



THE UNIVERSITY OF  
MELBOURNE

FACULTY OF  
BUSINESS &  
ECONOMICS

# Centre for Actuarial Studies

ANNUAL REPORT 2013

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# The Year in Review

## INTRODUCTION

The Centre for Actuarial Studies is located in the Department of Economics. The main activities of the Centre are teaching, research and knowledge transfer in actuarial studies and financial mathematics. The majority of undergraduate and Master students study to become actuaries, but a number of our students find employment in banking or investments; a good number of our PhD students have research topics in financial mathematics. 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 the Centre for Actuarial Studies is fully accredited by the Actuaries Institute, its students can obtain exemptions from the whole of Parts I and II of the Institute's 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, probability and statistics. The Centre has eight full-time academic staff and several part-time lecturers from the actuarial profession (the complete list is at the end of this report).

The Centre for Actuarial Studies continues to be the focal point for actuarial education in Victoria. It has the support of the actuarial profession in Australia and produces research of high quality. It also maintains strong international links and contributes to the local actuarial community.

## STAFF NEWS

Professor Daniel Dufresne was the Director of the Centre for 2013.

## RESEARCH AND GRANTS

Centre staff publish in top journals and present their research at seminars and conferences in Australia and overseas. Details of publications and additions to the Centre's Working Paper Series can be found later in this report, as well as a list of conference and seminar presentations.

Dr. Enrique Calderin received an Early Career Research Grant from the University of Melbourne. The topic was "On the search for new composite families for actuarial data". Dr. Calderin was also Member of the Scientific Committee for the 5th Workshop on Risk Management and Insurance, Gran Canaria, Spain.

Professor David Dickson was an invited plenary speaker at the 17th International Congress on Insurance: Mathematics & Economics, hosted by the University of Copenhagen in July. Professor Dickson is an editor of ASTIN Bulletin, an associate editor of Insurance: Mathematics and Economics and Annals of Actuarial Science, a member of the editorial board of North American Actuarial Journal and an Adjunct Professor at the University of Waterloo.

Professor Daniel Dufresne pursued his Australian Research Council/BHP Billiton Linkage Grant project "Understanding Cycles in Mineral Commodity Prices, a Market Model with Uncertainty".

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

Professor Mark Joshi received an NVIDIA professor partnership equipment grant to support the Kooderive open source project for pricing derivatives by Monte Carlo simulation on the graphics card.

Dr. Shuanming Li is an External Reviewer for the journal *Insurance Markets and Companies: Analyses and Actuarial Computations*. Dr. Li received the Faculty of Business and Economics' Dean's Certificate for Research Excellence for 2012.

## TEACHING

Although first-year enrolments increased, overall undergraduate student numbers were about the same in 2013 as they were in 2012. Honours student numbers declined slightly. At the Masters level student numbers are unchanged. Details of enrolments are given later in this report.

Professor Mark Joshi received a Learning and Teaching Initiative grant "Enhancing student learning of financial mathematics".

Teaching was supported by a number of external lecturers including Mr Richard Fitzherbert (Financial Mathematics I and II, APC III), Dr Jules Gribble, Mr David Heath, and Mr Donald Campbell (Actuarial Practice and Control I and II). Professor Claude Pichet, from the University of Quebec in Montreal, taught financial mathematics at undergraduate and Masters levels for the first half of semester one.

## KNOWLEDGE TRANSFER

Mark Joshi continued to develop and administer the project Kooderive for pricing derivative securities using graphics cards with the CUDA programming language. The first release of the Kooderive open source project was made in 2013. Professor Joshi also continued to support the xlw open source project for interfacing EXCEL with C++.

## PROFESSIONAL ACTIVITIES

Professor Daniel Dufresne attended the 2013 Actuaries Summit in Sydney.

The Actuaries Institute performed a thorough assessment of our teaching in relation to subjects taught for exemption purposes. The Centre's full accreditation (Parts I and II) was renewed for all its programs.

# The Year in Review / Teaching

## VISITORS

Dr Iain Currie, from Heriot-Watt University, visited on 26 July and gave a seminar entitled “Forecasting Mortality with Smooth 2-d P-spline models”. Professor Felisa Vázquez-Abad, from City University of New York (CUNY), visited the Centre in January and February. Associate Professor Hongmei Zhang, from Huazhong Agricultural University, China, was a visitor for a year from September 2013.

## MASTER OF ACTUARIAL SCIENCE

The Master of Actuarial Science degree commenced in 2011. This two-year Master program consists of 16 subjects (8 core plus 8 elective subjects) and aims to provide initial actuarial education for graduates who have mathematical or statistical specialisations (e.g. in mathematics, physics, or engineering). The course enables students who obtain a sufficiently high pass to receive exemptions from the professional actuarial examinations conducted by the Actuaries Institute and the Institute and Faculty of Actuaries (UK).

The program director is Professor David Dickson. Further information about this degree is available online at <https://mbs.unimelb.edu.au/degrees/9-master-of-actuarial-science>

The joint Master’s program in actuarial science with Nankai University began in 2012.

## TEACHING

### Undergraduate & Honours Class Sizes

Subject Name	2011	2012	2013
ACTL10001 Introduction to Actuarial Studies	174	169	178
ACTL20001 Financial Mathematics I	126	124	136
ACTL20002 Financial Mathematics II	115	108	123
ACTL30001 Actuarial Modelling I	112	95	88
ACTL30002 Actuarial Modelling II	112	94	87
ACTL30003 Contingencies	107	85	80
ACTL30004 Actuarial Statistics	102	84	83
ACTL30005 Models for Insurance and Finance	109	79	77
ACTL30006 Financial Mathematics III	107	87	80
ACTL40001 Actuarial Studies Research Essay	5	7	8
ACTL40002 Risk Theory I	50	45	37
ACTL40003 Risk Theory II	21	23	27
ACTL40004 Advanced Financial Mathematics I	50	45	37
ACTL40005 Actuarial Studies Projects	47	39	30
ACTL40006 Actuarial Practice and Control I	50	45	53
ACTL40007 Actuarial Practice and Control II	34	40	32
ACTL40008 Advanced Financial Mathematics II	10	7	9
ACTL40009 Actuarial Practice and Control III	37	43	33
<b>Total Enrolments</b>	<b>1368</b>	<b>1219</b>	<b>1216</b>



# Teaching

## Honours Grades over the Last Five Years

	H1	H2A	H2B	H3	N	Total
2009	15	7	13	2	0	37
2010	17	14	15	6	0	52
2011	18	14	13	8	0	53
2012	12	12	15	6	0	45
2013	10	9	13	2	4	38

## Master of Actuarial Science Class Sizes

Subject	Name	2011	2012	2013
ACTL90001	Mathematics of Finance I	4	18	16
ACTL90002	Mathematics of Finance II	3	16	16
ACTL90003	Mathematics of Finance III	4	14	10
ACTL90004	Insurance Risk Models	Not offered	15	11
ACTL90005	Life contingencies	Not offered	15	15
ACTL90006	Life Insurance Models 1	4	14	14
ACTL90007	Life Insurance Models 2	4	14	13
ACTL90008	Statistical Techniques in Insurance	Not offered	15	10
ACTL90009	Actuarial Practice and Control III	Not offered	2	18
ACTL90010	Actuarial Practice and Control I	Not offered	1	2
<b>Total Enrolments</b>		<b>19</b>	<b>124</b>	<b>125</b>

## Honours Essay And Project Topics

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

Bird, Andrew; Brass, Samuel; Cao, Jier; Chen, Allan; Fang, Jing; Feng, Yining; Huang, Jiayuan; Huang, Emily; Hum, David; Kong, Arthur; Lee, Timothy; Li, Han-Bo; Li, Jiangting; Li, Ruiyang; Li, Qingye; Lim, Justin; Luo, Yingjia; Peh, Wai; Qiao, Chu; Qu, Jinfeng; See, Yong; Tan, Senren; Tan, Yan; Tu, Xinqi; Wang, Yi; Waxmann, Brian; Wong, Wei; Wong, Jun; Xu, Mingda; Yan, Wei; Yang, Caijie; Yang, Chen; Yao, Xin; Yu, Simiao; Zhao, Ningxiao; Zheng, William; Zheng, Yang; Zhou, Zhiyuan.

An Honours research essay has about 10,000 words and counts for 25% of the final assessment for a student's Honours grade. Seven Honours students wrote an essay in 2013, and the topics they studied were:

- Pricing interest rate derivatives and computing pathwise Greeks in the extended Libor market model
- Price bubbles, synchronization risks and noise-trader risks in arbitrage
- Life settlement portfolio pricing and the implied rate of return
- The application of acceleration techniques to the cos method
- On the weighted class of premium calculation principles
- Gram-Charlier approximations to Asian options
- Investigation of a new composite model for insurance claims data

The majority of Honours students do three research projects instead of the essay. In 2013 the topics of those projects were:

- Real estate prices as geometric Brownian motion
- Applying Monte Carlo simulations
- Analysis of an investment project using CAPM

# Student Prize Winners

**Actuaries Institute Australia Prize**

For Research Essay and Projects

Timothy Lee

**ANZ Honours Prize**

For Advanced Financial Mathematics I and II

Hanbo Li

**Comminsure Prize**

For Introduction to Actuarial Studies

Mengtong Xia

**Deloitte Actuaries & Consulting Prize**

For Actuarial Practice and Control I and II

Hanbo Li

**Honours Medal in Actuarial Studies**

Hanbo Li

**Kingston Equities Award**

For Financial Mathematics III

Pham Thinh Le

**Martin Jilovsky Prize**

For best third year results

Thomas Bailey

**Taylor Fry Prize**

For Actuarial Statistics

Beatrice Chan

**Towers Watson Prize**

For Risk Theory I and II

Andrew Bird

# PhD Students and Research Topics

**Evan Hariyanto**

Pricing and risk management of reverse mortgages in the Australian market

**Can Jin**

On some generalisations of the expected discounted penalty functions in some insurance risk models

**Jingchao Li**

Ruin related quantities in insurance risk models

**Joan Nakoto**

Superannuation: Its challenges and recommendations

**Navin Ranasinghe**

Volatility derivatives

**Marjan Qazvini**

Risk models with capital injections

**Miao Zhang**

Continuous time mean-variance model for portfolio selection

**Nan Zhang**

Some optimal reinsurance problems

**Dan Zhu**

On fast and efficient computations of second order Greeks for financial products

**Finished their PhDs in 2013:****Qing Liu**

Statistical modelling of insurance claims

**Ciyu Nie**

On lower barrier insurance risk processes

**Peter Raymond**

Allowing for mortality uncertainty in life insurance models

# Publications and Other Research Activities in 2013

## BOOKS

**Dickson, D., Hardy, M. and Waters, H.** *Actuarial Mathematics for Life Contingent Risks*, 2nd Ed. Cambridge University Press, Cambridge.

**Dickson, D., Hardy, M. and Waters, H.** *Solutions Manual for Actuarial Mathematics for Life Contingent Risks*, 2nd Ed. Cambridge University Press, Cambridge.

**Joshi, M., and Paterson, J.** *Introduction to mathematical portfolio theory*. Cambridge University Press, Cambridge.

**Joshi, M., Denson, N., and Downes, A.** *Quant job interview questions and answers*. 2<sup>nd</sup> Ed. Pilot Whale Press.

## BOOK CHAPTER

**Jin Z., and Yin G.** Numerical methods for optimal annuity purchasing and dividend optimization strategies under regime-switching models: review of recent results. In: *State-Space Models and Application in Economics and Finance*, Springer Series Statistics and Econometrics in Finance, Vol. 1: 205-225.

## REFEREED JOURNAL ARTICLES

**Bertoin, J., Dufresne, D., and Yor, M.** Some two-dimensional extensions of Bougerol's identity in law for the exponential functional of linear Brownian motion. *Revista Matemática Iberoamericana* **29**: 1307-1324.

**Beveridge, C., Joshi, M., and Tang, R.** Practical policy iteration: generic methods for obtaining rapid and tight bounds for Bermudan exotic derivatives using Monte Carlo simulation **37**: 1342-1361.

**Calderín, E., and Gómez-Déniz, E.** An extension of the discrete Lindley distribution with applications. *Journal of the Korean Statistical Society* **42**: 371-373.

**Chan, J.H., and Joshi, M.** Fast and accurate long stepping simulation of the Heston stochastic volatility model. *The Journal of Computational Finance* **16**: 47-97.  
Chan, J.H., and Joshi, M. Fast Monte Carlo Greeks for financial products with discontinuous pay-offs. *Mathematical Finance* **23**: 459-495.

**Chen, P., and Yam, S.C.P.** Optimal proportional reinsurance and investment with regime-switching for mean-variance insurers. *Insurance: Mathematics and Economics* **53**: 871-883.

**Dickson, D., and Li, S.** The distributions of the time to reach a given level and the duration of negative surplus in the Erlang(2) risk model. *Insurance: Mathematics & Economics* **52**: 490-497.

**Dufresne, D., and Vázquez-Abad, F.** Cobweb theorems with production lags and price forecasting. *Economics E-Journal* **7** (2013-23): 1-49.

**Gómez-Déniz E., and Calderín, E.** The compound DGL/Erlang distribution in the collective risk model. *Revista de Métodos Cuantitativos para la Economía y la Empresa* **16**: 121-142.

**Gómez-Déniz, E. and Calderín, E., and Sarabia, J.M.** Gamma-generalized Inverse Gaussian class of distributions with applications. *Communications in Statistics: Theory and Methods* **42**: 919-933.

**Jin, Z., and Yin, G.** An optimal dividend policy with delayed capital injections. *ANZIAM Journal* **55**: 129-150.

**Jin, Z., and Yin, G.** Numerical methods for optimal dividend payment and investment strategy for Markov-modulated jump diffusion models with regular and singular controls. *Journal of Optimization Theory and Applications* **159**: 246-271.

**Jin, Z., Yin G., and Wu, F.** Optimal reinsurance strategies in regime-switching jump diffusion models: Stochastic differential game formulation and numerical methods. *Insurance: Mathematics and Economics* **53**: 733-746.

**Jin, Z., Yang, H., and Yin, G.** Numerical methods for optimal dividend payment and investment strategies of regime-switching jump diffusion models with capital injections. *Automatica* **49**: 2317-2329.

**Li, S., and Lu, Y.** On the generalised Gerber-Shiu function for a risk model with interest. *Insurance: Mathematics and Economics* **52**: 127-134.

**Li, S., and Ren, J.** The time of recovery and the maximum severity of ruin in a perturbed MAP risk process. *Statistics and Probability Letters* **83**: 993-998.

**Li, S., and Sendova, K.** Finite-time ruin probability for the compound binomial risk model. *European Actuarial Journal* **3**: 249-271.

**Li, S., Huang, F., and Jin, C.** Joint distributions for some ruin-related quantities in the compound binomial risk model. *Stochastic Models* **29**: 518-539.

**Liu, Q., Pitt, D., Wang, Y., Wu, X.** Survival analysis of left truncated income protection insurance data. *Asia-Pacific Journal of Risk and Insurance* **7**: 1-22.

Wu, X. Equilibrium distributions of discrete phase type. *Stochastic Models* **29**: 240-257.

**Yao, H., Yang, Z., and Chen, P.** Markowitz's mean-variance defined contribution pension fund management under inflation: A continuous-time model. *Insurance: Mathematics and Economics* **53**: 851-863.

## OTHER PUBLICATIONS

**Dickson, D.** Review of "Risk Modelling in General Insurance". *Annals of Actuarial Science* **7**: 345-346.

## CONFERENCE AND SEMINAR PRESENTATIONS

### Dickson, David

"On a risk model with capital injections". University of New South Wales, Sydney, May.

"Prabhu's formula revisited". 17th International Congress on Insurance: Mathematics & Economics, hosted by the University of Copenhagen, July

### Dufresne, Daniel

"The integral of geometric Brownian motion: history and recent results". Université du Québec à Montréal, Canada, June.

# Publications and Other Research Activities in 2013

## Jin, Zhuo

“Numerical methods for optimal dividend payment and investment strategies of regime-switching jump diffusion models with capital injections”, International Conference on Actuarial Science and Related Fields, East China Normal University, Shanghai, China, November.

“Optimal dividend policy with delayed capital injections”, Quantitative Methods in Finance conference, Sydney, December.

## Joshi, Mark

“Effective sub-simulation-free upper bounds for the Monte Carlo pricing of callable derivatives and various improvements to existing methodologies”. Macquarie University, Sydney, May.

“Effective sub-simulation-free upper bounds for the Monte Carlo pricing of callable derivatives and various improvements to existing”. Quantitative Methods in Finance conference, Sydney, December.

## Li, Shuanming

“Ruin theory: from the classical risk model to the Markov-modulated risk model”. China Institute for Actuarial Science, Central University of Finance and Economics, December.

## Wu, Xueyan

“Equilibrium distributions of discrete phase type”. The 2013 International Conference on Actuarial Risk and Related Topics, Nankai University, China, March.

“On a discrete-time two level NCD risk model”. Peking University, China, May.

“On a discrete-time two level NCD risk model”. Tsinghua University, China, May.

“On a discrete-time risk model with claim correlated premiums”. Macquarie University, November.

## Other Activities

Drs. Zhuo Jin and Shuanming Li are reviewers for American Mathematical Reviews. Staff of the Centre were examiners for PhD theses at Macquarie University and reviewers of research grant applications for the Israel Science Foundation and the Natural Sciences and Engineering Research Council of Canada (NSERC).

## Involvement as Referees

Abstract and Applied Analysis  
Acta Mathematicae Applicatae Sinica  
Annals of Actuarial Science  
Applied Mathematics and Computation  
Discrete Dynamics in Nature and Society  
Economic Modelling  
Frontiers of Mathematics in China  
Haceteppe Journal of Mathematics and Statistics  
IMA Journal of Management Mathematics  
Insurance: Mathematics & Economics  
Journal of Applied Mathematics  
Journal of Applied Statistics  
Journal of Computational and Applied Mathematics  
Journal of Control Theory and Applications  
Journal of Industrial and Management Optimization  
Journal of Systems Science and Complexity  
Mathematics and Computation  
Mathematical and Computer Modelling  
Mathematical Problems in Engineering  
Methodology and Computing in Applied Probability  
North American Actuarial Journal  
Quantitative Finance  
Scandinavian Actuarial Journal  
Statistical Methodology  
Statistics and Probability Letters

## Working Paper Series

The Centre has an established Research Paper Series, abstracts of the papers added in 2012 are given below. Electronic versions of all papers are available at the following address: <http://fbe.unimelb.edu.au/economics/ACT/workingpapers>

**No 233:** Joshi, M., and Kwok, C.F. The rate of convergence of the two-state lattice model for pricing vanilla options.

**No 234:** Jin, Z., Yang, H., and Yin, G. Numerical methods for optimal dividend payment and investment strategies of regime-switching jump diffusion models with capital injections.

**No 235:** Jin, Z., Yin G., and Wu, F. Optimal reinsurance strategies in regime-switching jump diffusion models: stochastic differential game formulation and numerical methods.



# Staff and Advisory Board

## STAFF

### Professors of Actuarial Studies

#### DAVID CM DICKSON:

BSc (Hons), PhD Heriot-Watt, FFA FIAA

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

#### DANIEL DUFRESNE:

BSc (Hons) Montreal, PhD The City University, FSA

Research interests: Financial mathematics, actuarial science, probability.

#### MARK JOSHI:

BA (Hons) Oxford, PhD MIT

Research interests: Financial mathematics

### Associate Professor in Actuarial Studies

#### SHUANMING LI:

BSc Tianjin, MEc Renmin, PhD Concordia

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

### Senior Lecturer in Actuarial Studies

#### XUEYUAN WU:

BS, MS Nankai University China, PhD Hong Kong

Research interests: Risk and ruin theory, discrete-time risk models, phase-type distribution in risk theory

### Lecturers in Actuarial Studies

#### PING CHEN:

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

Research interests: Actuarial science, financial mathematics, statistics and information

#### ENRIQUE JAVIER CALDERIN:

B.S., M.S (UNED, Spain), PhD (ULPGC, Spain) Research interests: Bayesian inference, statistical robustness, distribution theory, actuarial statistics

#### ZHUO JIN:

B.S., M.S. (HUST), M.A., PhD (WSU)

Research interests: Numerical methods for stochastic systems, mathematical finance, actuarial science

### Professorial Associate

#### GREG TAYLOR:

BA, PhD, FIA, FIAA, FIMA, CMath, AO

Research interests: Modelling in general insurance.

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**Mike Barker** (APC 3)

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Professor Daniel Dufresne

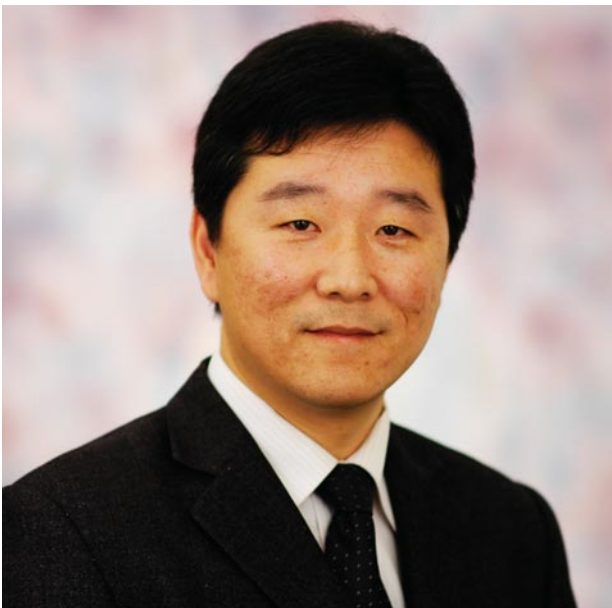
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Dr. Zhuo Jin



Professor Mark Joshi



Associate Professor Shuanming Li



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