ECONOPHYSIX

Academic partner(s) : Ecole Polytechnique

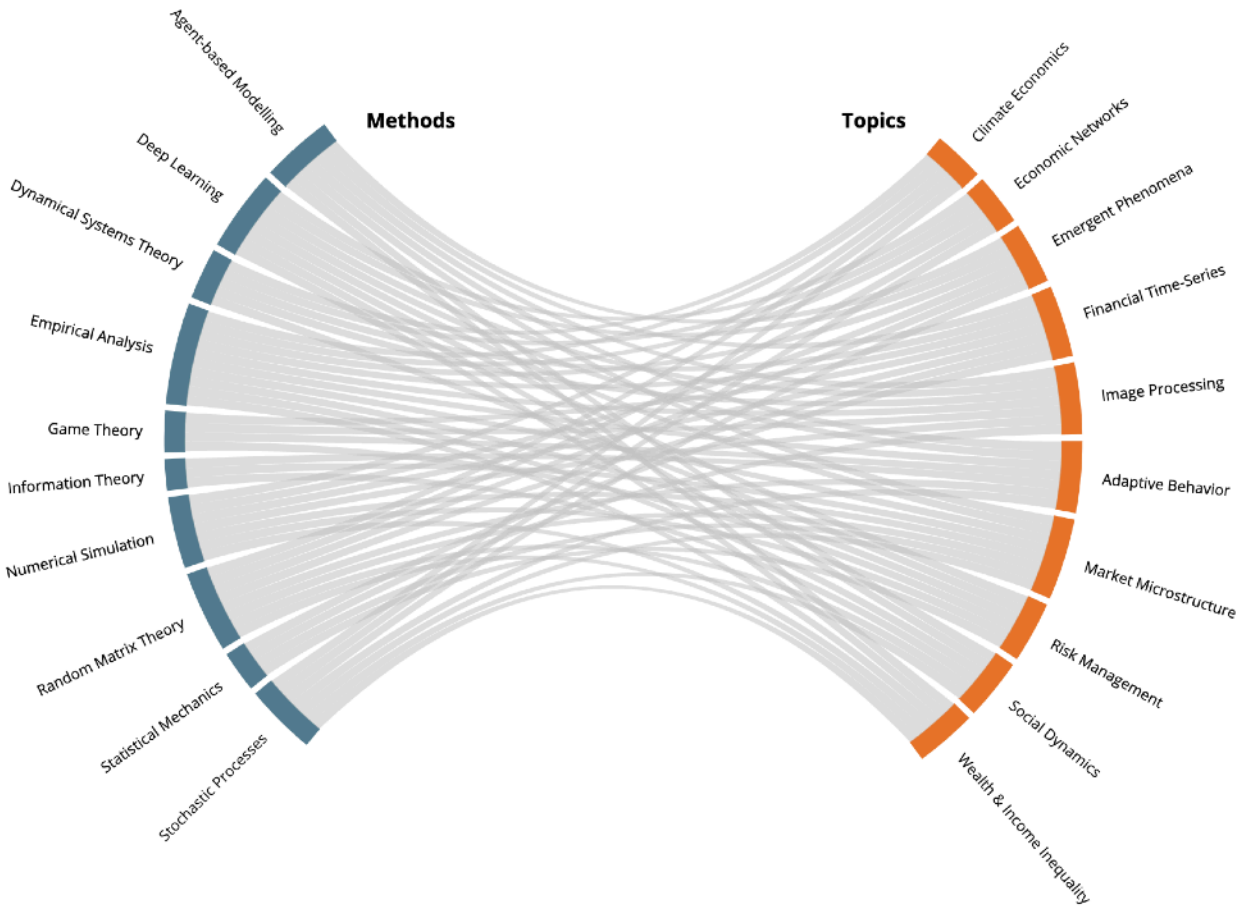
Financial partner(s) : Capital Fund Management

Scientific director(s) : Michael BENZAQUEN

Website : www.econophysiX.com

RESEARCH PROGRAM DESCRIPTION

The EconophysiX Lab is a dynamic research group based at Ecole Polytechnique, a leading French institute which combines top-level research, academics, and innovation at the cutting-edge of science and technology. Just 20 km south of Paris, we benefit from a beautiful campus spanning almost 160 hectares. Our approach is primarily empirical. We work in close collaboration with Capital Fund Management, one of the world's leaders in alternative investment management, counting a very pleasant space in the heart of Paris, and a large team of world-renowned experts in the field of quantitative finance. See methods and topics below, as well as econophysiX.com for more details.



Our research topics can be divided into four main categories.

A. Financial markets: Mostly market microstructure, including agent-based modelling, limit order book dynamics, market impact and instabilities, and endogenous liquidity crises. But also risk control, market inefficiencies, and optimal portfolios, as well as machine learning and financial time series.

B. General Economics: Generalised DSGE modelling including self-reflexivity, interactions, heterogeneity, and applications for monetary policy. Approach to equilibrium and excess volatility in firm networks. Capital investment driven business cycles. Learning in emerging markets.

C. Sociophysics: Habit formation and other memory effects in social systems. Individual *vs* collective learning. Ecology of fishing areas. Radical complexity in complex game theory.

D. Other Complex Systems: Statistical physics of image appreciation and maximally informative representations. Applications to statistical fractography.

RESEARCH TEAM

Researchers

Michael BENZAQUEN (CNRS/X)

Jean-Philippe BOUCHAUD (CFM)

Iacopo MASTROMATTEO (CFM)

Postdoctoral Researchers

Anirudh PAMMI (X)

Ruben ZAKINE (X)

Fabian AGUIRRE (X)

PhD Students

Jérôme GARNIER-BRUN (X) Cecilia AUBRUN (X)

Salma ELOMARI (X)

Max KNICKER (X)

Natasha HEY (X)

Jutta KURTH (X)

Elia MORETTI (X)

Rudy MOREL (ENS)
Samy LAKHAL (X)
Karl NAUMANN (X)
Victor LECOZ (Quant AI/X)
Nirbhay PATIL (EHESS)
Guillaume MAITRIER (BNP/X)
Antoine-Cyrus BECHARAT (X)
Swann CHELLY (Science Po)
Max TOPEL (University of Chicago)

Interns

Alessandro SALVATORE (EPFL/X)
Pierre BOUSSEYROUX (ENS)
Tomas ESPANA (X)
Alireza HASSANZADEH (X)
Azamat KAOLEV (X)

PUBLICATIONS OF THE YEAR DIRECTLY RELATED TO THE RESEARCH PROGRAM

1. Socioeconomic Agents As Active Matter in Nonequilibrium Sakoda-Schelling Models
Ruben Zakine, Jerome Garnier-Brun, Antoine-Cyrus Becharat, Michael Benzaquen
Phys. Rev. E (in press)

2. When Is Cross Impact Relevant?
Victor Le Coz, Iacopo Mastromatteo, Damien Challet, Michael Benzaquen
Quantitative Finance, pp 265-279, https://doi.org/10.1080/14697688.2024.2302827

3. Multiscale Relevance of Natural Images
Samy Lakhal, Alexandre Darmon, Iacopo Mastromatteo, Matteo Marsili, Michael Benzaquen
*Scientific Reports **13** (2023) 14879*

4. Income Inequalities Increase with City Size: Evidence from French Data
Nirbhay Patil, Jean-Pierre Nadal, J-P Bouchaud
arXiv preprint arXiv:2305.12864

5. The Cost of Misspecifying Price Impact
Natasha Hey, J-P Bouchaud, Iacopo Mastromatteo, Johannes Muhle-Karbe, Kevin Webster
arXiv preprint arXiv:2306.00599

6. The Stability Matrix Spectrum of Large Ecological and Economical Systems
Nirbhay Patil, Fabián Aguirre-López, J-P Bouchaud
arXiv preprint arXiv:2312.11149

7. Unlearnable Games and “Satisficing” Decisions: A Simple Model for a Complex World
Jerome Garnier-Brun, Michael Benzaquen, J-P Bouchaud
arXiv preprint arXiv:2312.12252

8. Trading with Concave Price Impact and Impact Decay - Theory and Evidence
Natasha Hey, Iacopo Mastromatteo, Johannes Muhle-Karbe, Kevin Webster
Available at SSRN

9. Wrapping and unwrapping multifractal fields
Samy Lakhal, Laurent Ponson, Michael Benzaquen, J-P Bouchaud
arXiv preprint arXiv:2310.01927

10. Bringing together two paradigms of non-equilibrium: Driven dynamics of aging systems
Tapias, D., Marteau, C., Aguirre-López, F., & Sollich, P.
arXiv preprint arXiv:2402.03516.

11. Random features and polynomial rules
Aguirre-López, F., Franz, S., & Pastore, M.
arXiv preprint arXiv:2402.10164

12. Post-COVID Inflation & the Monetary Policy Dilemma: An Agent-Based Scenario Analysis
Max Sina Knicker, Karl Naumann-Woleske, Jean-Philippe Bouchaud, Francesco Zamponi
*arXiv preprint arXiv:*2306.01284.

13. Agent-based Integrated Assessment Models: Alternative Foundations to the Environment-Energy-Economics Nexus
Karl Naumann-Woleske
arXiv preprint arXiv:2301.08135

14. Exploration of the parameter space in macroeconomic agent-based models
K. Naumann-Woleske, M. Sina Knicker, M. Benzaquen and J.-P. Bouchaud
Handbook of Complexity Economics (in press)

15. Multivariate quadratic Hawkes processes - Part I: Theoretical analysis
C. Aubrun, M. Benzaquen and J.-P. Bouchaud
Quantitative Finance 23 (2023) 741

16. Cross impact in derivative markets
M. Tomas, I. Mastromatteo and M. Benzaquen
*Wilmott Magazine **123** (2023) 16–28*

17. Microfounding GARCH models and beyond: A Kyle-inspired model with adaptive agents
M. Vodret, I. Mastromatteo, B. Toth and M. Benzaquen
J. of Economic Interaction & Coordination 18 (2023) 599

18. Bounded rationality and animal spirits: A fluctuation-response approach to Slutsky matrices
J. Garnier-Brun, J.-P. Bouchaud and M. Benzaquen
J. Phys. Complexity 4 (2023) 015004

19. A new spin on color quantization
S. Lakhal, A. Darmon and M. Benzaquen
J. Stat. Mech. (2023) 033401 [Highlights collection]

PhD theses

Turbulent approaches to image analysis and statistical fractography
Samy Lakhal

Navigating radical complexity: the influence of disorder, nonrelaxational dynamics and learning on aggregate coordination
Jerome Garnier-Brun

Modèles compacts de processus multi-échelles
Rudy Morel

MAJOR COMMUNICATIONS RELATED TO THE RESEARCH PROGRAM

— Imperial College Market Microstructure Conference (London)
— Citadel PhD Summit (London)
— Rencontres du non-linéaire (Paris)
— Zif Complexity, aesthetics, and data sonification (Bielefeld)
— Louis Bachelier Risk Forum (March 2024)
— Market Microstructure Seminar (Edinburgh)
— CFM's Market Impact Workshop (Paris)
— Quant Minds Conference (London)
— Economic Fitness and Complexity Spring School (Rome)
— Agent-based modelling Workshop (Paris)
— NetSci Conference (Vienna)
— Agent-based Stock Flow Consistent Modelling (Ancona)
— DPG Spring Meeting (Berlin)
— ABM4Policy Workshop at the Bank of England (London)
— GEOINNO Conference (Manchester)
— Winter Workshop on Complex Systems (Barcelona)

Events organized and financed by the program

EconophysiX annual retreat (3 days, Sainte Anne la Palud, Bretagne)

OTHER HIGHLIGHTS

Awards Natascha Hey
— Citadel PhD Summit, Poster Session Winner: Grant 25.000$
— Rebellion Research, Research Paper of the Year

Award Samy Lakhal
— JSPS Postdoctoral Scholarship

4th call for WIQF (Women In Quantitative Finance).

"Physics of Financial Markets: An Introduction to Econophysics" Class at Ecole Polytechnique. Cours de 3A (40h).

Max Topel, Visiting PhD program form University of Chicago

Outreach Project

Video Series: *EconophysiX lab in a nutshell* (our researchers share insights on their work and current projects through easy-to-understand short videos). See e.g. https://www.linkedin.com/company/71565575/admin/feed/posts/

19/03/2024	Clément Le Priol, postdoctoral associate at ENS	Rare event algorithms in Climate science: How does it work? What can it be good for?
20/03/2024	Ana Bugaenko, Senior Research Engineer at Man Group	Scale Invariance and Liquidity Games in Continuous Double Auctions
03/02/2024	Marcello Rozenberg, Laboratoire de Physique des Solides, Orsay	A bioinspired neurosynaptic device for automatic trading.
08/02/2024	Daniel Seara, University of Chicago	Sociohydrodynamics: data-driven modeling of social behavior
16/01/2024	Carmen Cabrera-Arnau, Geographic Data Science University of Liverpool	Using digital trace data to uncover the heterogeneity of human mobility patterns at various spatiotemporal scales
14/11/2023	Pierfrancesco Urbani, IPhT Saclay.	Statistical physics of learning algorithms
11/06/2023	Andrés Leon Baldelli, Institut d'Alembert, Paris 6	Cracks connect, as an irreversible process.
16/10/2023	Yves Caseau, Group Chief Digital & Information Officer at Michelin	Integrated Assessment Models (IAMs), Impact of Global Warming
17/10/2023	Alexei Poliakov, CEO and co-founder of locomizer	Spatial behaviour as a quantifiable identity
18/07/2023	Bart Taub, Professor in Finance at University of Glasgow	Price Impact in the Limit Order Book
30/06/2023	Andrea Roventini, Institute of Economics at Santa'Anna in Pisa	Macroeconomic policies for rapid decarbonization, sustainable growth and economic stability.
16/06/2023	Olivier Godechot,CNRS researcher Fellow at SciencePo	Bonus and Wages in finance and its contribution to global inequality .
23/05/2023	Andrea Gabrielli, Associate Professor at Roma Tre University	Laplacian Renormalization Group for heterogeneous networks: information core and entropic transitions
25/04/2023	by Emanuele Citera, St. Lawrence University (NY, USA).	The network origins of aggregate fluctuations: A demand-side approach
04/11/2023	Paul Valcke, Environmental Justice Program at Georgetown University	Complexity macroeconomics models for ecology: from Goodwin to physical multisectoriality
04/04/2023	Antoine Tilloy, Centre Automatique et Systèmes at Mines ParisTech.	Exploring the Metaphysical and Practical Implications of Quantum Mechanics
28/02/2023	Julien Guyon, Professor of Applied Mathematics at Ecole des Ponts	Fair random draws in sport competition
02/09/2023	Anxo Sánchez, Applied Mathematics at Universidad Carlos III de Madrid	A mathematical description of decision-making processes involving norms and its experimental validation.
01/12/2023	Matteo Smerlak, Max Planck Institute for Mathematics, Leipzig	Diversity begets stability in competitive ecological communities