



Chaire Finance et développement durable – Approches quantitatives

Academic partner(s) : Université Paris Dauphine - PSL, École Polytechnique

Financial partner(s) : CA-CIB, EDF

Scientific director(s) : Pierre-Louis Lions, Jean-Michel Lasry

Website : www.events.chairefdd.org

RESEARCH PROGRAM DESCRIPTION

The objectives assigned to the Chair was to contribute to the creation of knowhow and methods for evaluating, quantifying and managing, via the interaction of finance and the various economic fields, the risks weighing on the sustainable development of society. The specificity of the Chair (which distinguishes it from other chairs) is its emphasis on quantitative approaches (mathematical and statistical modelling, development of computational methods).

The scientific program of the Chair for the period 2022-2026 is in line with the objectives that were defined when the project was created in 2006: to develop scientific modelling and quantitative methods for research into a sustainable economy and responsible finance. This program and the results obtained are the cement of a high-level scientific team and a close relationship with the sponsors.

On the methodological level, we will continue to develop and apply the highly innovative, relevant and efficient quantitative methods that are the hallmark of the Chair: mean-field games, agency models, graph theory and numerical methods. New methods, resulting from recent developments in the field of artificial intelligence, have been added to this initial base. These quantitative methods form the methodological basis of the work carried out on the themes set out below, and make it possible to achieve breakthroughs that would otherwise be impossible (see below, Methodological basis)

In terms of themes, the research areas for the 2022-2026 period have been designed to focus on the analysis of ecological and health crises, as well as on the means to carry out transitions (ecological, energy, agricultural) that are more brutal and rapid than expected. A third axis focuses more specifically on the modelling of connected objects, given their central role in the transitions.

- Axis 1. Risk management in a context of climate change and transitions (ecological, energy, agricultural).
- Axis 2. Risk and systemic actors
- Axis 3. Modelling networks of machines and other connected objects

The methodological basis includes the following approaches: Mean-field games, Trajectory-dependent PDEs, Stochastic differential games and contract theory. It also includes the modelling of stochastic processes, equilibrium models, graph theory, statistical modelling and numerical approximation methodologies, in particular by the powerful learning methods currently available (neural networks).

Part of the Chair research work is conducted jointly with the “Fime Lab” Research Initiative. As a result, redundancies may appear between the work of these two projects.

RESEARCH TEAM

Researchers

- Eduardo Abi Jaber, Assistant Professor, École Polytechnique (2022-)
- Yves Achdou, Professor, Université Paris-Diderot (2015-)
- René Aïd, Professor, Université Paris-Dauphine & CREST (2006-)
- Charles Bertucci, Researcher at CNRS, CMAP, Ecole Polytechnique (2019-)
- Jean-Michel Lasry, Emeritus Professor, Université Paris-Dauphine (2006-)
- Pierre-Louis Lions, Professor, Collège de France (2006-)
- Delphine Lautier, Professor, Université Paris-Dauphine, DRM Finance (2008-)
- Nizar Touzi, Professor, Ecole Polytechnique, CMAP (2006-)

- Louis Bertucci, ILB
- Pierre Cardaliaguet, Université Paris Dauphine - PSL
- René Carmona, Princeton University
- Pierre-Noël Giraud, Mines Paris Tech
- Olivier Guéant, Université Paris 1 Panthéon Sorbonne
- Roger Guesnerie, Collège de France
- Benjamin Moll, LSE
- José Scheinkman, Columbia University
- Denis Talay, INRIA

PhD Students

- Adrien Séguret*, doctorant CIFRE EDF UPD, Dir. P. Cardaliaguet et C. Wang
- Mohamed Bahlali, doctorant Université Paris-Dauphine / ANR EcoRees, dir. R. Aïd et A. Creti
- Lorenzo Croissant*, doctorant Université Paris-Dauphine, dir. B. Bouchard
- Alicia Bassière, doctorante CREST / ANR EcoREES, dir. P. Tankov et D. Benatia
- Songbo Wang, doctorant X, dir. N. Touzi et Z. Ren
- Assil Fadle, doctorant X, dir. N. Touzi et R. Aïd
- Fanny Cartellier, doctorante CREST, dir. P. Tankov et C.-Y. Robert
- Thibaut Bourdais, doctorant ENSTA, dir. F. Russo
- Kang Liu, doctorant X, dir. J.-F. Bonnans
- Renzhi Liu (doctorant UPD), dir. R. Aïd et S. Benoit
- Nathan Sauldubois, doctorant X, dir. Nizar Touzi.
- Antoine Lotz, doctorant Université Paris Dauphine, dir. Marc Hoffmann, Pierre Gruet, Thomas Deschatre.
- Redouane Silvente, doctorant CREST (ENSAE), dir. Peter Tankov.
- Marc Yeterian doctorant Université Paris-Dauphine, dir. Bertrand Villeneuve.
- Xuanye Song, doctorant Université Paris-Cité, dir. Huyên Pham et Noufel Frikha.
- Mohamed Hamdouche, doctorant Université Paris-Cité, dir. Huyên Pham.
- Anna De Crescenzo, doctorant Université Paris-Cité, dir. Huyên Pham.
- Thibault Bourdais, doctorant X, dir. F. Russo et N. Oudjane
- Bianca Marin Moreno, doctorante CIFRE (EDF R&D / INRIA), dir. Margaux Brégère (EDF) et Pierre Gaillard (INRIA)
- Ruihua Ruan*, doctorante, Université Paris Dauphine, dir. E. Bacry

- Kang Liu*, doctorant IPP, dir. L. Pfeiffer & F. Bonnans.
- Shaun (Xiaoyuan) Li, doctorant Université Paris 1, dir. B. de Meyer et E. Abi Jaber
- Marius Potfer, doctorant IPP, dir. V. Perchet, P. Gruet et C. Wan

* PhD defended in 2023

Other people involved in the program (e.g. engineers)

- Damien Fessler, research engineer, ILB

Published

- Achdou, Y., Carlier, G., Petit, Q., & Tonon, D. (2023). A mean field model for the interactions between firms on the markets of their inputs. *Mathematics and Financial Economics*, 1-35.
- Achdou, Y., Carlier, G., Petit, Q., & Tonon, D. (2023). A simple city equilibrium model with an application to teleworking. *Applied Mathematics & Optimization*, 88(2), 60.
- Aïd, R., & Biagini, S. (2023). Optimal dynamic regulation of carbon emissions market. *Mathematical Finance*, 33(1), 80-115.
- Aïd, R., Bahlali, M., & Creti, A. (2023). Green innovation downturn: the role of imperfect competition. *Energy Economics*, 123, 106754.
- Aïd, R., Possamai, D., & Touzi, N. (2022). Optimal electricity demand response contracting with responsiveness incentives. *Mathematics of Operations Research*, 47(3), 2112-2137.
- Barrasso, A., & Touzi, N. (2023). Controlled diffusion Mean Field Games with common noise, and McKean-Vlasov second order backward SDEs. *Journal of Theoretical Probability* 66 (4), 613-639. Doi :10.1137/S0040585X97T990654.
- Bertucci, C. (2023). Monotone solutions for mean field games master equations: continuous state space and common noise. *Communications in Partial Differential Equations*, 1-41.
- Cardaliaguet, P., Daudin, S., Jackson, J., & Souganidis, P. E. (2023). An algebraic convergence rate for the optimal control of McKean–Vlasov dynamics. *SIAM Journal on Control and Optimization*, 61(6), 3341-3369.
- Cardaliaguet, P., & Souganidis, P. E. (2023). Regularity of the value function and quantitative propagation of chaos for mean field control problems. *Nonlinear Differential Equations and Applications NoDEA*, 30(2), 25.
- Djete, M. F., & Touzi, N. (2021). Mean Field Game of Mutual Holding. A paraître dans *The Annals of Applied Probability*. arXiv preprint arXiv:2104.03884.
- Hu, K., Ren, Z., & Touzi, N. (2022). On path-dependent multidimensional forward-backward SDEs. *Numerical Algebra, Control and Optimization*, Volume 13, Issue 3&4 : 413-430 (2023). Doi : 10.3934/naco.2022010.
- Keppo, J., Touzi, N., & Zuo, R. (2023). Dynamic Contracting in Asset Management under Worker- Manager- Owner Relationship. A paraître dans *Management Science*. Available at SSRN 3761499.
- Ren, Z., Tan, X., Touzi, N., & Yang, J. (2023). Entropic optimal planning for path-dependent mean field games. *SIAM Journal on Control and Optimization*, 61(3), 1415-1437.
- Ren, Z., Touzi, N., & Yang, J. (2022, May). Nonlinear predictable representation and L¹-solutions of backward SDEs and second-order backward SDEs. In *Annales de l'Institut Henri Poincaré (B) Probabilités et statistiques* (Vol. 58, No. 2, pp. 639-666). Institut Henri Poincaré.
- Talbi, M., Touzi, N., & Zhang, J. (2023). Viscosity solutions for obstacle problems on Wasserstein space. *SIAM Journal on Control and Optimization*, 61(3), 1712-1736.
- Talbi, M., Touzi, N., & Zhang, J. (2023). Dynamic programming equation for the mean field optimal stopping problem. *SIAM Journal on Control and Optimization*, 61(4), 2140-2164.

Under review

Abi Jaber, E., Neuman, E., & Voß, M. (2023). Equilibrium in Functional Stochastic Games with Mean-Field Interaction. *arXiv preprint arXiv:2306.05433*.

Abi Jaber, E., & Neuman, E. (2022). Optimal liquidation with signals: the general propagator case. *Available at SSRN*.

Abi Jaber, E., & Illand, C. (2022). The quintic Ornstein-Uhlenbeck volatility model that jointly calibrates SPX & VIX smiles. *arXiv preprint arXiv:2212.10917*.

Working papers

Achdou, Y., Mannucci, P., Marchi, C., & Tchou, N. (2022). First order Mean Field Games on networks. *arXiv preprint arXiv:2207.10908*.

Achdou, Y., Lasry, J. M., & Lions, P. L. (2022). Simulating numerically the Krusell-Smith model with neural networks. *arXiv preprint arXiv:2211.07698*.

Aïd, R., Kemper, A., & Touzi, N. (2023). A Principal-Agent Framework for Optimal Incentives in Renewable Investments. *arXiv preprint arXiv:2302.12167*.

Alasseur, C., Basei, M., Bertucci, C., & Cecchin, A. (2022). A mean field model for the development of renewable capacities. *arXiv preprint arXiv:2210.15023*.

Bertucci, C., Lasry, J. M., & Lions, P. L. (2023). On Lipschitz solutions of mean field games master equations. *arXiv preprint arXiv:2302.05218*.

Bertucci, C. (2023). Stochastic optimal transport and Hamilton-Jacobi-Bellman equations on the set of probability measures. *arXiv preprint arXiv:2306.04283*.

Bertucci, C., Lasry, J. M., & Lions, P. L. (2022). A singular infinite dimensional Hamilton-Jacobi-Bellman equation arising from a storage problem. *arXiv preprint arXiv:2210.02780*.

Cardaliaguet, P., Munoz, S., & Porretta, A. (2023). Free boundary regularity and support propagation in mean field games and optimal transport. *arXiv preprint arXiv:2308.00314*.

Cardaliaguet, P., Seeger, B., & Souganidis, P. (2022). Mean field games with common noise and degenerate idiosyncratic noise. *arXiv preprint arXiv:2207.10209*.

Djete, M. F., Guo, G., & Touzi, N. (2023). Mean field game of mutual holding with defaultable agents, and systemic risk. *arXiv preprint arXiv:2303.07996*.

Possamaï, D., & Touzi, N. (2020). Is there a Golden Parachute in Sannikov's principal-agent problem?. *arXiv preprint arXiv:2007.05529*.

Talbi, M., Touzi, N., & Zhang, J. (2022). From finite population optimal stopping to mean field optimal stopping. *arXiv preprint arXiv:2210.16004*.

MAJOR COMMUNICATIONS RELATED TO THE RESEARCH PROGRAM

Major academic conferences, invited speaker, etc.

Eduardo Abi Jaber

Stochastic Methods in Finance and Physics, Creta, Greece, 17-21 July 2023. Minicourse on Volterra processes in Finance.

Advances in Stochastic Analysis for Handling Risks in Finance and Insurance, CIRM Luminy, France, September 11-15, 2023.

Seminar of the Department of Economics and Finance, Luiss University, Rome, September 21, 2023.

Stochastic Numerics and Statistical Learning: Theory and Applications Workshop, KAUST University, Saudi Arabia, May 28-31, 2023. Mini-course on 'Non-Markovian models in Finance' with Christian Bayer.

(Invited) Workshop on rough volatility, Isle of Skye, Scotland, May 22-26, 2023. Rough volatility, too smooth? (Invited) Control & Optimisation Pisa 2023, Pisa, Italy, May 8-10, 2023. A direct approach to a class of finite-players and mean-field games. (Invited)

Workshop Stochastic Control and Risk, Hammamet, Tunisia, April 24-27, 2023. A direct approach to a class of finite-players and mean-field games. (Invited)

Seminar on Finance & Modeling, Université Paris 1, France, April 17, 2023. The Quintic model that jointly calibrates SPX/VIX.

Finance and Stochastics seminar, Imperial College, London, England, March 28, 2023. From the Quintic model that jointly calibrates SPX/VIX to Sig-Volatility models.

Yves Achdou

- Février 2023 : workshop Distributed Solutions to Complex Societal Problems, IMSI Chicago.

Conférence : Deterministic MFG in which the control is the acceleration, with state constraints.

-Avril 2023 : séminaire, Université de Padoue

- Mai 2023 : workshop Rome (à la mémoire de M. Falcone). Conférence : A class of short-term models for the oil industry that accounts for speculative oil storage

- Juillet 2023 : séminaire, Humboldt U. Berlin

- Juillet 2023 : workshop SPDEs, optimal control and mean field games - analysis, numerics and application, Bielefeld. Conférence : A class of shortterm

René Aïd

[1] Public panel on Tackling Climate Change and the Just Transition to Renewable Energy, University of British Columbia, July 26th-28th, 2023.

[2] Workshop on Mathematical Modelling and Forecasting of Renewables, Pacific Institute of Mathematical Sciences, July 26th-28th, 2023.

[3] MATS Seminar, College de France, July 19th, 2023.

[4] Volatility Conference, Singapore Management University, June 20th-21st, 2023.

[5] Seminar of Economics and Finance, LUISS University, Roma, May 18th, 2023.

[6] Applications of Stochastic Control to Finance and Economics, Banff International Research Station for Mathematical Innovation and Discovery, April 30th- May 5th, 2023.

[7] Conference on Risk and Uncertainty in Finance and Economics, School of Economics at the University of Johannesburg, 4th-7th April, 2023.

[8] Visiting at the Indian Institute of Technology of Mumbai, February 18th-25th, 2023.

[9] Workshop in Financial Mathematics, National University of Singapore, January, 13th-14th 2023.

Charles Bertucci

- Séminaire du département de Mathématiques de l'Université de Padoue en Février

- Distributed Solutions to Complex Societal Problems Reunion Workshop à l'IMSI en Chicago

Nizar Touzi

- The German Probability and Statistics Days Conference, University of Duisburg-Essen (Germany), 7-10 March 2023.
- Advances and perspectives in Mathematics, Hassan II Academy of Sciences and Technology, Rabat (Morocco) 7-8 September 2022.
- Stochastic Control and Fractional Dynamics, Newton Institute, University of Cambridge, 18-22 April 2022
- Control and optimisation Pisa 2023, 8-10 May 2023.
- Distributed Solutions to Complex Societal Problems ReunionWorkshop, IMSI, University of Chicago, 20-22 February 2023.
- Miniworkshop at the department of mathematics of the Chinese University of Hong Kong, 17-20 January 2023.
- Meeting of the ANR Dreames, Nantes (France), 12-14 September, 2022.
- Recent Developments in Stochastics with Applications in Mathematical Physics and Finance, Hammamet, 12- 16 September, 2022.
- Advances in Stochastic Control and Optimal Stopping with Applications in Economics and Finance, CIRM Luminy (France), 12-16 September, 2022
- Minicourse on Optimal martingale transport, NUS Singapore, 24 May 2023.
- Mathematical Finance seminar at the Luis University, Rome (Italy), 16 February 2023.
- Probability and Finance Seminar, Hong Kong Polytechnic University, 19 January 2023.
- Bielefeld Stochastic Afternoon : Mathematical Finance session", 21 December 2022, University of Bielefeld (Germany).

Events organized by the program

In 2023, the following events have been organized :

- Summer school « Big data and finance », Aussois, 12-16 June (around 35 participants).
<https://fimeschool.sciencesconf.org>.
- MATS Seminar, July 19 at Collège de France.
- « Journées-Ateliers » of the FiME Lab, 13-14 September, Palaiseau.
- FDD-FiME Seminar at Institut Henri Poincaré (18 talks)

Nizar Touzi also co-organized the following events (not funded by the Chair) :

- “Applications of Stochastic Control to Finance and Economics”, Banff Research Station (Canada), 1-5 May 2023.
- “Stochastic control and games in economics and finance”, Hammamet (Tunisie), 24-28 April 2023.

Pierre-Noël Giraud gave a lecture on "The economics of commodities", aimed at doctoral and Masters students at Dauphine. This Master 2 course is open to students in Masters 212 and 129 at Paris-Dauphine University and Mines Paris Tech (PSL course).

OTHER HIGHLIGHTS

Awards, scientific recognition, organization of calls for projects, involvement in master's courses, PhD program visiting researchers, etc...

- René Aïd took part in the panel Tackling the Climate Change and the Just Transition to Renewable Energy, as part of the French-Ameri-Can Climate Panels (FACTS) on climate change, at the University of British Columbia, July 2023.

- PhD student Margaux Zaffran has been named one of the "French Young Talents" in the #ForWomeninScience2023 programme run by the L'Oréal-UNESCO Foundation.