed as

$$V(\alpha) = E[\Phi(S_T(\alpha))],$$

where Φ is the payoff function and α a parameter. By naïve application of the chain rule, the sensitivity of V with respect to α can be expressed as

$$\frac{\partial V(\alpha)}{\partial \alpha} = \frac{\partial E[\Phi(S_T(\alpha))]}{\partial \alpha} = E\left[\Phi'\big(S_T(\alpha)\big)\frac{\partial S_T(\alpha)}{\partial \alpha}\right]$$

and one can think of performing Monte Carlo simulations to estimate this value. However, in most cases the distribution of S_T is unknown and Φ is not differentiable. Then one can approximate the middle expression above by finite differences. Alternately, applying Malliavin's integration by parts formula we get

$$\frac{\partial V(\alpha)}{\partial \alpha} = E\big[\Phi\big(S_T(\alpha)\big)H\big],$$

for some random variable $H = H\left(S(\alpha), \frac{\partial S(\alpha)}{\partial \alpha}\right)$. The numerical computation of the factor H usually involves a double stochastic integral. We propose a different way to compute the weight H. Following [Fournie et al., 1999], we have

$$\frac{\partial V(\alpha)}{\partial \alpha} = E\left[\Phi\big(S_T(\alpha)\big)\int_0^T \frac{z(t)}{T} dW_t\right],$$

where the process $z(t)$ can be obtained by (standard) pathwise integration, thus simplifying the estimation process. We compute the process $z(t)$ for some well known underlying processes such as Black-Scholes and CEV models and perform a numerical simulation study of the efficiency of our approach.

Authors:

Simona Sanfelici

Maria Elvira Mancino

Numerical Methods for Mean Field Games with Restrictions

Vladimir Shaydurov

Krasnoyarsk Scientific Center of Siberian Branch of Russian Academy of Sciences, Russia

Abstract:

In the talk, the numerical methods are proposed for non-cooperative Mean-Field Games with a continuum of players. These games frequently arise in the economic problems, production of exhaustible resources, environmental policy, and other socio-population models. Firstly, Mean Field approach was proposed by P.-L. Lions and J.-M. Lasry and was inspired by ideas in statistical physics in which the individual particles-players are considered in terms of Mean Field. Mean Field statement leads to forward-backward structure of the equilibrium given by the coupled system of two parabolic partial differential equations: the Fokker-Plank-Kolmogorov equation and the Hamilton-Jacobi-Bellman one. Along with the usual statement of minimizing a given cost functional, we consider the additional task of oncoming to a given state or the additional restriction on the final state.

This talk focuses on the discrete approximation of these equations which is similar to the MFG formulation with finite number of players. Also, we present the numerical algorithms for solving such problems with the difference schemes which are based on the semi-Lagrangian approximations and improve properties of discrete problems. Presented numerical experiments demonstrate good convergence of the proposed numerical methods.

Authors:

Vladimir Shaydurov

S. Zhang

V. Kornienko

Stackelberg Mutual Fund Management Game

Yang Shen

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Abstract:

This paper investigates a Stackelberg game between a mutual fund manager (he) and an individual investor (she), where the mutual fund manager manages an active fund and the investor can only allocate her wealth among a risk-free asset, the active mutual fund, and a passive index fund. The passive index fund is composed of a fixed portfolio of all the securities in the market. Assume that the mutual fund manager has the stock selection and market timing abilities, and he only invests the assets under management to the risk-free asset and a subset of profitable risky assets in the market. The investor aims at maximizing the expected constant relative risk aversion (CRRA) utility of her terminal wealth, while the active mutual fund manager's objective is to maximize the expected value of the accumulative discounted management fees from the investor. By applying the dynamic programming principle approach, we solve the associated Hamilton-Jacobi-Bellman (HJB) equations and get the closed-form expressions of Stackelberg equilibrium strategies for both the investor and the mutual fund manager. Finally, we provide numerical examples to analyze the effects of some parameters on the equilibrium strategies.

Authors:

Kai Han

Ximin Rong

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Hui Zhao

Compact Implicit Radial Basis Functions Finite Difference for Option Pricing

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Abstract:

The use of Radial Basis Functions (RBF) as a numerical method for solving partial differential equations has the advantage of being spectrally accurate over arbitrarily chosen grid construction for smooth enough problems. The localized RBF-Finite Difference (RBF-FD) method results in banded linear systems and recently, a more efficient implicit RBF Finite Difference with compact support (CRBF-FD) has been developed and has been shown to be more accurate than RBF-FD over the same stencils (Wright and Fornberg, 2017). In this work, we propose to use the CRBF-FD for option pricing which gives new high order convergent schemes for European and Barrier options when combined with a local grid refinement strategy. A vector valued rational approximation is used to obtain stable computations of the Gaussian RBF implicit and explicit coefficients which are shown to converge to the classical compact finite difference approximations for flat RBF. The proposed method can be easily extended to solve high-dimensional option pricing problems (Tour et al., 2019) and is expected to be even more efficient since RBF are meshfree methods.

Authors:

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Option Valuation under No-arbitrage SABR Using Meshfree Methods

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Abstract:

The stochastic alpha beta rho (SABR) model (Hagan, et al., 2002) enhances the Black-Scholes dynamics for asset prices in two important ways. First a CEV-type diffusion is assumed for the forward price and second, the volatility of the forward price follows a Black-Scholes type diffusion with zero drift. This structure of the model has the effect that the underlying asset price process may hit zero with positive probability. The resulting effect is the possibility of arbitrage opportunities for some options.

No-arbitrage prices can be obtained by imposing an absorbing boundary condition at zero and analytical approximations for arbitrage-free European option prices have been obtained by applying a series of transformations to a two-dimensional backward Kolmogorov partial differential equation (Yang, et al., 2017). Similar to analytical approximations for implied volatilities obtained through heat kernel expansions applied to the standard SABR model, the transformation approach results in option prices which lack accuracy for large maturities.

An efficient and accurate numerical method for solving the arbitrage-free two dimensional SABR equation is described in this work. The technique is based on employing radial-basis functions finite difference approximations on unstructured nodes. The accuracy of computed prices for low strike and large maturities are illustrated using various numerical examples. The corresponding risk-neutral probability density obtained through option prices at different strikes is shown to be non-negative.

Authors:

Nawdha Thakoor

Optimal Consumption and R&D Investment for a Risk-averse Entrepreneur

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Abstract:

In this report, we consider an optimal consumption problem for a risk-averse entrepreneur who invests into a research and development (R&D) project and intends to choose an optimal timing to invest into another project. We put the decision making problem into a real option game framework. We divide the problem into two stages: the pre-investment and post-investment problems. For the first problem, the entrepreneur puts his money into an R&D project whilst choosing a suitable timing to invest into a project. For the second problem, the entrepreneur just needs to control his personal consumption and the investment rate to obtain personal maximum utility. By the method of dynamic programming, we can change the pre-investment and post-investment problems into a nonlinear variational inequality and a nonlinear partial differential equation, respectively. Then, the value function, the optimal investment rate and the optimal consumption of the entrepreneur are given for the pre-investment and post-investment problems, respectively. The verification arguments for the pre-investment and post-investment problems are also provided. Finally, numerical simulations are given to illustrate the properties of our model.

Authors:

Ming-Hui Wang

Nan-Jing Huang

Robust Reinsurance Contracts with Mean-variance Criteria in a Three-factor Interest Rate Model

Ning Wang

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Abstract:

A class of reinsurance contract problems is studied under a continuous-time principal-agent framework with mean-variance criteria, where a reinsurer and an insurer play the roles of the principal and the agent, respectively. The insurer and the reinsurer can manage risk through investing in a financial market which is supposed to consist of a risk-free asset, a risky asset and a zero-coupon bond. A key feature of our model is that a three-factor model is adopted to provide a flexible way to model the term structure of the interest rate. Both the insurer and the reinsurer concern about model uncertainty and intend to seek robust reinsurance contract and investment strategies by maximizing their respective mean-variance cost functionals. To articulate the time-inconsistency issue under the mean-variance optimization criteria, we formulate the optimization procedure of each decision maker as a non-cooperate game and discuss it using an extended Hamilton-Jacobi-Bellman (HJB) equation following the literature about the time-consistent control. Explicit expression for the robust reinsurance contract and semi-analytical expressions for the robust investment strategies and the value functions of the insurer and the reinsurer are obtained. Numerical results and their economic interpretations are discussed.

Authors:

Ning Wang

Tak Kuen Siu

Kun Fan

Longevity Risk Hedging for Pension Schemes in Decumulation Phase

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Abstract:

Pension schemes are facing significant risk caused by members' unexpected longevity trend and seek to transfer their longevity risk to the financial market. This work studies a stochastic optimal control problem for a pension scheme which provides an income-drawdown policy to its members in the decumulation phase. To manage the scheme efficiently, the manager and members agree to share the risk based on a pre-decided risk-sharing rule. The objective is to maximise both sides' utilities by controlling the investment in risky assets and benefit withdrawals. Affine class models are used to describe stochastic mortality intensity, and a longevity bond whose coupon payment is linked to a survival index, is also introduced to hedge the longevity risk. In this work we also investigate the longevity basis risk which arises when the members' and the longevity bond's reference populations show different mortality behaviour. By applying the dynamic programming principle to solve the corresponding HJB equations, we derive optimal solutions for the single- and double-population cases. Our numerical results show that even in the presence of longevity basis risk, the longevity bond is an effective hedging instrument.

Authors:

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Christain-Oliver Ewald

Yongjie Wang

Does VPIN Provide Predictive Information for Realized Volatility Forecasting: Evidence From Chinese Stock Index Futures Market?

Conghua Wen

Xi'an Jiaotong-Liverpool University, China

Abstract:

Using intraday data, we explore the forecast ability of one high frequency trading order imbalance measure, i.e. the Volume-Synchronized Probability of Informed trading (VPIN), in predicting the realized volatility of the China Securities Index (CSI) 300 index futures. We employ the heterogeneous autoregressive model for realized volatility (HAR-RV) and compare the forecast ability of the model with and without the exogenous variable, VPIN. Our empirical results demonstrate that the augmented HAR model incorporates VPIN, i.e. HARX-RV, can generate more precise forecasts, which implies VPIN contains substantial information in describing the volatility dynamics. Our study also shed light on the relation between high frequency trading behavior and volatility forecasting in Chinese index futures market.

Authors:

Fei Jia

Conghua Wen

The Equivalent CEV Volatility of the SABR Model

Lixin Wu

Hong Kong University of Science and Technology, China

Abstract:

This study presents new analytic approximations of the stochastic-alpha-beta-rho (SABR) model. Unlike existing studies that focus on the equivalent Black-Scholes (BS) volatility, we instead derive the equivalent volatility under the constant-elasticity-of-variance (CEV) model, which is the limit of the SABR model when the volatility of volatility approaches zero. Numerical examples demonstrate the accuracy of the CEV volatility approximation for a wide range of parameters. Moreover, in our approach, arbitrage occurs at a lower strike price than in existing BS-based approximations.

Authors:

Jaehyuk Choi

Lixin Wu

Pricing European Options with Transaction Costs under the Heston Stochastic Volatility

Dong Yan

University of Wollongong, Australia

Abstract:

In this work, we formulate a pricing model for European options with transaction costs under Heston-type stochastic volatility. We propose a new approach different from Mariani et al. (2012) such that their major shortcoming is eliminated, and financial interpretations have been provided. The resulting pricing partial differential equations (PDEs) are a pair of non-linear convection-diffusion-reaction equations with mixed derivative terms, for the writing and holding prices, respectively. The equations are solved numerically by the explicit Euler method. Numerical experiments are presented to illustrate the order of convergence and the effect of the transaction costs on option prices.

Authors:

Xiaoping Lu

Song-Ping Zhu

Dong Yan

Optimal Pairs Trading under Multi-assets CEV Models

Jingyue Yang

Southwestern University of Finance and Economics, China

Abstract:

We define the optimal pairs trading by maximizing the expected utility for the portfolios of the co-integrated multi-assets with constant elasticity of variance. As shown in the literature, for the power utility, the problem can be transformed into a linear multi-dimensional partial differential equation (PDE). This PDE cannot be solved efficiently by the numerical methods (e.g., finite difference methods) due to the curse of dimensionality. We solve the problem using the coefficient Taylor series expansions. We use numerical examples to show the accuracy of the approach and provide the empirical studies.

Authors:

Jingyue Yang

Jingtang Ma

Qi Wang

Analysis of Markov Chain Approximation for Asian Options and Occupation-time Derivatives: Greeks and Convergence Rates

Wensheng Yang

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Abstract:

The continuous-time Markov chain (CTMC) approximation method is a powerful tool that has recently been utilized in the valuation of derivative securities, and it has the advantage of yielding closed-form matrix expressions suitable for efficient implementation. For two types of popular path-dependent derivatives, the arithmetic Asian option and the occupation-time derivative, this paper obtains explicit closed-form matrix expressions for the Laplace transforms of their prices and the Greeks of Asian options, through the novel use of pathwise method and Malliavin calculus techniques. We for the first time establish the exact second-order convergence rates of the CTMC methods when applied to the prices and Greeks of Asian options. We propose a new set of error analysis methods for the CTMC methods applied to these path-dependent derivatives, whose payoffs depend on the average of asset prices. A detailed error and convergence analysis of the algorithms and numerical experiments substantiate the theoretical findings.

Authors:

Wensheng Yang

Zhenyu Cui

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Optimal Retirement in a General Market Environment

Zhou Yang

South China Normal University, China

Abstract:

We study optimal retirement, consumption/portfolio selection problem of an agent in a non-Markovian environment. We show that under a suitable condition the optimal retirement decision is to retire when the individual's wealth reaches a threshold level. We express the value and the optimal strategy by using the strong solution of the backward stochastic partial differential variational inequality (BSPDVI) associated with the dual problem. We derive properties of the value function and the optimal strategy by analyzing the strong solution and the free boundary of the BSPDVI. We also make a methodological contribution by proposing an approach to investigate properties of the strong solution and the stochastic free boundary of BSPDVI by combining a probabilistic method and the theory of backward stochastic partial differential equations (BSPDEs).

Authors:

Zhou Yang

Hyeng Keun Koo

Yong Hyun Shin

Asset Prices with Investor Protection in Approximate Fractional Economy

Jia Yue

Southwestern University of Finance and Economics, China

Abstract:

In this talk, we consider a dynamic asset pricing model in an approximate fractional economy to address empirical regularities related to both investor protection and past information. Our newly developed model features not only in terms with a controlling shareholder who diverts a fraction of the output, but also the good (or bad) memory in his budget dynamics which can be well-calibrated by a path-wise way from the historical data. By establishing an approximation scheme for the good (or bad) memory of investors on the historical market information, we conclude that the good/bad memory would increase/decrease both real stock returns and interest rates while the equilibrium balances the economy by preventing investors from benefiting the memory.

Authors:

Jia Yue

Ben-Zhang Yang

Ming-Hui Wang

Nan-Jing Huang

Unspanned Stochastic Volatility Model for Variance Swaps

Xin Zang

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Abstract:

Most existing models for volatility derivatives imply that variance swaps or the CBOE VIX span the whole space of volatility risk. However, we find that variance swaps and the VIX have limited explanatory power for VVIX, the CBOE VIX of VIX. We term this feature as unspanned stochastic volatility (USV) for variance swaps. Thus, we present a new class of canonical-form affine models incorporating such USV factors. For practical applications, we propose a novel three-factor USV model and demonstrate its superior empirical performance in fitting the market by comparing with several existing popular models based on their calibration results.

Authors:

Xin Zang

Chenxu Li

Timer Option on Finite Horizon Time under Hull-White Volatility Model

Jichao Zhang

Beihua University, China

Abstract:

Analytical closed-form solutions for pricing options under stochastic volatility models are always desirable and yet they are very rare. In this paper, we present a path integral approach for option pricing and derive a close-form formula for the value of European-style timer options of finite expiry under the Hull-White stochastic volatility model. We determine the transition probability density function explicitly in terms of given parameters and thus, derive a closed-form formula for the price of the timer option. Our approach can potentially be extended to price other path-dependent options.

Authors:

Jichao Zhang

Pricing VIX Derivatives with Infinite-activity Jumps

Wenjun Zhang

Auckland University of Technology, New Zealand

Abstract:

In this talk, we investigate a two-factor VIX model with infinite-activity jumps, which is a more realistic way to reduce errors in pricing VIX derivatives, compared with Mencia and Sentana (2013). Our two-factor model features central tendency, stochastic volatility and infinite-activity pure jump Levy processes which include the variance gamma (VG) and the normal inverse Gaussian (NIG) processes as special cases. We find empirical evidence that the model with infinite-activity jumps is superior to the models with finite-activity jumps, particularly in pricing VIX options. As a result, infinite-activity jumps should not be ignored in pricing VIX derivatives.

Authors:

Jiling Cao

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Wenjun Zhang

Pricing Option of Credit Spread Based on the Equilibrium Model of Term Structure of Interest Rates

Xiaoyu Zheng

University Of International Business and Economics, China

Abstract:

The development of China's credit derivatives market is difficult to meet the needs of the real economy in current China. Therefore, this paper attempts to develop a pricing model of credit spread option that is in line with China's national conditions. First, this article simulates the dynamic process of credit spreads by using the equilibrium model of term structure of interest rates, where the credit spreads are assumed to follow the mean reversion process, the root mean square process and the mean reversion process with jump. Then, the Markov Chain Monte Carlo (MCMC) method is employed to estimate the parameter and we analyze the state of the credit bond market by the long-term average effect, the random fluctuation effect and the jump effect represented by the parameters. The empirical results show that the three equilibrium models all have appropriate explanatory power for the dynamic changes of credit spreads. And the long-term equilibrium values of credit spreads estimated by the three models are not significantly different. The random fluctuation effect of mean reversion process is stronger than that of mean reversion model with jump. This paper selects different option pricing methods, including risk-neutral adjustment method, Fourier transform method and no arbitrage pricing method, to calculate the price of credit spread options and compare the simulation pricing results of different models. The research results can enhance the understanding of credit spreads, credit risks and credit derivatives, and provide some reference for pricing the credit derivatives in China market.

Authors:

Xiaoyu Zheng

Risk Neutral Skewness, Risk Aversion and Learning Theory: Evidence from SSE 50ETF Option

Xin Zhou

New York University Shanghai, China

Abstract:

This paper uses an improved measure of risk-neutral skewness to study the information contents of RNS in China 50ETF option market. In earlier periods after the introduction of the option market, we find that RNS negatively predicts future excess returns of underlying 50ETF only when investors are risk-taking. In contrast, the relation between RNS and subsequent returns in later periods becomes positive, and it holds regardless of investors risk attitude. We also utilize a unique database from Shanghai Stock Exchange to investigate the relation between RNS and different kinds of investor behavior, and find that the individual investors' option trading activities play a dominant role on RNS. Furthermore, results show that individual investors prefer to trade deep OTM options in earlier periods and switch to ATM options in later periods. Empirical findings suggest that evolving RNS predictability is consistent with the learning theory showing that option investors are learning to be risk averse.

Authors:

Xin Zhou

An Analytical Series Solution for the HJB Equation Arising from the Merton Problem

Song-Ping Zhu

University of Wollongong, Australia

Abstract:

In this talk, an analytical solution for the well-known Hamilton–Jacobi–Bellman (HJB) equation that arises from the Merton problem subject to general utility functions is presented. The solution is written in the form of a Taylor's series expansion and constructed through the homotopy analysis method (HAM). The fully nonlinear HJB equation is decomposed into an infinite series of linear PDEs which can be solved analytically. Four examples are presented with the first two cases showing the accuracy of our solution approach; while the last two demonstrating its versatility.

Authors:

Song-Ping Zhu

Guiyuan Ma

American Real Option Pricing with Stochastic Volatility and Multiple Priors

Yihan Zou

University of Glasgow, United Kingdom

Abstract:

In this article we study stochastic volatility models in a multiple prior setting and investigate prices of American options from the perspective of an ambiguity averse agent. Using the theory of reflected backward stochastic differential equations (RBSDEs), we formalize the problem and solve it numerically by a simulation scheme for RBSDEs. We also propose an alternative to obtain the American option value without using the theory of RBSDEs. We analyze the accuracy of the numerical scheme with single prior models, of which American options could also be efficiently evaluated by the least squares Monte Carlo (LSM) approach. By comparing to the single prior case, we highlight the importance of the dynamic structure of the agent's worst-case belief. At last we explore the applicability of numerical schemes in a setting with multidimensional real option and ambiguity.

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