

## ACQuFRR Report for 2017

Part of the purpose of ACQuFRR is to integrate postgraduate teaching and research in quantitative and mathematical finance and some of its allied disciplines in the Faculty of Commerce at UCT. ACQuFRR mainly houses the research students and academic members of the African Institute of Financial Markets and Risk Management ([AIFMRM](#)). Our [website](#) contains comprehensive information about our activities, events, projects, and interests; as well as details of our Executive, Research Associates, Postdoctoral Research Fellows and Postgraduate Students. ACQuFRR received full accreditation by the University Research Committee in February 2016.

The unit also coordinates the minor research dissertations for the MPhil in Mathematical Finance and the projects for Research Master's and PhD students in quantitative finance and areas of economic risk, which includes AIFMRM PhD and Postdoctoral Research Fellows. ACQuFRR provides a forum for collaboration and discussion between its academic members, students, and industry associates, visiting academics, and collaborators through weekly seminars and a series of special seminars.

### Publications

In addition to various conference presentations and seminars, ACQuFRR produced five research publications this year. The titles and publication details appear on our [website](#).

### Seminars, Workshops & Conferences

Hosting and attending research events forms part of the ongoing activities of a research unit. However, the industry alignment of ACQuFRR means that we have an obligation to offer our research and discussion to a wider audience. These events help to create awareness of the unit and to publicise its contribution to the broader conversation.

ACQuFRR held a [weekly seminar series](#) throughout 2017 during term-time. The MPhil in Mathematical Finance and the PhD students and Postdoctoral Research Fellows affiliated with the unit and AIFMRM are required to attend these. We also invite Johannesburg and Cape Town-based practitioners. The series brings together research-minded academics in AIFMRM, Finance and Actuarial Science with students and industry participants. Students are also expected to present dissertation and thesis work in this forum. We often wrap seminars from visitors into this series.

ACQuFRR hosted two [special seminars](#) outside of the above series in 2017.

**Periklis Thivaos and Dimitri Anagnostopoulos** from **True North Partners** presented a seminar entitled *What is FinTech and does it matter?*, which addressed recent developments in financial technology (fintech) and critically analysed the opportunities as well as the risks associated with its use. The focus of the discussion was on blockchain technologies and big data, two of the most prevalent and misunderstood developments in the field. Students were presented the two technologies, uses and technical challenges, and were encouraged to critically evaluate their applicability and value to banking operations.

**Jakob Foerster** from the **University of Oxford** presented a seminar entitled, "*Learning to Communicate with Deep Multi-Agent Reinforcement Learning*" where he discussed the problem of multiple agents sensing and acting in environments with the goal of maximising their shared utility. In these environments, agents must learn communication protocols in order to share information needed to solve the tasks. By embracing deep neural networks, we are able to demonstrate end-to-end learning of protocols in complex environments inspired by communication riddles and multi-agent computer vision problems with partial observability. We propose two approaches for learning in these domains: Reinforced Inter-Agent Learning (RIAL) and Differentiable Inter-Agent Learning (DIAL). The former uses deep Q-learning, while the latter exploits the fact that, during learning, agents can back propagate error derivatives through (noisy) communication channels. Hence, this approach uses centralised learning but decentralised execution. Our experiments introduce new environments for studying the learning of communication protocols and present a set of engineering innovations that are essential for success in these domains.

One of our industry partners, Avior Capital Markets, collaborates with ACQuFRR in hosting **research seminars for their industry clients**. We co-organised two of these in 2016.

**Prof Matheus Grasselli** from McMaster University presented two seminars on *Understanding Financial Crises - a statistical perspective* and *Asset Price Bubbles: economics, mathematics and statistics*. The first seminar focussed on the description of the main statistical properties of financial crises, including their frequency, duration, and correlation with key economic variables such as capital flows. One application of this type of analysis is the construction of an early warning system for financial crises based on economic indicators, with the goal to help regulators and investors. This was also the topic of the problem mentored by Prof Grasselli during the Financial Mathematics Team Challenge that was taking place in July at UCT, and Avior delegates were given a sneak preview of the results obtained by the team.

In the second seminar gave an overview of well-known economic models for asset price bubbles, including rational bubbles and bubbles that arise from deviations from rationality such as investor overconfidence. The seminar also covered the recent mathematical models of bubbles as strict local martingales, as well as a review of the statistical tests that can be used to detect the presence of a bubble in a given market. Towards the end of the seminar, Prof Grasselli discussed the theoretical and practical limitations of these models and introduced an alternative approached based on endogenous money and the dynamics of credit available for speculation.

Together with Prof Doyne Farmer and his team at Oxford University, AIFMRM organized a **two-day workshop** on "Systemic Stress Testing using Agent-Based Modelling". The workshop entailed 12 presentations by students from both AIFMRM and the Institute for New Economic Thinking at Oxford University. The UCT team consisted of Ms Tina Koziol, Mrs Esti Kemp, Mr Allan Davids, as well as Dr Co-Pierre Georg. Following this workshop, both Allan Davids and Esti Kemp spent a month at Oxford working closely with the team there to increase our research output. The workshop also resulted in a joint research proposal from both teams to the NRF to develop an agent-based model of the housing sector in Cape Town to help detect emerging bubbles.

On 24 and 25 June 2017, AIFMRM Postdoctoral Fellow Christine Makanza and Dr Co-Pierre Georg organized a **one-and-a-half-day workshop** at Mont Fleur about their ongoing book project called 'The Promise of the Rainbow', in which they set out to develop a new economic agenda designed for young people, by young people. The workshop was quite extraordinary in that it brought together economists, lawyers, environmental and social activists from all areas of society to discuss how a more inclusive and prosperous economy of the future can look like. While the book is a long-term project, the workshop spurred some exciting ideas and most interesting discussions.

ACQuFRR is involved in the annual **Summer School in Mathematical Finance** held at the African Institute for Mathematical Sciences (AIMS) in Muizenberg. This year saw the [tenth anniversary edition](#) of the Summer School. The Director of ACQuFRR plays a key role in inviting the three speakers for this event and uses this opportunity to create and strengthen ties with leading international academic figures.

2017's Summer School was a week-long celebration with an extended [programme](#). Not only did we host three, top-quality international speakers, but we also held two-and-a-half days of talks from local academics/practitioners and graduate students. Our presenters this year were Prof Erik Schlögl (UTS, Australia), Dr Joerg Kienitz (UCT and Quaternion, Germany) and Prof Tom Hurd (McMaster University, Canada).

ACQuFRR research students are encouraged to attend the Summer School. The Summer School is free for full-time students at South African universities and AIMS. There were 55 students, academics and practitioners registered this year.

### **The Fourth Financial Mathematics Team Challenge**

One of the key aims of the Financial Mathematics Team Challenge (FMTC) is for South African postgraduate students in Financial and Insurance Mathematics to have the opportunity to focus on a topical, industry-relevant research project, while simultaneously developing links with international students and academics in the field. An allied purpose is to bring a variety of international researchers to South Africa to give them a glimpse of the dynamic environment that is developing at UCT in the African Institute of Financial Markets and Risk Management. The primary goal, however, is for students to learn to work in diverse teams and to be exposed to a healthy dose of fair competition.

The Fourth FMTC was held from the 18<sup>th</sup> to the 29<sup>th</sup> of July 2017. The challenge brought together five teams of Master's and PhD students from UCT, University College London, Freiburg University and the University of Technology Sydney to pursue intensive research in Financial Mathematics. Each team worked on an independent research problem during the

twelve days. Professional and academic experts from UCT, University of Technology Sydney, ETH Zürich, University of Vienna, McMaster University and Fundação Getulio Vargas individually mentored the teams, fostering teamwork and providing guidance. Glen Point Capital LLP, a London-based macro hedge fund, contributed one of the research problems and partial sponsorship for the 2017 challenge. As they have in the past, the students applied themselves with remarkable commitment and energy, and the teams produced outstanding research under extreme time pressure.

This year's research included topical projects on Realistic Risk Parity, An Early Warning System for Financial Crises and Long-term Asset Management, Model Calibration with Neural Nets, Managing Estimation Risk in Mean-Variance Portfolio Optimisation, and Rough Volatility. These were either directly proposed by our industry partners or chosen from areas of current relevance to the finance and insurance industry. In order to prepare the teams, guidance and preliminary reading was given to them a month before the meeting in Cape Town. During the final two days of the challenge, the teams presented their conclusions and solutions in extended seminar talks. The team whose research findings were adjudged to be the best was awarded a floating trophy.

Each team wrote a report containing a critical analysis of their research problem and the results that they obtained. These are collated in one volume that is [available](#) to future FMTC participants. It may also be of use and inspiration to Master's and PhD students in Financial and Insurance Mathematics. FMTC IV was a great success, so 2018 and FMTC V is already in the pipeline!

### Postdoctoral Research Fellows

ACQuFRR/AIFMRM has three, full-time, postdoctoral research fellows – Dr Suraj Shekar, Dr Daniel Opolot, and Dr Christine Makanza.

**Dr Shekhar's** research includes both theoretical and empirical Microeconomics. He has co-authored a paper on the importance of academic networks for student placement with a PhD student from AIFMRM (Michael Rose). His other internal collaboration involves a paper highlighting a new channel through which increased regulatory activity can be welfare reducing (with Co-Pierre Georg). Additionally, he has new research projects which study Self Help Groups in India (empirical, with Souvik Dutta and Abhirup Sarkar), and one on the impact of a spinoff on the parent firm (theoretical). While at AIFMRM, Dr Shekhar submitted his theoretical work on the US audit market and his work on ethnic conflicts for publication. Another paper of his (Signalling, Reputation and Spinoffs) received a revise and resubmit request from the Journal of Economic Behavior and Organization. Dr Shekhar presented his research at two international conferences in 2017 - the European Economic Association Meetings at the University of Lisbon, and the European Association for Research in Industrial Economics (EARIE) meetings at Maastricht University.

In 2017, **Daniel Opolot** worked on two research projects that culminated in two papers. The first paper is "Informal Intellectual Collaboration with Central Colleagues" (with Co-Pierre George and Michael Rose; Kiel Working Paper 2084, 2017). This project examines how the structure of intellectual collaboration among scientists influences the quality of research output. They find that collaborating with fellow scientists who are more central in the network of intellectual collaboration has a positive influence on the quality of one's research output. Their findings imply that research collaboration facilitates information spillover and that the

process of scientific research exhibits complementarities in research efforts. The second paper is “disagreement in naïve learning” (ready for journal submission). Here, Daniel examines the extent of disagreement in models of social learning where individuals’ average others’ beliefs or behaviour to develop their own. He shows that the main driving forces of disagreement are group cohesion in the society and the intensity of prejudices that individuals may hold about issues. Daniel has presented his research in external seminars: RUBEN Seminars at School of Economics - University of Cape Town; Stellenbosch University - Department of Economics; School of Economics - University of Cape Town; University of Pretoria - Department of Economics.

**Dr Makanza** worked with Co-Pierre Georg on a book that analyses how economic policy can improve socio-economic outcomes for South Africa's youth. The book pays emphasis to developing a future-proof South African economy by analysing the sectors in which future jobs are likely to be given the evolving global landscape, and the skills that young people need to be equipped with to ensure that they are employable. The book also focuses on how economic policy can be tailored to reduce inequality, steer economic growth, and support economic inclusion for young people. This is done through proposing a new deal that identifies flagship programs essential in taking the economy forward. Dr Makanza's research also concentrates on the formulation of prudent macroeconomic policy in developing and emerging countries. She considers the role of macroeconomic policy in achieving current account sustainability in deficit countries, the role of evolving capital flows in credit creation, and the relevance of the housing market in driving external imbalance. Her other research interests include international macroeconomics, dynamic stochastic general equilibrium modelling and applied time series analysis. She was a speaker at the 2017 Africa Meeting of the Econometric Society hosted by the Bank of Algeria, and the 2017 Biennial Conference of the Economic Society of South Africa hosted by Rhodes University.

## PhD Students

ACQuFRR has twelve full-time and part-time PhD students – Mr Obeid Mahomed, Mr Alex Backwell, Mr Ralph Rudd, Mr Michael Kateregga, Mr Mario Giuricich, Mr Michael Rose, Miss Tina Koziol, Mr Allan Davids, Mrs Esti Kemp, Ms Chernay Johnson, Mr Qobolwakhe Dube and Ms Nolwazi Hlophe.

**Mr Mahomed** was appointed as a full-time lecturer in AIFMRM in January 2015, and lectures on both the MPhil and MCom degrees. He registered as a full-time PhD student in 2015, having upgraded his Master's degree in 2014. His thesis is entitled Alternative Asset Pricing: Information and Calibration, and he is co-supervised by Associate Profs David Taylor and Thomas McWalter. His research has resulted in three potential research papers: Across Curve Pricing; Information-Based Pricing Kernels & Numeraire Portfolios; and Asset Pricing in Emerging Markets. The results from these papers will constitute his thesis. During 2017 he assisted in various consulting projects, undertaken by AIFMRM, and also created AIFMRM's Equity Risk Service. This is a continuation of a service previously offered by BNP Paribas Securities South Africa (Pty) Ltd since 1989, which provides up-to-date risk measures and associated statistics for JSE-listed stocks and indices.

**Mr Backwell** is in the final stages of his PhD, having just completed his fourth year. He is supervised by Associate Profs David Taylor and Peter Ouwehand and Adjunct Associate Prof Andrea Macrina. His research interest is term structure modelling, and more particularly the effect of stochastic volatility on the hedging of interest-rate derivatives. His empirical work

regarding term structure stochastic volatility has been presented several times, most notably in New York City at the 9th World Congress of the Bachelier Finance Society. Other theoretical results, developed during 2016 and 2017, were presented at the 6th Mathematics in Finance Conference in the Kruger Park, and are currently being finalised. He has been involved in teaching – both assisting in the MPhil in Mathematical Finance and lecturing undergraduates in Actuarial Science – and the supervision of several minor dissertations. He is financially supported by ACQuFRR, UCT and the NRF.

**Mr Rudd** graduated from the MPhil in Mathematical Finance in 2013 and commenced his PhD in 2014. He is co-supervised by Adjunct Associate Profs Thomas McWalter (UCT) and Jörg Kienitz (Quaternion Risk Management, University of Wuppertal and UCT) and Honorary Prof Eckhard Platen (University of Technology Sydney (UTS) and UCT). In 2016, Mr Rudd presented the first part of his thesis work at the 9th World Congress of the Bachelier Finance Society in New York. He then led his team to victory at the third annual Financial Mathematics Team Challenge (FMTC) under the supervision of Prof Eric Schlögl from UTS. The project concerned determining an optimal calibration frequency using a model risk criterion. In 2017, he presented the further developments of his thesis work at the Global Derivatives Trading and Risk Management conference in Barcelona as well as at the 13th WBS Fixed Income Conference in Florence. He also became the first team leader to win two FMTC trophies. The project investigated the efficiency and stability of risk parity portfolios and was supervised by Prof Rodrigo Targino from the Getulio Vargas Foundation in Brazil. Mr Rudd lectured the Mathematical Computing Skills pre-course for the MPhil in Mathematical Finance in 2015, 2016 and 2017. He was involved in tutoring the Numerical Methods in Finance courses and is currently supervising two minor dissertations. He has been financially supported by ACQuFRR, BANKSETA, and RMB.

**Mr Kateregga** Michael is a fourth year doctoral student in the Department of Actuarial Science with research interests in the broad class of Stable Distributions. He successfully completed his PhD thesis in October 2017, and he will be graduating on the 20th of December, 2017. His PhD thesis, co-supervised by Dr Sure Mataramvura and Prof David Taylor, focused on the application of stable distributions to model financial markets. His PhD research work resulted in two publications in the Cogent Journal of Economics and Finance, the third article is still under review in the International Journal of Theoretical and Applied Finance. Michael has presented some of his results at international conferences including the Quantitative Finance and Risk Analysis Conference in Santorini, Greece in June, 2015, the World Congress in Probability and Statistics in Toronto, Canada and at the International Imaginary Conference in Berlin, Germany on the efficient and innovative ways to communicate mathematics to society, in July, 2016. Michael's PhD research was funded by ACQuFRR, the African Institute for Mathematical Sciences (AIMS) and the NRF through the University of Cape Town Postgraduate Funding Office. Michael is now a full-time Software Engineer at Mira Networks in Cape Town, South Africa.

**Mr Giuricich** has successfully completed the third year of his PhD. He is co-supervised by Associate Professor Peter Ouwehand, Professor Krzysztof Burnecki (Wroclaw University of Technology, Poland) and Professor Eckhard Platen (University of Technology Sydney, Australia). His first paper, "Modelling left-truncated heavy-tailed data with application to catastrophe bond pricing" was accepted by the journal, Physica A: Statistical Mechanics and its Applications, subject to revision. His second paper, entitled "Weak Approximations at work in Catastrophe Bond Pricing" has also been completed and is being submitted to the Risks journal. However, the highlight of all his work this year concerned the idea for his third journal

paper: it was decided to introduce a new catastrophe-risk securitisation based on the traditional contingent convertible bonds issued by banks. Much research has been done on this new topic, and a partial draft paper has just been completed. He is currently collaborating on this work not only with his supervisors but also with Professor Zbigniew Palmowski from the Wroclaw University of Technology. This novel and exciting work is planned to be completed by January 2018. He is currently supported by ACQuFRR and BANKSETA.

**Mr Rose** joined ACQuFRR in April 2015. He holds an MSc in Quantitative Economics from Kiel University and visited the Kiel Institute for the World Economy's Advanced Studies Program before joining UCT. Under the supervision of Dr Georg, he works on Peer Effects in Financial Networks. In 2017, he has presented his work at UCT's School of Economics, Stellenbosch University, and Harvard Kennedy School as well as two international conferences: the Economics of Scientific Research at Erasmus University Rotterdam (Netherlands), and the 17th REER conference at Georgia Tech's Scheller College of Business (USA). He attended the Summer School on Economic Networks at the University of Oxford. Starting in August, he is currently visiting Scheller College of Business to conduct research on the Economics of Science with his colleague Alex Oettl. For this research stay, he won a Murray-Jelks Scholarship for International Travel from UCT. In 2018, his PhD studies will come to an end, and Mr Rose will enter the Economists Job Market. He is financially supported by ACQuFRR and AIFMRM.

**Miss Koziol** works under the supervision of Dr Co-Pierre Georg on projects in empirical banking and computational finance. She presented her research on resilience in the South African banking sector at the INET/UCT workshop on "Agent-Based Modelling for Systemic Stress Testing" in Oxford in March 2017. She also presented at the workshop on financial stability research organised by the South African Reserve Bank in October 2017. From July to September 2017, Tina worked as PhD intern in the financial stability research department at the Bank of England, London. She pursues a PhD in Economics and is in her second year of study. She is financially supported by ACQuFRR.

**Mr Davids** joined ACQuFRR in August 2016. He holds an MCom (Cum Laude) in Economics from Stellenbosch University. After a spell in industry as a data scientist, Allan decided to pursue his PhD full-time under the supervision of Dr Co-Pierre Georg, with a focus on household and consumer finance in South Africa. During 2017, Allan has spent time abroad as a visiting researcher at the Institute for New Economic Thinking at the University of Oxford and the Stern School of Business at New York University. Allan is financially supported by the Volkswagen Institute and ACQuFRR.

**Mrs Kemp** joined ACQuFRR in April 2016. She holds an MCom in Econometrics from the University of Pretoria and is currently an employee in the Financial Stability Department of the South Africa Reserve Bank. Under the supervision of Dr Georg, she works on Shadow banking in South Africa. She has presented her work at UCT's School of Economics, as well as the Southern African Finance Association Conference. She is financially supported by ACQuFRR.

**Ms Johnson** joined ACQuFRR in February this year as a PhD student majoring in Quantitative Finance and is jointly enrolled with Macquarie University under a cotutelle PhD arrangement. She holds a Master of Economic Science from the University of the Witwatersrand. Under the supervision of Dr Georg, she works on research related to optimising the microstructure of South African equity markets and collaborates closely with

industry partners such as the Johannesburg Stock Exchange and Capital Markets Cooperative Research Centre. She is supported financially by ACQuFRR and AIFMRM.

**Mr Dube** joined ACQuFRR in February this year. He holds an MCom in Risk Management of Financial Markets from UCT. Under the supervision of Dr Georg, he has been working on financial technology, examining the potential impact of blockchain technology on market microstructure. His research is being conducted in collaboration with the Capital Markets Cooperative Research Centre in Sydney, Australia.

**Ms Hlophe** joined ACQuFRR in March this year. She holds an MCom in Economics from the University of Pretoria and is currently an employee in the Financial Stability Unit of the Central Bank of Swaziland. Under the supervision of Dr Georg, she works on Shadow Banking and the Future of Financial Intermediation. She is financially supported by ACQuFRR.

All of our Master's and PhD students are housed in the RMB Loft on the 6<sup>th</sup> floor of the Leslie Commerce Building at UCT.

## Research Funding

Beneficiary	Source	Value
ACQuFRR	AIFMRM Annual Funding	R400,000
ACQuFRR	NWU-DST-ABSA Directed Risk Research	R152,000
ACQuFRR	AVIOR	R 12,000

## Visitors

Mr Jakob Foerster is a PhD student at Oxford University and a Research Associate at Google DeepMind. He worked on a joint research project with Dr Co-Pierre Georg on "Fake News in Social Networks" which was recently released as a working paper. Mr. Foerster visited from 22 March - 4 April.

Honorary Professors Eckhard Platen and Peter Ritchken spend an extended period with us every year, usually in January, February and March.

## Adjunct and Honorary Positions

One of the ways to strengthen quantitative finance at UCT is through appointing adjunct staff. This is a process where candidates are nominated and selected in a rigorous fashion for (usually unpaid) academic posts that hold all the benefits of rank. Payment and support of adjunct staff is normally funded through external sources. Adjunct staff are allowed to access UCT research funding and often perform the usual duties of a member of staff including research supervision and teaching.



Dr Tom McWalter, Dr Jörg Kienitz, Dr Daniel Polakow, Mrs Tanja Tippett and Dr Andrea Macrina are all Adjunct Associate Professors in AIFMRM and carry the title of Associate Professor while they are working at UCT. Prof Eckhard Platen and Prof Peter Ritchken are Honorary Professors.

Quantitative finance and risk research at UCT is in a strong position. The MPhil in Mathematical Finance and the MCom in Risk Management of Financial Markets attract some outstanding students each year, bearing testament to our reputation for quality and rigour.

The addition of new staff members through honorary, adjunct and full-time appointments in AIFMRM, and the variety of visitors that we host augments the profile of the area in the university and (South) Africa and inspires the students. We have a strong presence on the Commerce Faculty Facebook [page](#). Additional staff and research students help create a “critical mass” that allows the programme to expand and flourish in its activities.

A handwritten signature in black ink, appearing to read 'D. R. Taylor', with a horizontal line above it.

A/Prof David R Taylor, Director – ACQuFRR

24 November 2016