Maarten P. Scholl

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EDUCATION

DPhil in Computer Science
University of Oxford 2024
Institute for New Economic Thinking at the Oxford Martin School

Thesis: *The Financial Market as an Ecosystem.*

Selected Achievements

- Scholl, Calinescu and Farmer (2021). *How Market Ecology Explains Market Malfunction*, Proceedings of the National Academy of Sciences, Economic Sciences, https://www.pnas.org/content/118/26/e2015574118?cct=2461.
- Aymeric Vie, Maarten Scholl, Alissa M. Kleinnijenhuis, J. Doyne Farmer, *Evology: an Empirically-Calibrated Market Ecology Agent-Based Model for Trading Strategy Search*, ICML 2022, https://arxiv.org/abs/2210.11344.
- Design and implementation of an agent-based economic simulation library for high-performance market simulation https://github.com/INET-Complexity/ESL.
- Beneficiary to J.P. Morgan Chase & Co 2019 AI Research Grant to develop our market model to calibrate it to regulatory reporting data to construct realistic investment funds, and 2020 AI Research Grant to look at calibration of Agent-based Models using opponent modelling.

Working Papers

- Scholl et al. *Decoding Factors from Noisy Markets using Variational Auto-Encoders* (2023-).
- Scholl et al. *Testing the Market Ecology Hypothesis* (2024-).
- Scholl, Kleinnijenhuis, Wetzer, Kahros, Rosati, Farmer. *System Risk in the European Derivatives Markets* (2020-).

Technical Report

- Imitating Investment Managers using GANs.

ICML 2024 Area Chair Workshop on Agentic Markets.

ICAIF 2023 Program Committee Reviewer agent-based systems.

MSc in Computational Science, focus area Computational Finance
Universiteit van Amsterdam & Vrije Universiteit 2017
Thesis: *"The Role of Central Clearing Parties in OTC Derivatives Markets"* which was awarded with the Ernst & Young *Best Quantitative Finance Thesis Award* 2017.

Computational Finance	Stochastic Simulation
Numerical Algorithms	Large Scale Computing

BSc in Computer Science
Universiteit Utrecht 2013

Algorithmics	Concurrency
Networks	Computer Architecture

Exact Mathematical Sciences Honours Programme
Individual research project focusing on problems in Computational Finance that can be modelled using Graph Theory constituting one year of research into graph algorithms to approximate several NP-hard problems. Implemented and compared results of several parallel approximation algorithms in C++ to operate on large data-sets of FX pricing data.

BSc in Information Science, focus area Business Informatics
Universiteit Utrecht 2013

Data-Modelling and Databases Organisations and IT
Information Systems Society and IT

EXPERIENCE

AI Research Internship J.P. Morgan Chase & Co. June 2020-September 2020
London, United Kingdom

Summer Internship, working on an agent-based model of limit order books, I looked at developing the ABM to add more realistic strategies, and briefly worked on opponent modelling.

Research Consultant European Central Bank March 2018-March 2020
Frankfurt am Main, Germany

As a consultant to the Directorate General Markets Infrastructure and Payment Systems, I worked on analysing the EMIR Trade Repository data to compute the derivatives-contracts' valuations and risk sensitivities. I applied my previous experience in financial markets to correctly identify derivatives contracts, and use the recovered information in combination with market quotes to recover in detail the state of the European derivatives market for specific dates.

Project Officer ABN Amro, Counterparty Exposure Desk 2016-2017
Amsterdam, The Netherlands

At the counterparty exposure management desk I helped with mapping the pre- and post trade reporting process to provide a consistent and complete overview of current exposures. With this data in place, I worked on derivative portfolio compression. I also worked on combining public reporting data and summarising derivative reporting data (EMIR & Dodd Frank).

Summer Intern Global Markets ABN Amro 2016
Amsterdam, The Netherlands

Research Assistant Amsterdam Data Science 2015-2016
Amsterdam, The Netherlands

Experimental research into synchronisation of distributed large-scale network computations. Analysis of the PowerGraph processing system running on the https://www.cs.vu.nl/das5/Distributed ASCI Supercomputer 5. Developed performance measurement code in C++ and testing and analysis in Python.

Developer InAdmin RiskCo 2013-2014
Utrecht, The Netherlands

At the risk management consulting company RiskCo I developed several financial models for customer MetLife and worked on a distributed computational framework for large scale computation and sensitivity analysis of these models.

PROFESSIONAL TRAINING

Interest rate derivative pricing and market model construction.
Advanced knowledge of C++20, popular libraries such as QuantLib and Boost. Python (numpy, pandas, TensorFlow). Linux system management. Windows & .NET application development.
Computing Infrastructures for distributed and parallel computing: supercomputers, clusters, dynamic scaling (cloud) and GPGU computing using CUDA applied to option pricing.

HONORS, AWARDS AND SCHOLARSHIPS

Smith Programme Scholarship
J.P. Morgan & Chase AI Research Faculty Award
Ernst & Young *Best Quantitative Finance Thesis Award* 2017 (details)
Computer Science Department Conference Funding Grant
Hendrik Muller's Vaderlandsch Fonds Scholarship

GRANTS & SCHOLARSHIPS

JPMC AI Research Grant 2020 USD 150,000
ECB EMIR Bridge Programme Research Grant 2019 EUR 30,000
JPMC AI Research Grant 2019 USD 150,000
ECB Research Grant: Interconnectedness of Central Clearing Parties 2018 EUR 20,000

EXTRACURRICULAR ACTIVITIES

Oxford University Polo Club
Exact and Mathematical Sciences Honours Programme - Cambridge Visit - Chairman

THESIS ABSTRACT

The standard approach to the economic analysis of financial markets asserts that market participants are rational decision-makers. This leads us to pessimistic interpretations of phenomena like financial crises, flash crashes and speculative asset bubbles, as these seem unavoidable, rational, and perhaps even necessary consequences of the financial market system. Despite contradictory evidence from behavioural economics and unexpected outcomes in rational agent models, this assumption is pervasive in contemporary thinking about how we respond to economic crises, how we decide how to allocate our capital to technologies with the potential for growth, and how we financially plan our lives.

The consequence of this is that many negative externalities of financial markets are not well understood, and the wrong reading is taken from crises. We investigate models using boundedly rational agents, divided into 'species' of investors, as an alternative to the assumption of perfect rationality. With the aid of agent-based models, we simulate financial markets in which the agents use archetypes of real-world investment strategies. We show that there is a clear relation between the concentration of strategies and the qualitative aspects of the market such as mispricing and volatility. We draw an analogy between this property of complex financial systems and density dependence in ecological systems.

These endogenous dynamics are not present in equilibrium models and require new tools to be understood. The market food web is introduced as a tool to understand the interactions between different strategies in a market, and large-scale agent-based simulation enables its application through counterfactual simulation. It explain which investment activities are expected to receive the highest returns conditional on the composition of other market participants, and predicts what might happen if the population of investors changes in response to an intervention. We hypothesise that density dependence also exists in real-world markets, though will be more difficult to demonstrate, as data identifying individuals and their long-term interactionsis limited, and the rules and context of financial markets in the wider economy has changed over time. Nevertheless, we investigate the diversity of real-world long-term investment strategies by performing a holdings-based classification approach. This novel classification method uses publicly available data in the traditional format of portfolio holdings, balance sheets and income statements, and also allows comparison to other forms of data, such as the text in prospectuses of investment funds. Compared to returns-based analysis, this approach is shown to be sensitive to the reporting scope and frequency, and to suffer when data is not verified or validated. This approach is shown to benefit from deep learning techniques, and this enables us to better explain the cross-section of fund returns than competing holdings-based methods. Additionally, the models developed here can be used to power future agent-based models in need of realistic investment strategies.

Ultimately, we show that the necessary conditions for the market ecology hypothesis hold, and that therefore specific investment strategies are associated with qualitative changes in the market. However, to establish causation, more frequent data and data identifying counterparties are required. This thesis not only enhances our understanding of markets, but also underscores the need for detailed regulatory filing by financial market participants, for the benefit of the investing public. We also discuss how regulators can amend their policies to better understand markets from an ecological perspective. With such data, the ideas, methodology and software developed for this thesis enable regulators to describe financial markets as an ecosystem whose qualities are understood, and allow them to test policies to improve the qualities of financial markets. Such interventions would not only lead to fewer biases in pricing and reduced volatility, but offer a system-wide view that leads to fewer negative externalities.