

8. ACTUARIAL SCIENCE & MATHEMATICAL FINANCE

Programmeme director: Prof. dr. ir. M.H. Vellekoop
 Section: Quantitative Economics
 JEL-classification: C, G2
 Starting date: 1989
 Website: www.ase.uva.nl/act

8.1 MEMBERS OF THE RESEARCH GROUP AND RESEARCH IN FTES

<i>Name</i>	<i>Title</i>	<i>Function</i>	<i>Total 2015</i>	<i>Total 2016</i>	<i>Total 2017</i>	<i>Funding</i>
Antonio, K.	dr.	ud	0,10	0,10	0,10	1
Berkum, F. van	msc	phd	0,32	0,24	-	3
Berkum, F. van	msc	ud	-	-	0,11	3
Bilsen, S. van	dr.	ud	0,08	0,25	0,25	1
Bilsen, S. van	dr.	ud	0,10	0,30	0,30	3
Boonen, T.	dr.	ud	0,25	0,50	0,50	1
Boonen, T.	dr.	ud	0,25	-	-	3
Can, U.	dr.	ud	0,50	0,50	0,50	1
Doff, R.R.	dr.	guest	0,00	0,00	0,00	1
Engel, K.	msc	guest	0,00	0,00	0,00	1
Fan, Z.	msc	phd	0,80	0,80	-	3
Gastel, L. van	dr.	ud	0,11	0,11	0,08	3
Goovaerts, M.J.	prof. dr.	guest	0,00	0,00	-	1
Hooijsma, J.	msc	phd	0,40	0,40	0,27	3
Hooijsma, J.	msc	guest	-	-	0,00	1
Janssen, M.J.J.	drs.	guest	0,00	-	-	1
Kaas, R.	prof. dr.	guest	0,00	-	-	1
Kloek, T.G.	msc	guest	0,00	0,00	0,00	1
Kort, J. de	msc	phd	0,40	-	-	3
Kuné, J.B.	prof. dr.	guest	0,00	0,00	0,00	1
Laeven, R.	prof. dr.	hgl	0,70	0,70	-	3
Laeven, R.	prof. dr.	hgl	-	-	0,50	1
Lalu, A.	msc	phd	0,40	-	-	1
Li, Z.	msc	phd	0,27	0,80	0,80	1
Linders, D.	dr.	postdoc	0,12	0,23	-	3
Petrov, M.	msc	guest	0,00	0,00	-	1
Ronner, A.E.	prof. dr.	bijz. hgl	0,10	0,10	0,10	1
Schumacher, J.M.	prof. dr.	guest	-	-	0,00	1
Vellekoop, M.	prof. dr.	hgl	0,35	0,50	0,50	1
Vellekoop, M.	prof. dr.	hgl	0,30	-	-	3
Yang, L.	dr.	ud	-	-	0,17	1
Yang, X.	dr.	postdoc	0,53	-	-	3
Yue, Y.	msc	phd	0,80	0,80	0,80	3
Total 1st flow of funds			2,05	2,75	3,42	
Total 2nd flow of funds			0,00	0,00	0,00	
Total 3rd flow of funds			4,83	3,58	1,19	
Total 1st f.o.f. excl. PhD			1,38	1,95	2,62	
Total 1st-3rd flow of funds			6,88	6,33	4,61	
PhD students			3,39	3,04	1,61	

8.2 PROGRAMME DESIGN

The programme concerns both fundamental and applied research in the field of financial institutions. It is mainly directed at insurance companies (for life, non-life, pension and social insurance), but also at banks and other financial intermediaries. Research is performed on the mathematical modeling, estimation, appraisal and control of financial risks of such financial institutions under complete and incomplete information and for complete and incomplete markets. For long term insurance contracts, especially pensions, saving by insurance is significant, which leads to the study of optimal investment and consumption problems. An increasingly important aspect is the influence of the "risk of longevity" on the policies of life insurance, social insurance and care insurance. Newly reported statistics show that life expectancy continues to rise faster than predicted both in the Netherlands and abroad, and the modeling of this effect and its consequences for life insurance policies and pension contracts therefore remains an important area of investigation. Present-day challenges for non-life insurance contracts include decreasing profit margins, increasing competition and selective behaviour of the insured and of insurance companies. In social insurance, there are specific problems that emerge from the privatisation of social insurance contracts. Apart from studying problems in the separate fields of life, non-life, pension and social insurance, work is also done on the theoretical research subject which concerns the unification of several distinct actuarial theories in these fields, and their connection with stochastic financial mathematics.

Supervision and regulation of insurance companies and pension funds form an important part of the field of actuarial research. Methods for risk measurement and the determination of solvency requirements have come under intensified scrutiny in the wake of the recent financial crisis. The new European regulatory framework Solvency II for insurers and the Dutch FTK regulation for pension funds lead to many important new research questions. The Actuarial Science group therefore works on the further development of actuarial risk theory, in particular the development of new mathematical and economic models in the fields of market-consistent valuation, market-consistent pricing and market-consistent embedded value for insurance portfolios.

Other significant fields of research are the interaction between credibility theory, models for the estimation of unreported claims (IBNR) and actuarial ordering of risks, and their consequences for the determination of insurance premiums (risk classification). Credibility models can be viewed as Generalized Linear Mixed Models, having both random (subject-specific) and fixed effects in the linear predictor. Generalized Linear Models and Generalized Linear Mixed Models can be used for a variety of actuarial statistical problems like survival modelling, graduation, multiple-state models, loss distributions, risk classification, premium rating and claims reserving in non-life-insurance. Other aspects are the homogeneity and heterogeneity of insurance portfolios, the probabilistic and subsidising solidarity imposed on the insured, the voluntary or compulsory character of the insurance, and the auto-selection and anti-selection of those insured.

8.3 PROGRAMME EVALUATION

In 2017 a number of PhD projects were successfully concluded: Marko Petrov finished his research on derivatives pricing in a joint Erasmus Mundi project with Universidade Nova de Lisboa and Frank van Berkum submitted his thesis on the statistics of human mortality modelling. We are happy that Frank will remain affiliated with our group for one day a week to continue his research with Katrien Antonio and Michel Vellekoop. Ms. Lu Yang was appointed on a tenure track position after we visited the job market in Chicago at the beginning of 2017. Her research on copula models for insurance experience rating has already been published in the Journal of the American Statistical Association this year, confirming that top journals in statistics and mathematics appreciate actuarial applications when these require the derivation of new mathematical results. We continue to be highly visible in the top actuarial journals as well, with publications in ASTIN Bulletin by Antonio, van

Berkum and Vellekoop (on Bayesian estimation for survival models), and publications in Scandinavian Actuarial Journal and Insurance: Mathematics & Economics by Boonen (on the optimal use of reinsurance, on intergenerational risk sharing, on capital allocation problems and on risk sharing / redistribution with dual utilities) and by Antonio (on censored loss modelling).

Results were disseminated at numerous conferences but also during longer research stays abroad: Katrien Antonio visited the University of Lausanne, Tim Boonen the University of Waterloo, Roger Laeven the Bendheim Center for Finance in Princeton, Yue Yuan the École Polytechnique and Merrick Zhen Li the University of Cambridge. Our visibility in the international arena was further enhanced by the appointment of Roger Laeven on the editorial board of Insurance: Mathematics and Economics.

Although the focus in our research group is on theoretical results, we engage actively with both Dutch and international professionals working in the financial industry or in pension funds and insurance companies. Roger Laeven is the Selected Academic Member of the Insurance and Reinsurance Stakeholder Group (IRSG) of the European Insurance and Occupational Pensions Authority (EIOPA), and Frank van Berkum and Michel Vellekoop are members of the official body of the Dutch Actuarial Society (KAG) that is responsible for the new stochastic mortality model on which the official KAG mortality prognosis for Dutch pension funds and insurance companies is based. Servaas van Bilsen now coordinates the research seminars of Netspar, the Network for Studies on Pensions, Ageing and Retirement, in which Dutch policymakers and representatives from universities cooperate in research programmes which often lead to policy proposals for the Dutch system of retirement provisions. A research proposal about predictive analytics for non-life insurance (written in cooperation with Peter Boswijk and Noud van Giersbergen from the Econometrics Research Group) has resulted in a new PhD position in the section.

Strengths: The composition of our tenure tracks reflects the broad research profile of the group. We therefore expect to continue to play an important role in the national and international research networks which study problems in actuarial science and mathematical finance.

Weaknesses: The group has many junior researchers and only a few senior researchers.

Opportunities: Our statistical expertise makes us a natural partner for other academics and professionals in insurance companies and pension funds who are intensifying their use of data science.

Threats: The number of Bachelor and Master theses that need to be supervised will grow in the coming years, which will put extra strain on all staff members in the group.

8.4 RESOURCES AND FUNDING

- 2013-: EDEEM PhD Research Grant, jointly with Universidade Nova de Lisboa (Position of Marko Petrov).
- 2017-2021: Sponsoring of research project “Risk and Regulation” (in the chair of Risk and Insurance), Verbond van Verzekeraars.
- 2017- : VIVAT PhD Research Grant, jointly with Econometrics Group.

8.5 OUTPUT

Key publications

Aït-Sahalia, Y., J. Fan, R. J. A. Laeven, C. Dan Wang & X. Yang (2017). Estimation of the continuous and discontinuous leverage effects. Journal of the American Statistical Association 112 (520), 1744-1758.

van Berkum, F., Antonio, K., & Vellekoop, M. (2017). A Bayesian joint model for population and portfolio-specific mortality. *ASTIN Bulletin*, 47(3), 681-713.

Boonen, T. J., Tsanakas, A., & Wüthrich, M. V. (2017). Capital allocation for portfolios with non-linear risk aggregation. *Insurance: Mathematics & Economics*, 72, 95-106.

Can, S. U., Einmahl, J. H. J., Khmaladze, E. V., & Laeven, R. J. A. (2015). Asymptotically distribution-free goodness-of-fit testing for tail copulas. *The Annals of Statistics*, 43(2), 878-902.

Laeven, R. J. A. & M. A. Stajje (2014). Robust portfolio choice and indifference valuation. *Mathematics of Operations Research* 39, 1109-1141.

Forthcoming

Asimit, A. V., & Boonen, T. J. Insurance with multiple insurers: A game-theoretic approach. *European Journal of Operational Research*.

Boonen, T. J., Pantelous, A. A., & Wu, R. (2018). Non-cooperative dynamic games for general insurance markets. *Insurance: Mathematics & Economics*.

Boswijk, H. Peter, Roger J. A. Laeven & Xiye Yang. Testing for self-excitation in jumps, *Journal of Econometrics*.

Krätschmer, V., M. Ladkau, R. J. A. Laeven, J. G. M. Schoenmakers & M. Stajje. Optimal stopping under uncertainty in drift and jump intensity, *Mathematics of Operations Research*.

Shi, P., & Yang, L. (2017). Pair Copula Constructions for Insurance Experience Rating. *Journal of the American Statistical Association*.

E-publication ahead of print

Kaas, R., Laeven, R. J. A., Lin, S., Tang, Q., Willmot, G., & Yang, H. (2017). IME’s Editorial Board. *Insurance: Mathematics & Economics*.

Shi, P., & Yang, L. (2017). Pair Copula Constructions for Insurance Experience Rating. *Journal of the American Statistical Association*.

Stripling, E., Vanden broucke, S., Antonio, K., Snoeck, M., & Baesens, B. (2017). Profit maximizing logistic model for customer churn prediction using genetic algorithms. *Swarm and Evolutionary Computation*.

Publications in numbers

Output type	Classification	#
Articles in journals	Refereed	16
	Non-refereed	0
	Professional	1
	Popular	0
Books or book chapters	Refereed	0
	Non-refereed	0
	Professional	0
	Popular	0
Report	Professional	1
Conference proceedings		0
PhD theses		2
Total		20

Article in journal – refereed

- Aït-Sahalia, Y., Fan, J., Laeven, R. J. A., Wang, C. D., & Yang, X. (2017). Estimation of the Continuous and Discontinuous Leverage Effects. *Journal of the American Statistical Association*.
- Antonio, K., Devriendt, S., de Boer, W., de Vries, R., De Waegenaere, A., Kan, H. K., ... Vellekoop, M. (2017). Producing the Dutch and Belgian mortality projections: a stochastic multi-population standard. *European Actuarial Journal*, 7(2), 297-336.
- Bao, H., Ponds, E. H. M., & Schumacher, J. M. (2017). Multi-period risk sharing under financial fairness. *Insurance: Mathematics & Economics*, 72, 49-66.
- Berkum, F. van, Antonio, K., & Vellekoop, M. (2017). A Bayesian joint model for population and portfolio-specific mortality. *ASTIN Bulletin*, 47(3), 681-713.
- Boonen, T. J. (2017). Risk redistribution games with dual utilities. *ASTIN Bulletin*, 47(1), 303-329.
- Boonen, T. J., Tsanakas, A., & Wüthrich, M. V. (2017). Capital allocation for portfolios with non-linear risk aggregation. *Insurance: Mathematics & Economics*, 72, 95-106.
- Boonen, T. J., De Waegenaere, A., & Norde, H. (2017). Redistribution of longevity risk: The effect of heterogeneous mortality beliefs. *Insurance: Mathematics & Economics*, 72, 175-188.
- Boonen, T. J., & De Waegenaere, A. (2017). Intergenerational risk sharing in closing pension funds. *Insurance: Mathematics & Economics*, 74, 20-30.
- Boonen, T. J. (2017). Risk sharing with expected and dual utilities. *ASTIN Bulletin*, 47(2), 391-415.
- Boonen, T. J., & Li, H. (2017). Modeling and forecasting mortality with economic growth: a multipopulation approach. *Demography*, 54(5), 1921-1946.
- Boonen, T. J. (2017). Solvency II Solvency Capital Requirement for life insurance companies based on Expected Shortfall. *European Actuarial Journal*, 7(2), 405-434.
- Chen, A., Vellekoop, M., Optimal investment and consumption when allowing terminal debt, *European Journal of Operational Research*, 258, 1.
- Dhaene, J., Godecharle, E., Antonio, K., Denuit, M., & Hanbali, H. (2017). Lifelong health insurance covers with surrender values: updating mechanisms in the presence of medical inflation. *ASTIN Bulletin*, 47(3), 803-836.
- Kleinow, T., & Schumacher, J. M. (2017). Financial fairness and conditional indexation. *Scandinavian Actuarial Journal*, 2017(8), 651-669.
- Reynkens, T., Verbelen, R., Beirlant, J., & Antonio, K. (2017). Modelling censored losses using splicing: a global fit strategy with mixed Erlang and extreme value distributions. *Insurance: Mathematics & Economics*, 77, 65-77.
- Zhuang, S. C., Boonen, T. J., Tan, K. S., & Xu, Z. Q. (2017). Optimal insurance in the presence of reinsurance. *Scandinavian Actuarial Journal*, 2017(6), 535-554.

Article in journal – professional

- Kort, J. de, & Vellekoop, M. H. (2017). Existence of optimal consumption strategies in markets with longevity risk. *Insurance: Mathematics & Economics*, 72, 107-121.

Report - professional

- Boonen, T. (2017). *Expected Shortfall voor toezicht op verzekeraars: is het relevant?* (Netspar Design Paper; Vol. 80). Tilburg: Netspar.

Dissertation – internally prepared

- Kort, J.P. de (2017). Essays on long-term mortality and interest rate risk.
- Fan, Z. (2017). Essays on international portfolio choice and asset pricing under financial contagion.

Talk or presentation

Berkum, F. van (Speaker), Unraveling relevant risk factors explaining pension fund mortality: a case study in the Netherlands, Netspar Pension Day, 2017.

Can, U. (Speaker), Asymptotically Distribution-Free Goodness-of-Fit Testing for Copulas, 10th International Conference on Extreme Value Analysis, Delft, 30 June 2017.