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1 The Staff at the Laboratory of Actuarial Mathematics

Full-time scientific staff:
Professor Dr. Thomas Mikosch
Professor Dr. Hanspeter Schmidli
Associate Professor Dr. Jeffrey Collamore
Assistant Professor Ph.D. Thomas Møller (through 1st of February)
Assistant Professor Ph.D. Jesper Lund Pedersen (starting 1st of December)
Assistant Professor Ph.D. Mogens Steffensen
Ph.D. Student cand.act. Mikkel Dahl
Ph.D. Student cand.act. Peter Holm Nielsen
Ph.D. Student dipl.math.ETH Daniel Y. Straumann (through 30th of June)

Administrative staff:
Overassistent Rikke Helse (starting 1st of August)
Overassistent Mette B. Jensen
Overassistent Ulla Nielsen

Part-time scientific staff:
Cand.act. Eva Brinck
Cand.act. Tina Dawson
Skattedirektør, Cand.jur. Leif Normann Jeppesen
Kontorchef, Cand. jur. Johan Jessen
Cand.jur. Henning Jönsson
Chartered Accountant Birger Berg Nielsen
Cand.act. Pernille Overby

Teaching Assistants:
Julie Have Horstmann
Anders Hedegaard Jessen
Vicki Winther Njor
2 Introduction

The Laboratory of Actuarial Mathematics is a division of the Institute for Mathematical Sciences at the Faculty of Science at the University of Copenhagen. The objective of the Laboratory is to educate actuaries qualified to perform risk theoretical analyses in life and non-life insurance and related fields and to maintain research in insurance mathematics and other fields of Applied Probability Theory.

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3 The Study Programme for the Master’s Degree in Actuarial Sciences

The study programme consists of a compulsory core and an optional part. The compulsory part is divided into courses on mathematical analysis, linear algebra, computer science, mathematical statistics and probability theory, life and non-life insurance mathematics, financial mathematics, law and economics.

The optional courses are to be chosen from mathematics, statistics, insurance mathematics, computer science, economics, or law.

After the third year the Bachelor’s degree is awarded to those students who have completed two projects in insurance mathematics. After five years, the study programme ends with a Master’s thesis. The Ph.D. study lasts three years.

4 Research Activities 2003

Jeffrey Collamore: Ruin estimates are given for an insurance company which invests its excess capital, when the returns are modulated by a general Markov chain. Also, finite-time ruin probabilities are studied for heavy-tailed positive-drift processes, with application e.g. to operational risk management. Both projects draw upon methods from the theory of Harris-recurrent Markov chains and extreme value theory. (Joint work with H. Nyrhinen, U. Helsinki, and A. Höing, ETH Zürich.)
Mikkel Dahl:  *Stochastic mortality in life insurance:* A paper on stochastic mortality in life insurance has been completed. New expressions for premia and reserves are determined, and the concept of mortality-linked insurance contracts is introduced.

*Finance in insurance:* A fair distribution of the assets between the insured and the owners of an insurance company is determined using the no-arbitrage criterion from finance.

Thomas Mikosch:  I continued studying models in insurance, finance and telecommunications which exhibit unusually large values. The main focus was on time series models for financial data, their statistical and probabilistic properties. I studied the probabilities of rare events under heavy-tailed input distributions. Those include probabilities of large deviations for sums of dependent random variables.

Thomas Moller:  In a dynamic reinsurance market, the insurance risk process is viewed as a traded price process. This typically leads to an incomplete financial market which admit many different martingale measures. A criterion for comparison of prices under different martingale measures has been obtained. In particular, this criterion allows for comparison of the so-called minimal martingale measure and the minimal entropy martingale measure.

Peter Holm Nielsen:  *Optimisation problems in life insurance:* A paper on optimal bonus strategies for life insurance companies has been finished. The paper deals with traditional participating life insurance policies in a Markov chain interest rate environment and aims at determining optimal strategies for redistribution of surplus through a stream of dividends, which may be of a quite general type. A survey of the existing literature on investment and consumption problems has been started.

Jesper Lund Pedersen:  Different expressions are provided for the first hitting time density of an Ornstein-Uhlenbeck process to a fixed level. The different approaches are illustrated by numerical examples. (joint with Larbi Alili and Pierre Patie).

The project is to investigate hitting times of Markov processes. The emphasis is to study connections of a given law of a Markov process and a distributional property of an associated hitting time.
Hanspeter Schmidli: A classical Cramér-Lundberg risk model is controlled via reinsurance and investment. We show a Cramér-Lundberg approximation and that the optimal strategies converge. In another work it is shown how the optimal asymptotic strategy is calculated in an easy way.

For securitization of catastrophic claims PCS options had been introduced on the market. A PCS option is a spread on the PCS index, an estimate of the aggregate insurance claim from catastrophes. A model for the PCS index is introduced. It is discussed, how prices can be obtained. The correct price is then approximated by actuarial approximations, and compared to prices obtained via simulation.

Mogens Steffensen: The linear regulator as an approach to control in pension funds is studied for payments driven by a finite state Markov chain. This makes it possible to perform an optimal control on any level of individualisation in a life insurance portfolio.

Various portfolio optimisation problems have been studied; portfolio optimisation with a random time horizon correlated with market prices (with Holger Kraft), worst case portfolio optimisation (with Ralf Korn) and portfolio optimisation under wealth constraints (with Holger Kraft).

Daniel Y. Straumann: My research focused on parameter estimation in financial time series models.

5 Other Activities

5.1 Participation in meetings, visits to other institutions

Mikkel Dahl: International symposium on insurance and finance, Bergen, Norway, April, with talk: “Stochastic Mortality in Life Insurance: Market Reserves and Mortality-Linked Insurance Contracts”.
7th IME congress, Lyon (France), June, with talk: “Stochastic Mortality in Life Insurance: Market Reserves and Mortality-Linked Insurance Contracts”.
Nordic Summer School in Insurance Mathematics, Stockholm (Sweden), September, with talk: “Stochastic Mortality in Life Insurance”.
Thomas Mikosch: Participant in the Workshop in Honour of Willem Schaafsma, University of Groningen, January.
Invited lecture at the Department of Mathematics of Chalmers University Gothenburg, January.
Participant in the Workshop on Stochastic Analysis in Finance and Insurance, Oberwolfach (Germany), March.
Conference on Asymptotic Statistics, Barcelona, September, with invited talk: “Regular variation with applications in finance and insurance.”
Lecturer at the Concentrated Advanced MaPhySto Course on Statistical Methods for Financial Risk Management, Copenhagen, May.
Lecturer of the Course on Modelling of Financial Time Series and their Extremes.
Autumn School on Financial Mathematics of the University of Jena, Siegmundsburg, November.

Thomas Møller: Workshop on Stochastic Analysis in Finance and Insurance, Oberwolfach (Germany), March, with talk: “Quadratic hedging and stochastic orders in dynamic reinsurance markets.”
Technical University Munich, May, with guest lecture: “Stochastic orders in dynamic reinsurance markets.”
7th International Congress on Insurance: Mathematics and Economics, Lyon, June, with talk: “Stochastic orders in dynamic reinsurance markets.”
XXXIV ASTIN Colloquium, Berlin, August, with talk: “Stochastic orders in dynamic reinsurance markets.”
The first Nordic summer school in insurance mathematics: New financial products in insurance, Stockholm, September, main lecturer (with M. Steffensen).
Joint AFIR and Swiss Re Seminar, Zürich, October, with invited talk: “Valuation and risk-management for equity-linked policies with asset value guarantee.”

Peter Holm Nielsen: International Symposium on Insurance and Finance, Norwegian School of Economics and Business Administration, Bergen (Norway), April, with talk: “On Optimal Control of Bonus in Life Insurance.”
Ph.D. Workshop in finance, Nyborg (Denmark), May, with talk: “On Optimal Control of Bonus in Life Insurance.”
7th International Congress on Insurance: Mathematics & Economics, Lyon (France), June, with talk: “On Optimal Control of Bonus in Life Insurance.”
Jesper Lund Pedersen: The fourth DYNSTOCH workshop, Helsinki, May.
Two days symposium, Department of Biostatistics, University of Copenhagen, September.

Hanspeter Schmidli: CAF members meeting, Sandbjerg, January, with talk: “Asymptotics of ruin probabilities for risk processes under optimal reinsurance and investment policies: the large claim case.”
Meeting of the ASTIN group of the German Association of Actuaries, Bonn (Germany), April, with invited talk: “Optimierungsprobleme in der Risikotheorie.”
University La Sapienza, Rome (Italy), May, with guest lecture: “Modelling PCS options via individual indices.”
Applied Probability and Advanced Communications Networks, Bedlewo (Poland), May, with invited talk: “On minimising the ruin probability by investment and reinsurance.”
University of Karlsruhe (Germany), July, with guest lecture: “Modelling PCS options via individual indices.”
Amases 27th annual congress, Cagliari (Italy), September, with invited talk: “Control Problems in Risk Theory.”
Annual Meeting of the German Mathematical Association, Rostock (Germany), September, with talk: “Modelling PCS options via individual indices.”
Royal Institute of Technology, Stockholm (Sweden), October, with guest lecture: “On minimising the ruin probability by investment and reinsurance.”
Mini Conference on Stochastic Models in Finance & Insurance, Bonn (Germany), November, with invited talk: “Optimisation Problems in Non-Life Insurance.”
University of Hannover (Germany), November, with guest lecture: “Asymptotics of ruin probabilities for controlled risk processes.”
Applied Probability, Oberwolfach (Germany), December, with talk: “Optimisation Problems in Non-Life Insurance.”

Mogens Steffensen: Den Danske Aktuarforening, Copenhagen, April, with invited talk: “Hvad laver de på universitetet? — og hvad kan det bruges til?”
Scientific Conference on Insurance and Finance, Bonn, April, with invited talk: “On Merton’s Problem for Life Insurers.”
2. Workshop on Dynamic Optimisation Problems in Finance and Insurance, Kaiserslautern, June, with invited talk: “Optimisation in Life Insurance.”
7th International Congress on Insurance: Mathematics and Economics, Lyon, June, with talk: “Quadratic Optimisation of Life Insurance Payment Streams.”
Technical University Munich, July, with guest lecture: “Optimisation in Life insurance.”
University of Ulm, July with guest lecture: “Optimisation in Life Insurance.”
The first Nordic summer school in insurance mathematics: New financial products in insurance, Stockholm, September, main lecturer (with T. Møller).
Daniel Y. Straumann: ETH Zürich (Switzerland), February, with talk: “Quasi-maximum-likelihood estimation in heteroscedastic time series: a stochastic recurrence equations approach.” Annual Meeting of the German Mathematical Association, Rostock (Germany), September, with talk: “Quasi-maximum-likelihood estimation in heteroscedastic time series: a stochastic recurrence equations approach.”

5.2 Professional and administrative activities

Jeffrey Collamore: Co-organiser of MaPhySto/DYNSTOCH Concentrated Advanced Course: Statistical methods for financial risk management, Copenhagen, May. Member of the Danish Actuarial Association. Member of the Institute of Mathematical Statistics.

Mikkel Dahl: Member of the Danish Actuarial Association.

Products in Insurance, at Sastaholm Conference Centre in Taby (Sweden), September.
Member of DYNSTOCH — Statistical Methods for Stochastic Dynamical Systems 2000-2004, a research training network under the FP5 Programme of the European Commission.
Member of MaPhySto, the Danish Research Network for Mathematical Physics and Stochastics.

**Thomas Møller:** Co-organiser MaPhySto/CAF/DYNSTOCH workshop Financial methods in insurance in Copenhagen, February.
Member of the Danish Actuarial Association.

**Peter Holm Nielsen:** Member of the Danish Actuarial Association.

**Jesper Lund Pedersen:** Member of Danish Society for Theoretical Statistics.

**Hanspeter Schmidli:** Head of the Laboratory of Actuarial Mathematics.
Member of the Board of the Institute for Mathematical Sciences (IMF), Copenhagen.
Member of the Board of the Department of Applied Mathematics and Statistics (AMS), Copenhagen.
Member of the Library Committee of the IMF.
Member of the Ph.D. Committee of the IMF.
Member of the Strategy Committee of the IMF.
Head of Selection Committee for Assistant Professorship at FML.
Member and referee of the Ph.D. committee of Agnes Volpi, University of Nancy, France.
Member of the Scientific Programme Committee of the of the 3rd Conference on Actuarial Science and Finance, Samos 2004.
Member of DYNSTOCH — Statistical Methods for Stochastic Dynamical Systems 2000-2004, a research training network under the FP5 Programme of the European Commission.
Member of the Danish Actuarial Association.
Member of the Swiss Association of Actuaries.
Member of the Danish Society for Theoretical Statistics.
Member of the Bernoulli Society for Mathematical Statistics and Probability.
Member of the Institute of Mathematical Statistics.
Member of the ‘Fachgruppe Stochastik’ of the German Mathematical Society.

**Mogens Steffensen:** Co-organiser MaPhySto/CAF/DYNSTOCH workshop Financial methods in insurance in Copenhagen, February.
Referee for Ph.D. Martin Krekel, Fraunhofer ITWM, Kaiserslautern.
Member of the Danish Actuarial Association.
Member of the CPD committee under the Danish Actuarial Association.

**Daniel Y. Straumann:** Member of the Institute of Mathematical Statistics.
Member of the Bernoulli Society for Mathematical Statistics and Probability.
Member of the Swiss Association of Actuaries.

### 5.3 Honours and awards

**Richard A. Davis** (Colorado State University, Ft. Collins) was awarded DKK 120 000 from Villum Kann Rasmussen Fond as a Guest Professor at the Laboratory.

### 5.4 Consulting

Peter Holm Nielsen has done consulting for Edlund A/S.

### 5.5 Referee reports

Members of the Laboratory have refereed or reviewed articles for the following journals:

- Acta Mathematica Sinica
- Advances in Applied Probability/Journal of Applied Probability
- Annals of Applied Probability
- Annals of Probability (2)
- Annals of Statistics (2)
- ASTIN
6 Courses held in 2003

The courses given by the Laboratory comprised:

Compulsory Courses:

Basic Non-Life Insurance Mathematics (FM0-S) by T. Mikosch
Basic Life Insurance Mathematics (FM0-L) by M. Steffensen
Life Insurance Mathematics A (FM1A) by J. Collamore
Life Insurance Mathematics B (FM1B) by P.H. Nielsen
Non-Life Insurance Mathematics A (FM2A) by H. Schmidli
Non-Life Insurance Mathematics B (FM2B) by H. Schmidli
Bachelor Project in Life Insurance Mathematics by T. Dawson
Bachelor Project in Non-Life Insurance Mathematics by E. Brinck and P. Overby
Topics in General Insurance (Insurance Law) by J. Jessen and H. Jönsson
Topics in General Insurance (Accounting) by B.B. Nielsen
Project Course in Mathematical Topics by S. Ryom-Hansen, I. Henningsen and M. Steffensen
Optional Courses:

- *Introduction to Large Deviations* by J. Collamore
- *Approximation and Simulation of Processes and Distributions* by T. Mikosch
- *Hedging in Insurance* by T. Møller
- *Stochastic Control in Non-life Insurance* by H. Schmidli

7 Colloquia at the Laboratory

Organisers: Hanspeter Schmidli and Mogens Steffensen


17th March, Jørgen Aase Nielsen, University of Aarhus: “No Arbitrage Conditions on the Volatility of the Futures Prices”

25th March, Harri Nyrhinen, University of Helsinki: “On perpetuities and associated ruin problems”


13th May, Hansjörg Albrecher, Graz University of Technology: “On extensions to the classical ruin model”

30th September, Per Linnemann, PENSAM: “Værdiansættelse af livsforsikringsforpligtelser”

7th October, Jesper Andreasen, Nordea: “Derivatives – the View from the Trenches”

21st October, Michael Vogt, University of Karlsruhe: “Optimal Dynamic Reinsurance”

25th November, Josef Steinebach, University of Cologne: “On a Change Analysis of Stochastic Processes Based on Weak Invariance Principles”
8  Graduates, Students, and Admission per Year over the last Five Years

<table>
<thead>
<tr>
<th>Year</th>
<th>Graduates</th>
<th>Admissions</th>
<th>Total</th>
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<tbody>
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<td>1999</td>
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<td>2000</td>
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<td>2002</td>
<td>11</td>
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</tr>
<tr>
<td>2003</td>
<td>9</td>
<td>22</td>
<td>110</td>
</tr>
</tbody>
</table>

9  Graduates in 2003 and their Master’s thesis

**Brøndel, Rikke:** Risikominimering og fraktildhedging for unit-link kontrakter (in Danish).

**Buch-Larsen, Tine:** A unified approach to the estimation of financial and actuarial loss distributions.

**Høgh, Nils:** Conscious risk selection using shareholder value as optimality measure.

**Melchior, Peter David:** Optimal allocering og udlodning af overskud i livsforsikring (in Danish).

**Müller, Johannes:** Numerical approximation to strong solutions of stochastic differential equations.

**Nielsen, Anja Lind:** Nyttemaksimering af katastrofeobligationer - en model i to perioder (in Danish).

**Niemann, Simon Riise:** Levy Processes - The Normal Approximation.

**Overby, Pernille:** Quadratic hedging for insurance contracts with financial risk.

**Thomsen, Peter Bøgh:** Sensitivity analysis applied to life insurance.
10  Publications

10.1  Books


10.2  Refereed Articles


10.3 Preprints


10.4 Lecture Notes

**Collamore, J.** *An Introduction to Large Deviations*. FML.


**Mikosch, T.** *Simulation and Approximation of Stochastic Processes and Distributions*. FML.

11 Other Communications