



THE UNIVERSITY OF  
MELBOURNE

FACULTY OF  
BUSINESS &  
ECONOMICS

**Centre for Actuarial Studies**

**ANNUAL REPORT 2010**



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# The Year in Review

## Introduction

The main activities of the Centre for Actuarial Studies are teaching future actuaries, research and knowledge transfer. The Centre is proud of the high achieving students it attracts and strives to give them the best preparation for actuarial and other quantitative work. Because it is fully accredited by the Institute of Actuaries of Australia, the Centre for Actuarial Studies allows its students to obtain exemptions from the whole of Parts I and II of the actuarial examinations. With regard to research, the members of the Centre are experts in their fields and are internationally recognised for their work in actuarial science, financial mathematics and related disciplines. The Centre has seven full-time academic staff and a number of part-time lecturers from the actuarial profession (the complete list is at the end of this report). The new degree of Master of Actuarial Science came into existence in 2011. In 2010 the Centre saw an increase in the number of students, while research output increased.

The Centre for Actuarial Studies continues to be the focal point for actuarial education in Victoria. It attracts the support of the actuarial profession in Australia and produces quality applied and theoretical research. It also maintains strong international links and contributes to the local actuarial community. The Centre is designated as a Centre of Excellence by the Institute of Actuaries of Australia.

## Staff News

Daniel Dufresne continued to be the Director of the Centre for Actuarial Studies in 2010.

David Pitt resigned his position at the Centre for Actuarial Studies in July 2010 to take a position at Macquarie University. The Centre for Actuarial Studies would like to thank David for his contributions to teaching, research and administration over the five years he was with the Centre.

Mark Joshi was promoted to Professor effective from the beginning of 2011. Xueyuan Wu was promoted to Senior Lecturer in September 2010.

## Research Activities

Research continued in a variety of areas including applied probability, disability income insurance, financial mathematics, investments, market models and risk theory. Staff of the Centre publish in quality journals and present their research at seminars and conferences around the world; the number of publications increased in 2010.

Details of publications and presentations by staff can be found later in this report.

## Research Grants

Mark Joshi, David Dickson and David Pitt continued their work on the Australian Research Council Discovery Project Grant "The pricing and risk management of reverse mortgages in the Australian market".

Daniel Dufresne pursued his work on ARC Linkage Grant "Understanding cycles in mineral commodity prices, a model with uncertainty".

David Pitt and Yan Wang (RMIT) continued the Australian Actuarial Research Grant awarded last year for the project "Claim termination for income protection insurance and data mining". Xueyuan Wu and Shuanming Li continued the Australian Actuarial Research Grant awarded last year for the project "On the recursive evaluation of aggregate claims for a large family of claim number distributions". These grants are funded by the Institute of Actuaries of Australia.

## Teaching Activities

Enrolments maintained continued to increase from 2008-2009 levels. At the 2nd and 4th year levels, enrolments were higher; 52 students completed the Honours year. Details of enrolments are given later in this report.

Teaching activities were supported by a number of external lecturers including Richard Fitzherbert for Financial Mathematics I and II, and, for Actuarial Practice and Control, Jules Gribble, David Heath, Cary Helenius, Donald Campbell and Andrew Gale.

## Visitors

Professor David Stanford, from the Department of Statistics and Actuarial Science at the University of Western Ontario, visited the Centre and Department of Mathematics and Statistics in July.

Professor Felisa Vázquez-Abad, from the City University of New York, visited the Centre in January and February.

## Knowledge Transfer

Mark Joshi launched a new open-source project: Kooderive, for pricing exotic interest rate derivatives using GPUs. NVIDIA have contributed six high end graphic cards.

During the year the members of the Centre acted as referees for a wide variety of academic and professional journals (a list is given at the end of this report).

## Professional Activities

David Dickson is an external examiner (and independent examiner for the UK actuarial profession) at Nanyang Business School, Singapore.

# The Year in Review

## Master Of Actuarial Science

The Master of Actuarial Science degree commenced in February 2011. This two-year Master's program consists of 16 subjects (8 core plus 8 electives) and aims to provide initial actuarial education for graduates who have mathematical or statistical specialisations (e.g. in commerce, mathematics, physics, or engineering). The course enables students who obtain a sufficiently high pass to receive some exemptions from the professional actuarial examinations conducted by the Institute of Actuaries of Australia and the Institute of Actuaries (UK). The program director is Professor David Dickson. Further information about this new degree is available online at <http://www.gsbe.unimelb.edu.au/programs/actuarial-studies/master-of-actuarial-science.html>

## Australasian Actuarial Education And Research Symposium

Following similar events at Macquarie University in 2008 and at the University of New South Wales in 2009, the 2010 Australasian Actuarial Education and Research Symposium was hosted by the Centre on 25 and 26 November. The 2010 Symposium aimed to bring together actuarial researchers, teachers and industry

practitioners. The Symposium was attended by 49 participants from 7 universities and 6 companies in Australia and New Zealand. Thirty-two talks were presented in three plenary sessions and six parallel sessions covering various topics such as statistical methods, education, risk theory, financial mathematics, mortality and credit risk. The Symposium provided an opportunity for researchers and industry practitioners to interact and develop potential new research projects. Financial help from the Institute of Actuaries of Australia is gratefully acknowledged.

## Organising Committee

Xueyuan Wu (Melbourne)  
Daniel Dufresne (Melbourne)  
Shuanming Li (Melbourne)  
Ping Chen (Melbourne)

## Program and Scientific Committee

David Dickson (Melbourne)  
Mark Joshi (Melbourne)  
Shuanming Li (Melbourne)  
Sachi Purcal (Macquarie)  
David Pitt (Macquarie)  
Timothy Higgins (ANU)



# Teaching

## Teaching

### Undergraduate & Honours Teaching

Subject name	2008	2009	2010
ACTL10001(300-101) Introduction to Actuarial Studies	164	161	178
ACTL20001(300-203) Financial Mathematics I	146	119	158
ACTL20002(300-204) Financial Mathematics II	130	99	130
ACTL30001(300-312) Actuarial Modelling I	86	119	99
ACTL30002(300-313) Actuarial Modelling II	87	118	102
ACTL30003(300-314) Contingencies	82	97	93
ACTL30004(300-315) Actuarial Statistics	84	89	92
ACTL30005(300-316) Models for Insurance and Finance	80	89	87
ACTL30006(300-334) Financial Mathematics III	80	109	93
ACTL40001(300-400) Actuarial Studies Research Essay	5	6	7
ACTL40002(300-406) Risk Theory I	48	39	55
ACTL40003(300-407) Risk Theory II	23	15	29
ACTL40004(300-408) Advanced Financial Mathematics I	42	37	51
ACTL40005(300-409) Actuarial Studies Projects	41	33	45
ACTL40006(300-410) Actuarial Practice and Control I	45	37	54
ACTL40007(300-411) Actuarial Practice and Control II	31	27	41
ACTL40008(300-412) Advanced Financial Mathematics II	9	17	11
<b>Total Enrolments</b>	<b>1183</b>	<b>1211</b>	<b>1325</b>

### Honours Results and Theses Topics

The following students successfully completed a Bachelor of Commerce (Honours) with a specialisation in Actuarial Studies:

Hung Fai Chan	Guang Oscar Chen
Janice Chye-Zhen Cheng	Sing Vi, Kelvin Chew
Slesha Puja Devi Bharat Kumar	Elizabeth Bai Guo
Lin Sin Hu	Dai Daniel Huang
Matthew Lawrence Irvine	Ju Bee khaw
Christopher Keng-Thau Khoo	Yew Kit Kuan
Kerri Lam	Sing Leung Law
Bonnie Ka Yung Li	Lin Li
Ping Li	Lucy Cheng Cheng Liu
Shunzhi Liu	Priscilla Yoke Pui Loh
Fatt Sheng Low	Zi Xiang Low
Kin Lung Mak	Michael Peter Nair
Ka Chun Ng	Tin Lok Ng
Nicholas Allen Parkin	Gopi Pathmalinkam
Shao Jun Pook	Thomas Edmund Price
Anirudh Rajgopal	Navin Ranasinghe
Michael Rozenbilt	Junxia Su
Qifeng Sun	Darren Tan
Kar Kiat Tan	David Truong

Fei Yin Wang  
Daniel Aditya Wirjoprawiro  
Haiyao Xu  
Daniel Zhang  
Qin Zhang  
Peter Zheng  
Menghan Zhou

Alexander Wei Zwen Wiguna  
Chen Guang Xu  
Hu Xue  
Peng Zhang  
Yao Zhang  
Lisang Zhou  
Min Zhu

The following list includes topics of Honours essays submitted by Honours students. An Honours research essay is about 10,000 words and counts as 25% of the final assessment for a student's Honours grade.

- Accelerating pathwise Greeks in the LIBOR market model
- Asian options in electricity market using a regime switching trinomial tree
- Design of an optimal no claim bonus system when claim frequency and claim severity are of both phase-type distributions.
- Predictive regression modeling with quantile regression
- Reverse mortgages in Australia: product innovation and pricing the no-negative-equity guarantee
- Out of control—a study of asian basket cases
- Modeling of motor vehicle accident frequency

The topics of Actuarial Research Projects were:

- Critical look at the efficient market hypothesis
- Application of Monte Carlo simulation
- Dependence structure investigation among insurance claim variables.

Three Research Projects replace the Actuarial Research Essays for the majority of students.

The table below shows the numbers of students awarded each classification of Honours in the last four years.

	H1	H2A	H2B	H3	Total
2008	13	16	11	6	46
2009	15	7	13	2	37
2010	17	14	15	6	52



# Student Prize Winners

## Centre Awards

### Actuarial Honours Prize (Medal)

Alexander Wei Zwen Wiguna

### ANZ Prize

For Financial Mathematics

Alexander Wei Zwen Wiguna and Navin Ranasinghe

### Aviva Prize

For Contingencies

Matthew Chan

### Comminsure Prize

For Introduction to Actuarial Studies

Yang Zheng

### Deloitte Actuaries & Consulting Prize

For Actuarial Practice and Control I and II

Navin Ranasinghe

## Institute of Actuaries of Australia Prize

For Research

Alexander Wei Zwen Wiguna

## Taylor Fry Prize

For Actuarial Statistics

Leon Hua Looi

## Towers Perrin Prize

For Risk Theory I and II

Alexander Wei Zwen Wiguna

## Faculty of Economics & Commerce Awards

### Kinsman Award

For the Honours students in the Faculty with the best publishable article

Ting Chen

# PhD Students and Research Topics

## Christopher Beveridge

Pricing long-dated exotic interest rate contracts in the displaced diffusion LIBOR market model

## Jiun Hong Chan

Methodologies for computation in the stochastic volatility LMM

## Stephen Chin

Option pricing under stochastic volatility

## Nicholas Denson

Variance reduction using a Markov LIBOR market model

## Evan Hariyanto

Pricing and risk management of reverse mortgages in the Australian market

## Jingchao Li

Finite time ruin problems

## Qing Liu

Bivariate claim modelling for general insurance

## Ciyu Nie

A lower barrier alerting system for risk processes

## Robert Tang

The accurate estimation of Greeks in multi-factor credit interest-rate hybrid models

## Chao Yang

Pricing and hedging models

# Publications and Other Research Activities in 2010

## Refereed Journal Articles

**Chen P and Yang H.** Pension funding problem with regime switching geometric Brownian motion assets and liabilities. *Applied Stochastic Models in Business and Industry* **26** (2): 125-141.

**Chen P and Luo S.** Clocks and Fisher information. *Theoretical and Mathematical Physics* **156** (2): 1552-1564.

**Dickson D and Li S.** Finite time ruin problems for the Erlang(2) risk model. *Insurance: Mathematics and Economics* **46**: 12-18.

**Dufresne D.** Beta products with complex parameters. *Communications in Statistics-Theory and Methods* (39): 837-854.

**Dufresne D.** G distributions and beta-gamma algebra. *Electronic Journal of Probability* (15): 2163-2199.

**Fitzherbert R and Pitt D.** Investment return calculations and senior school mathematics. *Australian Senior Mathematics Journal* **24**(1): 7-17.

**Li S and Lu Y.** On the maximum surplus before ruin and maximum severity of ruin in the compound Poisson risk model with a threshold dividend strategy. *Scandinavian Actuarial Journal* **2**: 136-147.

**Joshi M.** Graphical Asian options. *Wilmott Journal* **2** (2): 97-107.

**Joshi M.** Achieving higher order convergence for the prices of European options in binomial trees. *Mathematical Finance* **20** (1): 89-103.

**Joshi M and Tang R.** Pricing and deltas of discretely-monitored barrier options using stratified sampling on the hitting-times to the barrier. *International Journal of Theoretical and Applied Finance* **13**(5): 717- 750.

**Joshi M and Yang C.** Fast and accurate pricing and hedging of long-dated CMS spread options. *International Journal of Theoretical and Applied Finance* **13**(6): 839 -865.

**Pitt D and Joshi M.** Fast sensitivity computations for Monte Carlo valuation of pension funds. *Astin Bulletin* **40**(2): 655-667.

**Pitt D, Qian G and Cui J.** Model selection and claim frequency for workers' compensation insurance. *Astin Bulletin* **40**(2): 779-796.

**Wu X and Li S.** Matrix-form recursions for a family of compound distributions. *ASTIN Bulletin* **40**: 351-368.

**Wu X.** Ruin probabilities for a risk model with two classes of risk processes. *Australian Actuarial Journal* **16**(1): 87-108

**Yip P, Pitt D, Wang Y, Wu X, Watson R, Huggins R and Xu Y.** Assessing the impact of suicide exclusion periods on

life insurance. *Crisis: The Journal of Crisis Intervention and Suicide Prevention* **31**(4): 217-223.

**Zhang Z, Yang H and Li S.** The perturbed compound Poisson risk model with two-sided jumps. *Journal of Computational and Applied Mathematics* **23**(8): 1783-1784.

## Other Publications

**Denson N and Joshi M.** Smooth calibration of Markov functional models for pricing exotic interest rate derivatives, *Risk Magazine*, August 2010, 81-83.

**Dufresne D.** Stochastic volatility and option pricing. *Risk and Rewards* (55): 28-31.

**Gribble J.** Banking insight. *Actuary Australia* **154**: October 2010.

**Gribble J.** Actuarial value – an Australian view. *Actuarial Society of Hong Kong Newsletter*: December 2010.

**Fitzherbert R.** Degrees in 'Actuarial Science', *Actuary Australia*, June 2010, 20-21.

## Conference and Seminar Presentations

### Chen, Ping

Markowitz's mean-variance asset-liability management with regime switching: A multi-period model, Australasian Actuarial Education and Research Symposium, Melbourne, November

Markowitz's mean-variance asset-liability management with regime switching: A multi-period model, International Conference on Applied Statistics And Financial Mathematics, Hong Kong, December

### Chin, Stephen

A general formula for option prices in a stochastic volatility model, Australasian Actuarial Education and Research Symposium, Melbourne, November

### Dickson, David

Erlang risk models and finite time ruin problems, The 3rd International Gerber—Shiu Workshop, University of Waterloo, June

Erlang risk models and finite time ruin problems, The 2010 International Conference on Insurance and Actuarial Science, Chongqing University, China, June

### Dufresne, Daniel

Derivative pricing using the Gram-Charlier process, Australasian Actuarial Education and Research Symposium, Melbourne, November

# Publications and Other Research Activities in 2010

Changes of measure for the square-root stochastic volatility process, 45th Actuarial Research Conference, Vancouver, July

Changes of measure for the square-root stochastic volatility process, Concordia University, Montreal, August

Changes of measure for the square-root stochastic volatility process, 54th Annual Australian Mathematical Society, Brisbane, September

Changes of measure for the square-root stochastic volatility process, Morgan Stanley, New York, November

## **Fitzherbert, Richard**

The importance of history in actuarial education, Australasian Actuarial Education and Research Symposium, Melbourne, November

## **Gribble, Jules**

Unit pricing errors and compensation, Unit Pricing Conference, IBR, Sydney, May

The age pension – in or out?, Institute of Actuaries of Australia Super Policy Forum, Melbourne, October

Actuarial control + actuarial practice = actuarial value, Australasian Actuarial Education and Research Symposium, Melbourne, November

## **Li, Shuanming**

The moments of the aggregate discounted claims in dependent risk models, 14th International Congress on Insurance: Mathematics and Economics, Toronto, Canada, June.

## **Liu, Qing**

A Bayesian approach to parameter estimation for kernel density estimation via transformations, Australasian Actuarial Education and Research Symposium, Melbourne, November

## **Nie, Ciyu**

Minimizing the ruin probability through capital injections, Australasian Actuarial Education and Research Symposium, Melbourne, November

## **Pitt, David**

Model selection for mixed models using the Gibbs sampler, 14th International Congress on Insurance: Mathematics and Economics, Toronto, Canada, June

## **Taylor, Greg**

Maximum likelihood and estimation efficiency of the chain ladder, Australasian Actuarial Education and Research Symposium, Melbourne, November

A statistical basis for claims experience monitoring, Institute of Actuaries of Australia General Insurance Seminar, Gold Coast, November

## **Yang, Chao**

Fast and accurate Greek estimations in financial mathematics, FIRN Doctoral Tutorial, Melbourne, September

Fast and accurate Greek estimations in financial mathematics, Australasian Actuarial Education and Research Symposium, Melbourne, November

Fast adjoint Gamma computations, Quantitative Methods in Finance, Sydney, December.

## **Wu, Xueyuan**

Matrix-form recursions for a family of compound distributions, The 2010 International Conference on Insurance and Actuarial Science, Chongqing University, China, June

Matrix-form recursive evaluation of the aggregate claims distribution revisited, 14th International Congress on Insurance: Mathematics and Economics, Toronto, Canada, June

## **Other Activities**

David Dickson is an editor of *ASTIN Bulletin*, an associate editor of *Insurance: Mathematics and Economics*, the *British Actuarial Journal*, and *Annals of Actuarial Science*. David is also a member of the editorial board of *North American Actuarial Journal* and an Adjunct Professor at the University of Waterloo.

Shuanming Li is a reviewer for *American Mathematical Reviews (AMR)* and *Insurance Markets and Companies: Analyses and Actuarial Computations*.

David Pitt is an associate editor of the *Australian Actuarial Journal*.

Greg Taylor is an associate editor of *Insurance: Mathematics and Economics*.



# Publications and Other Research Activities in 2010

## Involvement as Referees

Acta Mathematicae Applicatae Sinica  
Acta Mathematicae Scientia  
Annales de l'Institut Henri Poincaré  
Applied Mathematical Finance  
Applied Mathematics and Computation  
Applied Mathematics and Computation Stochastics  
Applied Stochastic Models in Business and Industry  
ASTIN Bulletin  
Australian Actuarial Journal  
Bachelier Finance Conference  
Communications in Statistics – Theory and Methods  
Frontiers of Mathematics in China

Insurance: Mathematics and Economics  
International Journal of Financial Markets and Derivatives  
Journal of Computational and Applied Mathematics  
Journal of Risk and Insurance  
Journal of Systems Science and Complexity  
Methodology and Computing in Applied Probability  
Mathematical and Computer Modeling  
Quantitative Finance  
Risk Magazine  
Scandinavian Actuarial Journal  
Stochastic Processes and Their Applications  
Statistics and Probability Letters

## Research Paper Series

The Centre has an established Research Paper Series; abstracts are given below for the papers added in 2010. Electronic files are available on the web at: <http://mercury.ecom.unimelb.edu.au/SITE/actwww/wps2010.shtml>

### No 202: Erlang Risk Models And Finite Time Ruin Problems

**By David C M Dickson and Shuanming Li**

We consider the joint density of the time of ruin and deficit at ruin in the Erlang( $n$ ) risk model. We give a general formula for this joint density and illustrate how the components of this formula can be found in the special case when  $n = 2$ . We then show how the formula can be implemented numerically for a general value of  $n$ . We also discuss how the ideas extend to the generalised Erlang( $n$ ) risk model.

### No 203: Modelling and Replicating Hedge Fund Returns

**By Wang Chun Wei**

This paper provides discussion on factor-based modelling for hedge fund returns, and demonstrates replication via both rolling windows and Kalman filters. In particular, we focus on estimating time-varying hedge fund returns exposure through various asset-based style (ABS) factors. It is shown that certain hedge fund strategies are more susceptible to cloning, suggesting a higher likelihood of creating transparent liquid replication products as either an alternative investment vehicle or as a benchmarking/style analysis tool for institutional investors.

### No 204: Ruin Probabilities For A Risk Model With Two Classes Of Risk Processes

**By Xueyuan Wu**

In this paper a risk model with two classes of business is considered, in which claim number processes are modeled by two independent Erlang(2) processes, aiming to calculate probabilities of ruin caused by a claim from a certain class. To do so, integro-differential equations for the ruin probabilities are derived and their Laplace transforms are then obtained. At the end of this paper, numerical results for the ruin probabilities are calculated for individual claim sizes with exponential and Gamma distributions.

### No 205: Matrix-form Recursive Evaluation of the Aggregate Claims Distribution Revisited

**By Kok Keng Siaw and Xueyuan Wu**

This paper aims to evaluate the aggregate claims distribution under the collective risk model when the number of claims follows a so-called generalised ( $a$ ;  $b$ ; 1) family distribution. The definition of the generalised ( $a$ ;  $b$ ; 1) family of distributions is given first, followed by some detailed discussions on several members of the family. Of particular interest, it can be shown that all discrete phase-type (DPH) distributions belong to the generalised ( $a$ ;  $b$ ; 1)

# Research Paper Series

family. A simple matrix-form recursion, which is a counterpart of the Panjer's recursion for the  $(a; b; 1)$  family, is then derived to calculate the aggregate claims distribution with non-negative individual claims, either discrete or continuous. Recursive formula for calculating the moments of aggregate claims is also obtained in this paper. At last, several numerical examples are presented to illustrate the recursive calculations using Mathematica.

## No 206: Minimising The Ruin Probability Through Capital Injections

**By Ciyu Nie, David C M Dickson and Shuanming Li**

We consider an insurer who has a fixed amount of funds allocated as the initial surplus for a risk portfolio, so that the probability of ultimate ruin for this portfolio is at a known level. We consider the question of whether the insurer can reduce this ultimate ruin probability by allocating part of the initial funds to the purchase of a reinsurance contract. This reinsurance contract would restore the insurer's surplus to a positive level  $k$  every time the surplus fell between 0 and  $k$ . The insurer's objective is to choose the level  $k$  that minimizes the ultimate ruin probability. Using different examples of reinsurance premium calculation and claim size distribution we show that this objective can be achieved, often with a substantial reduction in the ultimate ruin probability from the situation when there is no reinsurance. We also show that by purchasing reinsurance the insurer can release funds for other purposes without altering its ultimate ruin probability.

## No 207: Monte Carlo Bounds for Game Options Including Convertible Bonds

**By Christopher Beveridge and Mark Joshi**

We introduce two new methods to calculate bounds for zero-sum game options using Monte Carlo simulation. These extend and generalise the duality results of Haugh-Kogan/Rogers and Jamshidian to the case where both parties of a contract have Bermudan optionality. It is shown that the Andersen-Broadie method can still be used as a generic way to obtain bounds in the extended framework, and we apply the new results to the pricing of convertible bonds by simulation.

## No 208: Monte Carlo Market Greeks in the Displaced Diffusion Libor Market Model

**By Mark Joshi and Kang Kwon**

The problem of developing sensitivities of exotic interest rates derivatives to the observed implied volatilities of caps and swaptions is considered. It is shown how to compute these from sensitivities to model volatilities in the displaced diffusion LIBOR market model. The example of a cancellable inverse floater is considered.

## No 209: Fast Monte-Carlo Greeks for Financial Products with Discontinuous Pay-Offs

**By Jiun Hong Chan and Mark Joshi**

We introduce a new class of numerical schemes for discretizing processes driven by Brownian motions. These allow the rapid computation of sensitivities of discontinuous integrals using pathwise methods even when the underlying densities post-discretization are singular. The two new methods presented in this paper allow Greeks for financial products with trigger features to be computed in the LIBOR market model with similar speed to that obtained by using the adjoint method for continuous pay-offs. The methods are generic with the main constraint being that the discontinuities at each step must be determined by a one-dimensional function: the proxy constraint. They are also generic with the sole interaction between the integrand and the scheme being the specification of this constraint.

## No 210: Fast and Accurate Long Stepping Simulation of the Heston Stochastic Volatility Model

**By Jiun Hong Chan and Mark Joshi**

In this paper, we present three new discretization schemes for the Heston stochastic volatility model - two schemes for simulating the variance process and one scheme for simulating the integrated variance process conditional on the initial and the end-point of the variance process. Instead of using a short timestepping approach to simulate the variance process and its integral, these new schemes evolve the Heston process accurately over long steps without the need to sample the intervening values. Hence, prices of financial derivatives can be evaluated rapidly using our new approaches.



# Research Paper Series

## No 211: First and Second Order Greeks in the Heston Model

**By Jiun Hong Chan and Mark Joshi**

In this paper, we present an efficient approach to compute the first and the second order price sensitivities in the Heston model using the algorithmic differentiation approach. Issues related to the applicability of the pathwise method are discussed in this paper as most existing numerical schemes are not Lipschitz in model inputs. Depending on the model inputs and the discretization step size, our numerical tests show that the sample means of price sensitivities obtained using the Lognormal scheme and the Quadratic-Exponential scheme can be highly skewed and have fat-tailed distribution while price sensitivities obtained using the Integrated Double Gamma scheme and the Double Gamma scheme remain stable.

## No 212: Truncation and Acceleration of the Tian Tree for the Pricing American Put Options

**By Ting Chen and Mark Joshi**

We present a new method for truncating binomial trees based on using a tolerance to control truncation errors and apply it to the Tian tree together with acceleration techniques of smoothing and Richardson extrapolation. For both the current (based on standard deviations) and the new (based on tolerance) truncation methods, we test different truncation criteria, levels and replacement values to obtain the best combination for each required level of accuracy. We also provide numerical results demonstrating that the new method can be 50% faster than previously presented methods when pricing American put options in the Black-Scholes model.

## No 213: Fast Gamma Computations for CDO Tranches

**By Mark Joshi and Chao Yang**

We demonstrate how to compute first- and second-order sensitivities of portfolio credit derivatives such as synthetic collateralized debt obligation (CDO) tranches using algorithmic Hessian methods developed in Joshi and Yang (2010) in a single-factor Gaussian copula model. Our method is correct up to floating point error and extremely fast. Numerical result shows that, for an equity tranche of a synthetic CDO with 125 names, we are able to compute the whole Gamma matrix with computational times measured in seconds.

## No 214: Fast Greeks for Markov-Functional Models Using Adjoint PDE Methods

**By Nick Denson and Mark Joshi**

This paper demonstrates how the adjoint PDE method can be used to compute Greeks in Markov-functional models. This is an accurate and efficient way to compute Greeks, where most of the model sensitivities can be computed in approximately the same time as a single sensitivity using finite difference. We demonstrate the speed and accuracy of the method using a Markov-functional interest rate model, also demonstrating how the model Greeks can be converted into market Greeks.

## No 215: Efficient Pricing And Greeks In The Cross-Currency LIBOR Market Model

**By Chris J. Beveridge, Mark S. Joshi and Will M. Wright**

We discuss the issues involved in an efficient computation of the price and sensitivities of Bermudan exotic interest rate derivatives in the cross-currency displaced diffusion LIBOR market model. Improvements recently developed for an efficient implementation of the displaced diffusion LIBOR market model are extended to the cross-currency setting, including the adjoint-improved pathwise method for computing sensitivities and techniques used to handle Bermudan optionality. To demonstrate the application of this work, we provide extensive numerical results on two commonly traded cross-currency exotic interest rate derivatives: cross-currency swaps (CCS) and power reverse dual currency (PRDC) swaps.

# Staff

## Staff

### CENTRE FOR ACTUARIAL STUDIES

#### Professor in Actuarial Studies

DAVID C M DICKSON: BSc (Hons), PhD Heriot-Watt, FFA FIAA

Research Interests: Aggregate claims distributions, renewal risk processes, recursive methods in risk theory.

#### Professor in Actuarial Studies

DANIEL DUFRESNE: BSc (Hons) Montreal, PhD The City University, FSA

Research Interests: Financial mathematics, actuarial science, probability.

#### Professor in Actuarial Studies

MARK JOSHI: BA (Hons) Oxford, PhD MIT

Research Interests: Financial mathematics

#### Associate Professor in Actuarial Studies

SHUANMING LI: BSc Tianjin, MEd Renmin, PhD Concordia

Research Interests: Risk and ruin theory, stochastic modelling in insurance and finance, actuarial science.

#### Senior Lecturers in Actuarial Studies

DAVID PITT: BEc, BSc Macquarie, PhD ANU, FIAA

Research Interests: Analysis of disability income insurance portfolios, stochastic modelling in actuarial science.

XUEYUAN WU: BS, MS Nankai University China, PhD Hong Kong

Research Interests: Risk and Ruin theory, discrete-time risk models

#### Lecturer in Actuarial Studies

PING CHEN: BAM (Qufu), M.Sc (CAS), PhD (Hong Kong)

Research Interests: Actuarial Science, Financial Mathematics

## Statistics and Information

### Professorial Associate

GREG TAYLOR: BA, PhD, FIA, FIAA, FIMA, CMath, AO

Research Interests: Modelling in general insurance.

### Honorary Senior Fellows

RICHARD FITZHERBERT: BSc, FIA, FIAA, F Fin

JULES GRIBBLE: BSc (Hons), PhD St Andrews, FIAA, FCIA, FSA

GRANT HARSLETT : BSc (Hons) Adel, FIA, FIAA, ASA

ALLEN TRUSLOVE: BSc(Hons), PhD Monash, MBA Deakin, FIAA, FIA

### External Lecturers

DONALD CAMPBELL: BCom Melbourne, FIAA

DAVID HEATH: BEc (Hons) Monash, FIAA, CPA, F Fin

CARY HELENIUS: BSc (Hons), Dip Ed Melbourne, FIAA

ANDREW GALE, BSc Melbourne, FIAA

### External Examiner for Part II

Martin Fry

### Tutors

OSCAR CHEN

RICHARD FITZHERBERT (FIAA)

ALLAN HORSFALL

KERRI LAM

SING LEUNG LAW

BONNIE LI

JINGCHAO LI, BCom (Hons)

LUCY LIU

QING LIU, BCom (Hons)

CIYU (JADE) NIE, BCom (Hons)

JUNXIA SU

ROBERT TANG, BCom (Hons)

CHAO YANG, BCom (Hons), MCom (Finance)

PENG ZHANG



# Advisory Board

## Advisory Board

The membership of the Advisory Board is as follows:

### External Members

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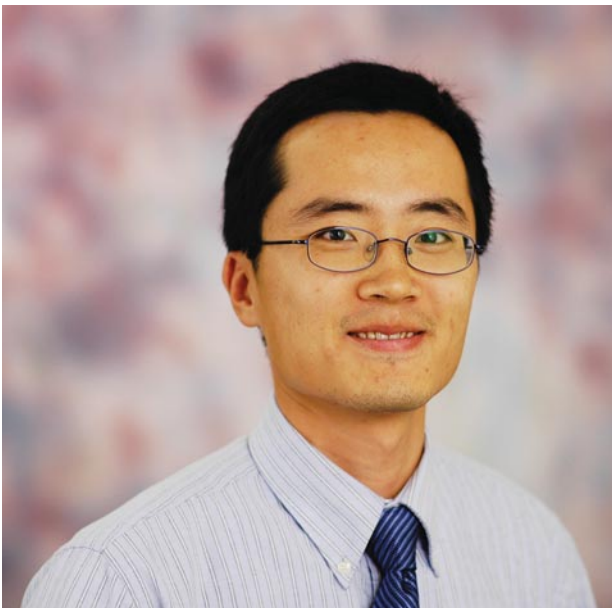
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