## CONTACT DETAILS

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## EMPLOYMENT

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|---|---|
| Jul 2015 - present | **Professor of Mathematics**, Mathematical Institute, University of Oxford<br>**Official Fellow and Tutor in Mathematics**, St John's College, Oxford |
| Sep 2012 - Jun 2015 | **Associate Professor of Mathematical Finance**, Mathematical Institute, U. of Oxford<br>**Official Fellow and Tutor in Mathematics**, St John's College, Oxford |
| Nov 2008 - Aug 2012 | **University Research Lecturer**<br>Mathematical Institute, University of Oxford |
| Oct 2006 - Oct 2008 | **Marie Curie Fellow**<br>Department of Mathematics, Imperial College London |
| Sep 2005 - Aug 2006 | **ATER** (Research and Teaching Assistant)<br>Laboratoire de Probabilités, Université Paris 6 |

## EDUCATION

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|---|---|
| Dec 2005 | **Ph.D. in Mathematics, Honours** (fr. *très honorable*)<br>University Paris 6, France *and* University of Warsaw, Poland<br>under direction of Marc Yor and co-direction of Stanisław Kwapień |
| Jan 2004 | **M.A. in Sociology**<br>thesis on game-theoretical approach to norms and control<br>under direction of Grzegorz Lissowski; University of Warsaw, Poland |
| Jun 2002 | **M.Sc. in Mathematics, Honours**<br>under direction of Stanisław Kwapień; Warsaw University, Poland |
| Mar 2002 | **M.Sc. in Probability Theory**<br>under direction of Marc Yor; Université Paris 6, France |

## MAJOR GRANTS

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|---|---|
| 2014 - 2018 | *European Research Council (ERC) Starting Grant*<br>1,218,000 EUR – funded by the European Commission FP7: 335421-ROBUSTFINMATH |
| 2006 - 2008 | *Marie Curie Intra–European Fellowship* at Imperial College London<br>152,000 EUR – funded by the European Commission FP6: MEIF-CT-2006-040623 |

## OTHER GRANTS and FELLOWSHIPS

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|---|---|
| Fall 2019 | *International Visitor*, Sydney Mathematical Research Institute, 15,000 AUD |
| Dec 2011 | *Bruti-Liberati Fellowship*, University of Technology, Sydney, Australia 7,700 AUD |
| prior 2010 | *Travel and Research grants* totalling around 17,000 EUR |

## AWARDS and HONOURS

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|---|---|
| 2022 | Elected *Vice-President of the Bachelier Finance Society* |
| 2015 | *Recognition of Distinction* – Professorial title award, University of Oxford, UK |
| 2010 | *Teaching Award*, University of Oxford, UK |
| 2004 | *Outstanding Young Scientist Prize*, 'Polityka Weekly' Fundation, Poland |
| 2017 | *Plenary invited talk* in the 8$^{\text{th}}$ General AMaMeF Conference, Amsterdam |
| 2014 | *Plenary invited talk* in the 5$^{\text{th}}$ SIAM Conference on Financial Mathematics & Engineering, Chicago |

## SUPERVISION and EXAMINING EXPERIENCE

Post-docs at University of Oxford:

Dr Tongseok Lim, 2016–2018; now Assistant Professor at Purdue University
Dr Gaoyue Guo, 2016–2018; now a lecturer at Centrale Supélec, France
Dr Anna Aksamit, 2015–2017; now a Lecturer at University of Sydney
Dr Pietro Siorpaes, 2014–2016; now a Lecturer at Imperial College London

D.Phil. students at University of Oxford:

Benjamin Joseph, since 2021; supported by CDT Random Systems
Johannes Wiesel, 2016–2020; now an Assistant Professor at Columbia University
supported by my ERC grant and a DAAD scholarship;
Zhaoxu Hou, 2012–2016, supported by Oxford-Man studentship; now at Goldman Sachs
Peter Spoida, 2011–2014, supported by DAAD scholarship and Oxford-Man studentship
now at Goldman Sachs
Sigrid Källblad, 2009–2013; now an associate professor at Technical University of Vienna
co-supervised by Thaleia Zariphopoulou (University of Texas)
supported by Santander Graduate Scholarship and Dr Marcus Wallenberg's foundation
Vladimir Cherny, 2009–2013, supported by Clarendon Scholarship; now at JP Morgan

M.Sc. students:

2008 - present | I supervised 25 M.Sc. thesis on the full time and part-time M.Sc. programmes in Mathematical and Computational Finance at University of Oxford

2006 - 2008 | I supervised 4 M.Sc. thesis on the full time M.Sc. programme in Mathematical and Computational Finance at Imperial College London

Examining:

*Chairman of the Part A Exam Board covering all of the 2$^{nd}$ year mathematics* (2020-2021)
*Prelims Examiner covering all of the 1$^{st}$ year mathematics* (2018-2019)
*Chairman of the Supervisory Committee for the MSc in Mathematical Finance* (2015–2019)
*Examiner for the MSc/Diploma in Mathematical Finance* (2008–2013)
*Examiner for numerous viva, transfer of status or confirmation D.Phil. (Ph.D.) exams*
Mathematical Institute, University of Oxford

2014 - 2019 | *External Examiner for MRes in Mathematical Sciences*
Imperial College London

*External Examiner for viva (Ph.D. defence)*
Imperial College London (2013), University of Cambridge (2014)

## TEACHING EXPERIENCE

Undergraduate Teaching

Oxford Warsaw | *Probability, Measure and Martingales* (2$^{\text{nd}}$ year), *Continuous martingales and stochastic calculus* (3$^{\text{rd}}$ year), *Discrete-time Stochastic Processes with applications to Social Sciences* (3$^{\text{rd}}$ year). I designed and introduced the last two courses to the syllabus.

Oxford Paris Warsaw | I have extensive experience of teaching in small groups (classes, tutorials) on topics related to probability and mathematical finance from St John's College and the University of Oxford and also from University of Warsaw and Université Paris 6

Graduate Teaching at University of Oxford:

Oxford | I have extensive experience teaching core and optional courses at full and part-time MSc programs, and on the intensive courses for visiting students from University of Singapore & University of Nanjing
Courses taught included: *Financial Derivatives, Fixed Income Markets, Risk and Decision Theory, Market Microstructure and Algorithmic Trading, Martingales & Measure changes*

Invited Graduate Lecture Courses:

2014 | Lecture (8h) in German–Polish summer school organised by RTG1845 Berlin–Potsdam and IMPAN
2013 | Lectures (8h) at the Chinese University of Hong-Kong
2012 | Lecture (8h) at the 5$^{\text{th}}$ European Summer School in Financial Mathematics

## ORGANISATION OF SEMINARS AND CONFERENCES

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|---|---|
| Mar 2022 | Co-organiser of BIRS Workshop 20w5229 *Stochastic Mass Transfers*, Banff |
| Sep 2021 & Oct 2019 | Co-organiser of CIRM Workshop *Advances in Stochastic Analysis for Handling Risks in Finance and Insurance*, Marseille |
| Sep 2018 & Mar 2010 | Member of the Scientific Committee and the main organiser of a major international conference on *Robust Techniques in Quantitative Finance* in Oxford. |
| Sep 2017 & Mar 2016 | Co-organiser of Workshop on *Skorokhod embeddings, Martingale Optimal Transport and their applications* hosted in Oxford and supported by my ERC grant. |
| Nov 2016 | Member of the Organising Committee for the *Sixth SIAM Conference on Financial Mathematics and Engineering*, Austin, TX, USA |
| Sep 2014 | Main organiser of the 7th *European Summer School in Financial Mathematics* hosted by the Oxford-Man Institute, Nomura Centre of Mathematical Finance and the Mathematical Institute, University of Oxford |
| 2010 - 2018 | Co-organiser of the flagship weekly seminar Mathematical and Computational Finance Group, University of Oxford |
| Jun 2011 | Organiser of an Invited Session during the 35th Conference on Stochastic Processes and Their Applications (SPA), Oxaca, Mexico |
| Jun 2007 | Member of the Program Committee and Session Organiser *Skorokhod Space 50 years on* Conference in Kyiv, Ukraine |

## PROFESSIONAL SERVICES

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| Editorial positions | Guest co-editor, *Mathematical Finance* 31(4), (2021)<br>*special issue dedicated to the memory of Mark H. A. Davis*<br>Associate Editor, *Finance and Stochastics* (since 2020)<br>Associate Editor, *Stochastic Processes and Their Applications* (since 2015)<br>Associate Editor, *Mathematical and Financial Economics* (since 2014)<br>Associate Editor, *SIAM Journal on Financial Mathematics* (since 2014)<br>Associate Editor, *Applied Mathematical Finance* (since 2013) |
| Leadership & committee work | Vice-President, Bachelier Finance Society (2022-)<br>Chairmen of the *Meetings Committee* (2020-), Bachelier Finance Society<br>Member of the *Finance* and *Estates* Committees (2014-2020), St John's College Oxford<br>Member of the *Executive Committee* (2009-2016) and *Research Committee* (2009-2013)<br>Oxford-Man Institute of Quantitative Finance, University of Oxford |
| Recruitment panel *member* | President, St John's College Oxford, 2020<br>Principal Bursar, St John's College Oxford, 2020<br>Associate Professor, University of Oxford, 2016 & 2018<br>Supernumerary Lecturer in Mathematics, St John's College Oxford, 2014 & 2020<br>Post-doc, Mathematical Institute, University of Oxford, 2011, 2012, 2018<br>Senior Research Fellow, Oxford-Man Institute of Quantitative Finance, 2011 & 2012 |
| *chairman* | Post-doc (PDRA), Mathematical Institute, University of Oxford, 2014 & 2016 |
| Evaluation panels | Expert for the Ministry of Higher Education of Luxembourg for their comprehensive evaluation of University of Luxembourg (one out of three mathematicians), Sep 2016<br>Member of the Expert Panel, National Science Centre, Poland, 2020 |
| Referee services | *Finance and Stochastics, Mathematical Finance, Annals of Applied Probability, Séminaire de Probabilités, Stochastics (Int. J. Prob. Stoch. Proc.), Stochastic Processes and their Applications, Studia Mathematica, Annales IHP, Electronic Communications in Probability, Mathematical Reviews (AMS), Applied Mathematical Finance, Canadian Mathematical Bulletin, Zentralblatt MATH, SIAM Journal on Control and Optimization, Probab. Theory Related Fields, Inventiones Mathematicae, SIAM Journal on Financial Mathematics, JEMS* |

## SELECTED INVITED TALKS IN CONFERENCES

Apr 2021 | XVI Probability Conference, Będlewo, Poland

Dec 2019 | (Plenary) "The Quantitative Methods in Finance 2019 Conference", Sydney, Australia
Apr 2019 | "Waterloo Conference in Statistics, Actuarial Science and Finance", Waterloo, Canada

Nov 2018 | "Research in Options" (IMPA Conference), Buzios, Brazil
May 2018 | "Byrne Workshop on Stochastic Analysis in Finance and Insurance", Ann Arbor, USA
May 2018 | "Stochastic Analysis and Mathematical Finance" CMO-BIRS Workshop, Oaxaca, Mexico

Jun 2017 | (Plenary) "8th General AMaMeF Conference", Amsterdam, Netherlands
May 2017 | "Optimal Transport meets Probability, Statistics and Machine Learning" CMO-BIRS Workshop

Nov 2016 | "Robust Finance and Model Uncertainty" conferences, Milan, Italy
May 2016 | "Stochastic Analysis and Mathematical Finance" CMO-BIRS Workshop, Oaxaca, Mexico
Apr 2016 | "Pathwise methods, Functional Calculus and Mathematical Finance" workshop, WPI, Vienna, Austria

Sep 2015 | "Control & Optimisation UK" workshop, Oxford, UK
Mar 2015 | The 5th Workshop on "Mathematical Finance and Related Issues", Osaka, Japan

Nov 2014 | (Plenary) 5th SIAM Conference on Financial Mathematics & Engineering, Chicago
*one of nine plenary talks, details available at http://www.siam.org/meetings/fm14/*
May 2014 | Mathematical Finance: Arbitrage and Portfolio Optimization, BIRS Workshop, Banff, Canada
May 2014 | Stochastic Analysis in Finance and Insurance Workshop, MF Oberwolfach, Germany

Jul 2013 | New Developments in Stochastic Analysis: Probability and PDE Interactions, Beijing, China
Jun 2013 | UK Mathematical Finance Workshop, King's College London, UK

Sep 2012 | Workshop on Mathematical Finance and Related Issues, Kyoto, Japan
Jul 2012 | SIAM Conference on Financial Mathematics, Minneapolis, USA
Jul 2012 | 6th European Congress of Mathematics, Kraków, Poland

Dec 2011 | (Plenary) Quantitative Methods in Finance (QMF) Conference, Sydney, Australia
*The Bruti-Liberati lecture, details available at http://www.qfrc.uts.edu.au/Bruti_Liberati/*
Jul 2011 | Mathematical Finance Minisymposium
International Congress of Industrial and Applied Mathematics (ICIAM), Vancouver, Canada
Jan 2011 | Stochastic Analysis in Finance and Insurance Workshop, Oberwolfach, Germany

## SELECTED TALKS IN RESEARCH SEMINARS

Mar 2021 | Bachelier Seminar, Paris

Sep 2020 | Colloquium, Department of Mathematics, Florida State University
May 2020 | Bachelier Finance Society One World Seminar

Sep 2019 | Sydney Financial Mathematics Workshop, Sydney, Australia
Jan 2019 | Mathematisches Kolloquium, University of Bielefeld, Germany

Nov 2018 | "Perspectives from Academia and Industry: Synergies in financial research", King's College London
Oct 2018 | Mathematical Finance Seminar, Jiao Tong University, Shanghai, China

Jul 2017 | Bielefeld Stochastic Afternoon: Math-Finance Session, University of Bielefeld, Germany

Feb 2016 | London Mathematical Finance Seminar, London, UK

Nov 2015 | Decision Mathematics Seminar, Toulouse School of Economics, Toulouse, France

Nov 2014 | Cambridge Finance Seminar, Cambridge, UK
Sep 2014 | De Finetti Risk Seminar, Milan, Italy

Nov 2013 | Berlin Probability Colloquium, Berlin, Germany
Sep 2013 | Mathematical Finance Seminar, Department of Mathematics, Columbia University, NY, USA
Mar 2013 | Colloquium, Department of Applied Mathematics, Polytechnic University, Hong Kong
Jan 2013 | Probability Seminar, University of Warsaw, Poland

Nov 2011 | Statistics & Probability Seminar, University of Bath, Bath, UK
Feb 2011 | Finance and Stochastics Seminar, Imperial College London, UK
Sep 2010 | Stochastic Seminar, Vrije Universiteit, Amsterdam, Netherlands

Nov 2009 | Colloquium, Department of Mathematics, University of Vienna, Austria

## JOURNAL ARTICLES


[1] S. Hu, J. Obłój and X. Zhou, "A Casino Gambling Model under Cumulative Prospect Theory: Analysis and Algorithm", *Manage. Sci.* forthcoming, available at SSRN:3779900.

[2] I. Guo, G. Loeper, J. Obłój, S. Wang. "Joint Modelling and Calibration of SPX and VIX by Optimal Transport," *SIAM J. Financial Math.*, **22**:1, 1–31, 2022.

[3] D. Bartl, S. Drapeau, J. Obłój and J. Wiesel. "Sensitivity analysis of Wasserstein distributionally robust optimization problems", *Proc. R. Soc. A*, **477**: 20210176, 2021.

[4] J. Obłój and J. Wiesel. "Distributionally robust portfolio maximisation and marginal utility pricing in discrete time", *Math. Finance* **31**(4): 1454–1493, 2021.

[5] J. Obłój and J. Wiesel. "A unified Framework for Robust Modelling of Financial Markets in discrete time," *Finance Stoch.*, **25**: 427–468, 2021.

[6] R. Łochowski, J. Obłój, D. Promel and P. Siorpaes. "Local times and Tanaka-Meyer formulae for cádlág paths", *Electron. J. Probab.* **26**, 2021.

[7] S. Eckstein, G. Guo, T. Lim and J. Obłój, "Robust pricing and hedging of options on multiple assets and its numerics", *SIAM J. Financial Math.* **12**(1): 158–188, 2021.

[8] J. Obłój and J. Wiesel. "Statistical estimation of superhedging prices," *Ann. Stat.* **49**(1): 508–530, 2021.

[9] A. Aksamit, Z. Hou and J. Obłój, "Robust framework for quantifying the value of information for pricing and hedging," *SIAM J. Financial Math.* **11**(1): 27–59, 2020.

[10] L. Carassus, J. Obłój and J. Wiesel. "The robust superreplication problem: a dynamic approach," *SIAM J. Financial Math.* **10**(4): 907–941, 2019.

[11] M. Fukasawa and J. Obłój, "Efficient discretisation of stochastic differential equations," *Stochastics* **92**(6): 833–851, 2020.

[12] G. Guo and J. Obłój. "Computational Methods for Martingale Optimal Transport problems," *Ann. App. Probab.*, **29**(9): 3311–3347, 2019.

[13] M. Burzoni, M. Frittelli, Z. Hou, M. Maggis and J Obłój, "Pointwise Arbitrage Pricing Theory in Discrete Time," *Math. Oper. Res.* **43**(3): 1034–1057, 2019.

[14] X. He, S. Hu, J. Obłój and X. Zhou. "Optimal Exit Time from Casino Gambling: Strategies of Pre-Committed and Naive Gamblers," *SIAM J. Control Optim.* **57**(3): 1845–1868, 2019.

[15] M. Beiglböck, T. Lim and J. Obłój. "Dual attainment for the martingale transport problem," *Bernoulli* **25**(3): 1640–1658, 2019

[16] A. Aksamit, S. Deng, J. Obłój and X. Tan. "Robust pricing–hedging duality for American options in discrete time financial markets," *Math. Finance* **29**(3): 861–897, 2019.

[17] X. He, S. Hu, J. Obłój and X. Zhou. "Two explicit Skorokhod embeddings for simple symmetric random walk," *Stoch. Proc. Appl.* (online), **129**(9): 3431–3445, 2019.

[18] A.M.G. Cox, J. Obłój and N. Touzi, "The Root solution to the multi-marginal embedding problem: an optimal stopping and time-reversal approach," *Prob. Theory Relat. Fields* **173**: 211–259, 2019

[19] S. Källblad, J. Obłój and T. Zariphopoulou. "Time-consistent investment under model uncertainty: the robust forward criteria," *Finance Stoch.* **22**(4): 879–918, 2018.

[20] Z. Hou and J. Obłój. "Robust pricing-hedging dualities in continuous time," *Finance Stoch.* **22**(3): 511–567, 2018.

[21] M. Davis, J. Obłój and P. Siorpaes. "Pathwise stochastic calculus with local times." *Ann. Inst. H. Poincaré Probab. Statist.* **54**(1): 1–21, 2018.

[22] J. Obłój and P. Spoida. "An Iterated Azéma-Yor Type Embedding for Finitely Many Marginals." *Ann. Probab.* **45**(4): 2210–2247, 2017.

[23] S. Nadtochiy and J. Obłój. "Robust Trading of Implied Skew." *Inter. J. Theo. App. Finance* **20**: 1750008 [41 pp.], 2017.

[24] X. He, S. Hu, J. Obłój and X. Zhou. "Path-Dependent and Randomized Strategies in Barberis' Casino Gambling Model." *Operations Research* **65**(1): 97–103, 2017.

[25] K. Kardaras, J. Obłój and E. Platen, "The numeraire property and long-term growth optimality for drawdown-constrained investments," *Math. Finance* **27**(1): 68–95, 2017.

[26] A. Cox, Z. Hou and J. Obłój. "Robust pricing and hedging under trading restrictions and the emergence of local martingale models." *Finance Stoch.* **20**(3): 669–704, 2016.

[27] P. Henry-Labordère, J. Obłój, P. Spoida and N. Touzi. "The Maximum maximum of martingales with given marginals," *Ann. Appl. Probab.* **26**(1): 1–44, 2016.

[28] P. Guasoni and J. Obłój, "The incentives of hedge fund fees and high-water marks," *Math. Finance* **26**(2): 269–295, 2016.

[29] J. Obłój, P. Spoida and N. Touzi. "Martingale Inequalities for the Maximum via Pathwise Arguments." in: C. Donati-Martin et al (eds.), *In Memoriam Marc Yor - Seminaire de Probabilite XLVIII*, LNM 2137, 227–247, Springer, 2015.

[30] A. Cox and J. Obłój. "On joint distributions of the maximum, minimum and terminal value of a continuous uniformly integrable martingale." *Stoch. Proc. Appl.* **125**(8): 3280-3300, 2015.

[31] M. H. A. Davis, J. Obłój and V. Raval, "Arbitrage bounds for prices of weighted variance swaps," *Math. Finance* **24**(4): 821–854, 2014.

[32] A. M. G. Cox, D. Hobson and J. Obłój, "Utility theory front to back - inferring utility from agents' choices," *Inter. J. Theo. App. Finance* **17**(3): 1450018 [44 pp.], 2014.

[33] V. Cherny and J. Obłój, "Portfolio optimisation under non-linear drawdown constraints in a semimartingale financial model," *Finance Stoch.* **17**(4): 771–800, 2013.

[34] J. Obłój and F. Ulmer, "Performance of robust hedge of digital double barrier options," *Inter. J. Theo. App. Finance* **15**(1): 1250003 [34 pp.], 2012.

[35] L. Carraro, N. El Karoui and J. Obłój, "On Azéma-Yor processes, their optimal properties and the Bachelier-Drawdown equation," *Ann. Probab.* **40**(1): 372-400, 2012.

[36] A. M. G. Cox and J. Obłój, "Robust hedging of double no-touch barrier options," *Finance Stoch.* **15**(3): 573–605, 2011.

[37] A. M. G. Cox and J. Obłój, "Robust hedging of double touch barrier options," *SIAM J. Financial Math.* **2**: 141–182, 2011.

[38] A. M. G. Cox, D. Hobson and J. Obłój, "Time-homogeneous diffusions with a given marginal at a random time," *ESAIM Probab. Statist.* **15**: 11–24, 2011.

[39] J. Obłój and M. Pistorius, "On an explicit Skorokhod embedding for spectrally negative Lévy processes," *J. Theoret. Probab.* **22**(2): 418–440, 2009.

[40] M. Davis and J. Obłój, "Market completion using options," w *Advances in Mathematics of Finance*, (Ł. Stettner, ed.), vol. 83 of *Banach Center Publ.*: 49–60, Polish Acad. Sci. Inst. Math., Warszawa, 2008.

[41] A. M. G. Cox, D. Hobson and J. Obłój, "Pathwise inequalities for local time: applications to Skorokhod embeddings and optimal stopping," *Ann. Appl. Probab.* **18**(5): 1870–1896, 2008.

[42] A. M. G. Cox and J. Obłój, "Classes of measures which can be embedded in the Simple Symmetric Random Walk," *Electron. J. Probab.*, **13**: 1203–1228, 2008.

[43] J. Obłój, "An explicit solution to the Skorokhod embedding problem for functionals of excursions of Markov processes," *Stoch. Proc. Appl.* **117**(4): 409–431, 2007.

[44] J. Obłój, "The maximality principle revisited: on certain optimal stopping problems," in *Séminaire de Probabilités XL*, vol. 1899 *Lecture Notes in Math.*: 309–328, Berlin: Springer, 2007.

[45] J. Obłój, "A complete characterization of local martingales which are functions of Brownian motion and its maximum," *Bernoulli* **12**(6): 955–969, 2006.

[46] J. Obłój and M. Yor, "On local martingale and its supremum: harmonic functions and beyond," in *From Stochastic Calculus to Mathematical Finance* (Y. Kabanov, R. Lipster, and J. Stoyanov, eds.), 517–534, Springer-Verlag, 2006.

[47] J. Obłój, "The Skorokhod embedding problem and its offspring," *Probab. Surv.* **1**: 321–390 (electronic), 2004.

[48] J. Obłój and M. Yor, "An explicit Skorokhod embedding for the age of Brownian excursions and Azéma martingale," *Stoch. Proc. Appl.* **110**(1): 83–110, 2004.

## OTHER PUBLICATIONS

[49] I. Guo, G. Loeper, J. Obłój, S. Wang. "Optimal Transport for model calibration" *Risk: Cutting Edge*, Jan 2022.

[50] J. Obłój and T. Zariphopoulou, "In memoriam: Mark H. A. Davis and his contributions to mathematical finance", *Math. Finance* **31**(4): 1099-1110, 2021.

[51] J. Obłój, "Skorokhod Embedding," in *Encyclopedia of Quantitative Finance* (R. Cont, ed.), pp. 1653–1657, Wiley, 2010.

[52] J. Obłój, "Fine tune your smile: Correction to Hagan et al.," *Wilmott Magazine*, Wiley, May 2010.

## PREPRINTS

[53] J. Obłój and P. Siorpaes, "Structure of martingale transports in finite dimensions," available at arXiv:1702.08433.