Johannes Muhle-Karbe

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Research Interests

Mathematical Finance; Stochastic Processes; Stochastic Optimization.

Employment and Education

Chair in Mathematical Finance, Imperial College London, from January 2019.

Director, CFM-Imperial Institute of Quantitative Finance, from January 2019.

Associate Professor (with tenure), Carnegie Mellon University, since September 2017.
On leave from January 2019.

Associate Professor (with tenure), University of Michigan, January 2016 to August 2017.

Assistant Professor, ETH Zürich, October 2010 to December 2015.

Member, Swiss Finance Institute, June 2012 to December 2015.

Postdoctoral Reseach Fellow, Universität Wien, October 2009 to September 2010.

Teaching Assistant, TU München, October 2006 to September 2009.

Ph.D. in Mathematics, TU München, April 2009. Advisor: Jan Kallsen. With distinction.

Diploma in Mathematics, TU München, September 2006. With distinction.

Abitur, Martin-Luther-Schule Marburg, May 2000. With distinction.

Visiting Positions

Professeur Invité, Université Paris Dauphine, May 2017.

Simons Visiting Professor, ETH Zürich and MF Oberwolfach, February 2017.

Visiting Professor Forschungsinstitut Mathematik, ETH Zürich, July to August 2016, 2017, 2018.

Visiting Professor, University of Technology Sydney, June 2012.

Visiting Scholar, Columbia University, June 2011 to August 2011.

Grants and Awards

Project *Financial Markets with Small Frictions: From Individual Investors Towards Equilibria* (PI, CHF 203,637), 2014-2016, funded by the Swiss National Science Foundation.

Nicola Bruti Liberati Visiting Fellowship 2012.

Ph.D. thesis *On Utility-Based Investment, Pricing and Hedging in Incomplete Markets* awarded the Förderpreis of the Fachgruppe Stochastik of the German Mathematical Society in 2010, and the inaugural Nicola Bruti Liberati Prize of the Bachelier Finance Society in 2012.

Diploma thesis *Portfoliooptimierung in Modellen mit stochastischer Volatilität* awarded a main prize at the 2007 student conference of the German Mathematical Society.

Publications

1. Switching cost models as hypothesis tests (with Samuel N. Cohen, Timo Henckel, Gordon D. Menzies, and Daniel J. Zizzo), *Economics Letters*, to appear.

2. Portfolio choice with small temporary and transient price impact (with Ibrahim Ekren), *Mathematical Finance*, to appear.

3. Sensitivity of optimal consumption streams (with Martin Herdegen), *Stochastic Processes and their Applications*, to appear.

4. Who should sell stocks? (with Paolo Guasoni and Ren Liu), *Mathematical Finance*, to appear.

5. Equilibrium returns with transaction costs (with Bruno Bouchard, Masaaki Fukasawa, and Martin Herdegen), *Finance and Stochastics*, **22**(3): 569–601, 2018.

6. Information and inventories in high-frequency trading (with Kevin Webster), *Market Microstructure and Liquidity*, **3**(2): 1750010 (21 pages).

7. A risk-neutral equilibrium leading to uncertain volatility pricing (with Marcel Nutz), *Finance and Stochastics*, **22**(2): 281–295, 2018.

8. Stability of Radner equilibria with respect to small frictions (with Martin Herdegen), *Finance and Stochastics*, **22**(2): 443–502, 2018.

9. Optimal rebalancing frequencies for multidimensional portfolios (with Ibrahim Ekren and Ren Liu), *Mathematics and Financial Economics*, **12**(2): 165–191, 2018.

10. Rebalancing with linear and quadratic costs (with Ren Liu and Marko Weber), *SIAM Journal on Control and Optimization*, **55**(6): 3533–3563, 2017.

11. A primer on portfolio choice with small transaction costs (with Max Reppen and H. Mete Soner). *Annual Review of Financial Economics*, **9**: 301–331, 2017.

12. Model uncertainty, recalibration, and the emergence of delta-vega hedging (with Sebastian Herrmann). *Finance and Stochastics*, **21**(4): 873–930, 2017.

13. The general structure of optimal investment and consumption with small transaction costs (with Jan Kallsen). *Mathematical Finance*, **27**(3): 659–703, 2017.

14. Trading with small price impact (with Ludovic Moreau and H. Mete Soner). *Mathematical Finance*, **27**(2): 350–400, 2017.

15. Hedging with small uncertainty aversion (with Sebastian Herrmann and Frank Seifried). *Finance and Stochastics*, **21**(1): 1–64, 2017.

16. Robust portfolios and weak incentives in long-run investments (with Paolo Guasoni and Hao Xing). *Mathematical Finance*, **27**(1): 3–37, 2017.

17. Liquidation with self-exciting price impact (with Thomas Cayé). *Mathematics and Financial Economics*, **10**(1): 15–28, 2016.

18. Long horizons, high risk aversion, and endogenous spreads (with Paolo Guasoni). *Mathematical Finance*, **25**(4): 724–753, 2015.

19. Option pricing and hedging with small transaction costs (with Jan Kallsen). *Mathematical Finance*, **25**(4): 702–723, 2015.

20. Optimal liquidity provision (with Christoph Kühn). *Stochastic Processes and their Applications* **125**(7): 2493–2515, 2015.

21. Asymptotics for fixed transaction costs (with Albert Altarovici and H. Mete Soner). *Finance and Stochastics*, **19**(2): 363–414, 2015.

22. Transaction costs, shadow prices, and duality in discrete time (with Christoph Czichowsky and Walter Schachermayer). *SIAM Journal on Financial Mathematics* **5**(1): 258–277, 2014.

23. Transaction costs, trading volume, and the liquidity premium (with Stefan Gerhold, Paolo Guasoni, and Walter Schachermayer). *Finance and Stochastics* **18**(1): 1–37, 2014.

24. Asymptotic power utility-based pricing and hedging (with Jan Kallsen and Richard Vierthauer). *Mathematics and Financial Economics* **8**(1): 1–28, 2014.

25. On the existence of shadow prices (with Giuseppe Benedetti, Luciano Campi, and Jan Kallsen). *Finance and Stochastics* **17**(4): 801–818, 2013.

26. Portfolio choice with transaction costs: a user's guide (with Paolo Guasoni). In V. Henderson and R. Sircar, editors, *Paris-Princeton Lecture Notes in Mathematical Finance 2013*, Springer, 2013.

27. On the performance of delta-strategies in exponential Lévy models (with Stephan Denkl, Martina Goy, Jan Kallsen, and Arnd Pauwels). *Quantitative Finance* **13**(8): 1173–1184, 2013.

28. Portfolio selection with small transaction costs and binding portfolio constraints (with Ren Liu). *SIAM Journal on Financial Mathematics* **4**(1): 203–227, 2013.

29. The dual optimizer for the growth-optimal portfolio under transaction costs (with Stefan Gerhold and Walter Schachermayer). *Finance and Stochastics* **17**(2): 325–354, 2013.

30. Asymptotic and exact pricing of options on variance (with Martin Keller-Ressel). *Finance and Stochastics* **17**(1): 107–133, 2013.

31. Asymptotics and duality for the Davis and Norman problem (with Stefan Gerhold and Walter Schachermayer). *Stochastics (Special Issue for Mark Davis' Festschrift)* **84**(5-6): 625–641, 2012.

32. Utility maximization, risk aversion, and stochastic dominance (with Mathias Beiglböck and Johannes Temme). *Mathematics and Financial Economics* **6**(1): 1–13, 2012.

33. Option pricing in multivariate stochastic volatility models of OU-type (with Oliver Pfaffel and Robert Stelzer). *SIAM Journal on Financial Mathematics* **3**(1): 66–94, 2012.

34. Small-time asymptotics of option prices and first absolute moments (with Marcel Nutz). *Journal of Applied Probability* **48**(4): 1003–1020, 2011.

35. Pricing options on variance in affine stochastic volatility models (with Jan Kallsen and Moritz Voß). *Mathematical Finance* **21**(3): 627–641, 2011.

36. Method of moment estimation in time-changed Lévy models (with Jan Kallsen). *Statistics and Decisions* **28**(2): 169–194, 2011.

37. Existence of shadow prices in finite probability spaces (with Jan Kallsen). *Mathematical Methods of Operations Research* **73**(2): 251–262, 2011.

38. A characterization of the martingale property of exponentially affine processes (with Eberhard Mayerhofer and Alexander Smirnov). *Stochastic Processes and their Applications* **121**(3): 568–582, 2011.

39. Utility maximization in models with conditionally independent increments (with Jan Kallsen). *The Annals of Applied Probability* **20**(6): 2162–2177, 2010.

40. Discrete-time variance-optimal hedging in affine stochastic volatility models (with Jan Kallsen, Natalia Shenkman, and Richard Vierthauer). In R. Kiesel, M. Scherer, and R. Zagst, editors, *Alternative Investments and Strategies*. World Scientific, Singapore, 2010, 375–394.

41. On using shadow prices in portfolio optimization with transaction costs (with Jan Kallsen). *The Annals of Applied Probability* **20**(4): 1341–1358, 2010.

42. Utility maximization in affine stochastic volatility models (with Jan Kallsen). *International Journal of Theoretical and Applied Finance* **13**(3): 459–477, 2010.

43. Exponentially affine martingales, affine measure changes and exponential moments of affine processes (with Jan Kallsen). *Stochastic Processes and their Applications* **120**(2): 163–181, 2010.

Preprints

1. Inventory management for high-frequency trading with imperfect competition (with Sebastian Herrmann, Dapeng Shang, and Chen Yang), 2018.

2. Optimal trading with general signals and liquidation in target zone models (with Christoph Belak and Kevin Ou), 2018.

3. Liquidity in competitive dealer markets (with Peter Bank and Ibrahim Ekren), 2018.

4. Simple bounds for transaction costs (with Bruno Bouchard), 2018.

5. Trading with small nonlinear price impact (with Thomas Cayé and Martin Herdegen), 2018.

6. Scaling limits of processes with fast nonlinear mean reversion (with Thomas Cayé and Martin Herdegen), 2017.

7. Lifetime investment and consumption with recursive preferences and small transaction costs (with Yaroslav Melnyk and Frank Seifried), 2017.

8. High-resilience limits of block-shaped order books (with Jan Kallsen), 2014.

9. Portfolio choice with stochastic investment opportunities: a user's guide (with Ren Liu), 2013.

Advising

Postdoctoral Fellows

1. Sebastian Herrmann, Byrne Research Assistant Professor at the University of Michigan, since September 2016.

2. Martin Herdegen, SNF Postdoc at ETH Zürich, September 2014–August 2016. Now tenure-track Assistant Professor at the University of Warwick.

Ph.D. Students

1. Xiaofei Shi, since April 2018.

2. Kevin Ou, since April 2018.

3. Thomas Cayé, *Trading with Small Nonlinear Price Impact: Optimal Execution and Rebalancing of Active Investments*, June 2013 – May 2017. Now SNF PostDoc with Paolo Guasoni at Dublin City University.

4. Ren Liu, *Portfolio Selection with Frictions*, June 2012 – December 2015. Now Quantitative Analyst at Credit Suisse.

5. Blanka Horvath (joint with Josef Teichmann), *Robust Methods for the SABR Model and Related Processes: Analysis, Asymptotics and Numerics*, February 2011 – October 2015. Now Lecturer at King's College London.

Master Theses

Lauro Böni (joint with Ashkan Nikeghbali); Ksenia Melnikova (joint with Kathrin Glau); Sarkhan Badirli; Giacomo Pianta (July 2014); Denis Schelling (joint with Michael Schmutz); Marcel Brod (joint with Tomoyuki Ichiba); Sara Svaluto-Ferro (joint with Ren Liu); Nadine Roduit (joint with Blanka Horvath); Michael Zubler; Manolis Manoli (joint with Blanka Horvath and Holger Plank); Anna-Lena Hashagen; Simon Lanthaler (joint with H. Mete Soner); Christian Gebauer (joint with Maxim Bichuch); Meng Li; Ren Liu (joint with H. Mete Soner); Ilya Dubovets; Etienne Michoud; Michael Punz (joint with Walter Schachermayer); Daniela Selch (joint with Rudi Zagst); Christian Hanke (joint with Alexander Schied); Oliver Pfaffel (joint with Robert Stelzer, awarded a main price at the 2010 student conference of the German Mathematical Society); Natalia Shenkman (joint with Jan Kallsen); Moritz Voß (joint with Jan Kallsen); Stephan Denkl (joint with Jan Kallsen); Hailin Zhang (joint with Jan Kallsen); Xiaolei Feng (joint with Jan Kallsen).

Semester Papers

Diyora Salimova; Teja Turk; Marcel Brod; Nadine Roduit; Giada Bordogna; Etienne Michoud.

Bachelor Theses

Mathias Mauchle (joint with Martin Herdegen); Philipp Schmocker; Meta-Lina Spohn (joint with Martin Herdegen); Dénes Heins; Klaus Steigmiller (joint with Thomas Cayé); Manuel Moser; Matthäus Geiger; Moris Strub (joint with Ren Liu); Timo Looser; Marcel Brod.

Teaching

46-915 Advanced Derivative Models, Carnegie Mellon University, Fall 2018.

21-882 - Stochastic Control and Applications in Finance, Carnegie Mellon University, Spring 2018.

21-370 - Discrete Time Finance, Carnegie Mellon University, Fall 2017.

Equilibrium Models with Transaction Costs, 10th European Summer School on Mathematical Finance, TU Dresden, Summer 2017.

MATH 623 - Computational Finance, University of Michigan, Fall 2016, Winter 2017.

MATH 574 - Financial Mathematics II, University of Michigan, Winter 2016.

Summer School on *Mathematical Finance* and Winter Research Day on *Consistent Hedging*, Life Insurance Division of Munich Re, 2015.

New Trends in Stochastic Portfolio Theory (joint with Martin Larsson), ETH Zürich, Fall 2015.

Asymptotics in Finance, ETH Zürich, Spring 2015.

Interest Rate Theory, ETH Zürich, Fall 2012, Fall 2014.

Seminar on *Equilibria in Financial Markets with Frictions*, ETH Zürich, Spring 2014.

Equilibrium Models in Financial Economics, ETH Zürich, Fall 2013.

Portfolio Choice, Princeton University, RTG Summer School 2013.

Seminar on *Illiquid Markets* (joint with Ludovic Moreau), ETH Zürich, Spring 2013.

Optimal Portfolio Choice in Markets with Frictions, ETH Zürich, Spring 2012.

Probability and Statistics, ETH Zürich, Fall 2011.

New Trends in Stochastic Portfolio Theory (joint with Josef Teichmann), ETH Zürich, Spring 2011.

Seminar on *Pricing and Hedging with Jump Processes*, ETH Zürich, Fall 2010.

Mathematical Finance 2 (joint with Walter Schachermayer), Universität Wien, Summer 2010.

Service

Director of Industrial Engagement, Imperial College London, from January 2019.

Member of the steering committee, *Center for Computational Finance*, Carnegie Mellon University, September 2017-December 2018.

Departmental committees for PhD admission (2017/2018), hiring (2017/2018), qualifying exams in Mathematical Finance (2018).

Organizer (with Erhan Bayraktar, Romuald Elie, and Sergey Nadtochiy), *Young Researcher Workshop on Mathematical Finance*, Ann Arbor, April 2017.

Organizer (with Erhan Bayraktar and Sergey Nadtochiy), *Byrne Workshop on Stochastic Analysis for Finance and Insurance*, Ann Arbor, June 2016.

Member of the dissertation committees for Albert Altarovici (ETH Zürich), Jiatu Cai (Paris VII and Paris VI), Christa Cuchiero (ETH Zürich), Mark-Roman Feodoria (CAU Kiel), Roman Gayduk (University of Michigan), Sebastian Herrmann (ETH Zürich), Jiaqi Li (University of Michigan), Max Reppen (ETH Zürich), Tanawit Sae-Su (Carnegie Mellon University), Maximilian Stroh (Goethe-Universität Frankfurt), Bezirgen Veliyev (Universität Wien), and Mirjana Vukelja (ETH Zürich).

Associate Editor for *Annals of Applied Probability*, *Applied Mathematical Finance*, *Mathematics and Financial Economics*.

Referee for *Annals of Applied Probability*, *Applied Mathematics and Optimization*, *Decisions in Economics and Finance*, *Finance and Stochastics*, *International Journal of Theoretical and Applied Finance*, *Journal of Banking and Finance*, *Journal of Computational Finance*, *Journal of Economic Dynamics and Control*, *Mathematical Finance*, *Mathematical Methods of Operations Research*, *Mathematics and Financial Economics*, *Mathematics of Operations Research*, *Operations Research*, *Quantitative Finance*, *Review of Finance*, *SIAM Journal on Financial Mathematics*, *Statistics and Probability Letters*, and *Stochastic Processes and their Applications*.

Reviewer, *Mathematical Reviews* and *Zentralblatt Mathematik.*

Member, Program Committees for the 2015 and 2016 conferences of the European Finance Association.

Talks

2019: Risk and Stochastics Conference, London School of Economics; CUHK-Imperial Conference, Hong Kong; SIAM Conference on Financial Mathematics and Engineering, Toronto; 9th General AMaMeF and Conference, Paris; Workshop on Stochastic Control, Singapore.

2018: Capital Fund Management, Paris; London Mathematical Finance Seminar; Risk and Stochastic Seminar, London School of Economics; Mathematical Finance Workshop, University of Connecticut; Columbia University; University of Southern California; 10th Bachelier Congress of the Bachelier Finance Society, Dublin; International Workshop on Applied Probability, Budapest; CAU Kiel; METE - Mathematics and Economics: Trends and Explorations, Zurich; Princeton-Rutgers Math Finance Day, New Brunswick; ETH Zurich; CMU Tepper School of Business, Pittsburgh; Fields Institute of Mathematical Sciences, Toronto; University of Pittsburgh; University of Vienna.

2017: ETH Zürich, CFM-Imperial Workshop on Market Microstructure, London; 3rd Eastern Conference on Mathematical Finance, New Tork; Workshop on Advances in Stochastic Analysis for Risk Modeling, CIRM, Luminy; Jim Gatheral's 60th Birthday Conference, Courant Institute, New York; University of Michigan; Worcester Polytechnical Institute; University of Zurich; TU Berlin; Warwick University; Thera Stochastics – A Mathematics Conference in Honor of Ioannis Karatzas; Seminaire Bachelier; Capital Fund Management, Paris; École Polytechnique; Carnegie Mellon University, Pittsburgh; Columbia University, New York; Workshop on Stochastic Models and Control, Trier; Workshop on Mathematics of Quantitative Finance, Oberwolfach.

2016: Conference on Market Microstructure: Confronting Many Viewpoints, Paris; SIAM Conference on Financial Mathematics and Engineering, Austin; University of California Santa Barbara; Actuarial and Financial Mathematics Laboratory, Montreal; Boston University; Vienna Congress on Mathematical Finance; Tokyo Metropolitan University; London School of Economics; Workshop on Stochastic Analysis and Mathematical Finance, Casa Mathemática Oaxaca; Carnegie Mellon University; University of Michigan, ETH Zürich.

2015: TU Berlin; TU Munich; Universität Wien; Columbia University; 7th General AMaMeF and Swissquote Conference, Lausanne; Copenhagen Business School; Conference on Stochastic Portfolio Theory and Related Topics, New York; University of Washington; University of Zurich; EPFL Lausanne; Workshop on Stochastic Models and Control, Kaiserslautern; The London Quantitative Finance Seminar; ETH-Imperial Workshop; Johns Hopkins University; Rutgers University; Carnegie Mellon University; University of Texas; Stanford University; University of Michigan.

2014: Universität Duisburg-Essen; SIAM Conference on Financial Mathematics and Engineering, Chicago; Workshop Stochastic Analysis for Risk Modeling, Luminy; Workshop on New

Directions in Financial Mathematics and Mathematical Economics, Banff; SIAM-SMAI Conference on Financial Mathematics, Paris; 8th Bachelier Congress of the Bachelier Finance Society, Brussels; Workshop on Mathematical Finance: Arbitrage and Portfolio Optimization, Banff; TU Berlin; Dublin City University; 11th German Probability and Statistics Days, Ulm; Oxford University; Conference on Advances in Financial Mathematics, Paris.

2013: CAU Kiel; Risk and Stochastics Seminar, London School of Economics; LUH Colloquium, Hannover; Eötvös Loránd University; 6th European Summer School in Financial Mathematics, Vienna; RTG Summer School in Financial Mathematics, Princeton; SFI Research Day, Gerzensee; Conference on Frontiers in Financial Mathematics, Dublin; Bonn University; Séminaire Bachelier, Paris; TU München; First Asian Quantitative Finance Conference, Singapore.

2012: Universität Wien; CoLab Workshop, Lisbon; SIAM Conference on Financial Mathematics and Engineering, Minneapolis; Quantitative Methods in Finance Conference, Cairns; 7th World Congress of the Bachelier Finance Society, Sydney; FINRISK Research Day, Gerzensee; Politecnico di Milano; Columbia University; Princeton University; 10th German Probability and Statistics Days, Mainz; Frankfurt MathFinance Colloquium.

2011: 58th World Statistics Congress of the International Statistical Institute, Dublin; 35th Conference on Stochastic Processes and Their Applications, Oaxaca; FINRISK Research Day, Gerzensee; CAU Kiel; Universität Wien; London School of Economics; University of Oxford; Minerva Lectures, Columbia University; Princeton University; Workshop on Stochastic Analysis in Finance and Insurance, Oberwolfach.

2010: École Polytechnique; Séminaire Bachelier, Paris; AMaMeF Workshop, Berlin; Risk Day, ETH Zürich; 34th Conference on Stochastic Processes and Their Applications, Osaka; Analysis, Stochastics, and Applications – A Conference in Honour of Walter Schachermayer, Vienna; Frankfurt MathFinance Colloquium; 6th World Congress of the Bachelier Finance Society, Toronto; Conference on Incomplete Markets, CASS Business School, London; 9th German Open Conference on Probability and Statistics, Leipzig; Dublin City University; 4th Bachelier Colloquium, Metabief.

2009: ETH Zürich; TU München; Universität Wien; 33rd Conference on Stochastic Processes and Their Applications, Berlin; 23rd European Conference on Operations Research, Bonn; Oberseminar Finanzmathematik und Numerik, CAU Kiel; IAS Workshop on Advances in Risk Analysis and Stochastic Modelling, München; Promotionsvortrag, TU München; Workshop on Finance and Insurance, Jena; Mini-Workshop on Mathematical Finance, Kiel; TU Wien.

2008: Carnegie Mellon University, Pittsburgh; HU Berlin; 1st European Summer School in Financial Mathematics, Paris; 5th World Congress of the Bachelier Finance Society, London; IAS Workshop: Risk Modelling and High Frequency Data, München; CAU Kiel; 3rd Bachelier Colloquium, Metabief.

2007: Mid-Term Conference on Advanced Mathematical Methods for Finance, Wien; Fraunhofer Institut für Techno- und Wirtschaftsmathematik, Kaiserslautern; Conference on Advances in Mathematics of Finance, Bedlewo; LMU München; Studierendenkonferenz der DMV, Berlin.

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