

**FESTSCHRIFT FOR ALAN KIRMAN**  
Moorgate Auditorium, Bank of England  
*16-17 March 2023*

Professor Alan Kirman's early research interests focused on theoretical economics, in particular general equilibrium and game theory. However, as problems with the foundations became clear, his interests turned to empirical evidence on how the economy in general, and some markets in particular, function. He has become increasingly involved in modelling the economy and markets as complex adaptive systems in which aggregate behaviour emerges from interaction between, rather than the addition of, economic agents with limited knowledge. He has argued that economic actors are perhaps closer to ants than to *homo economicus*.

This event celebrates Alan's vast and important contributions to economics, covering themes such as heterogeneity and aggregation; interaction and emergence; co-operative and non-co-operative behaviour; equilibrium and non-equilibrium solutions; and the application of economic theory to policy. It aims to bring together insights from his career and what they may mean for the future of economics. The papers will be published in a volume in honour of Alan's contributions to economics.

*N.B. We have had to change some timings / events due to the train strike on Thursday, 16<sup>th</sup> March. Please note, photo ID is strictly required for admission.*

**Thursday 16 March 2023**

**15:30 – 15:50 Registration**

**15:50 – 16:00 Welcome and opening remarks**

Henrietta Moore, Institute for Global Prosperity, UCL

**16:00 – 16:45 Alan's Intellectual Journey**

Chair: William Hynes, New Approaches to Economic Challenges, OECD

James Heckman, Winner of the Nobel Memorial Prize in Economic Sciences, University of Chicago (*by video*)

Robert Axtell, George Mason University

Lucrezia Reichlin, London Business School

**16:45 – 18:00 How Science can Improve Understanding of the Economy**

Chair: Rachana Shanbhogue, The Economist

Alan Kirman, Ecoles des Hautes Etudes en Science Sociales (EHESS)

Joseph Stiglitz, Winner of the Nobel Memorial Prize in Economic Sciences, Columbia University

Audience Discussion

**18:00 End of Day 1**



## Friday 17 March 2023

8:30 – 9:00	<b>Registration</b>
9:00 – 9:50	<b>Keynote Address</b>  Chair: Angus Armstrong, Rebuilding Macroeconomics, UCL Joseph Stiglitz, Winner of the Nobel Memorial Prize in Economic Sciences, Columbia University Discussant: John Kay, FT and St John's Oxford
9:50 – 11:10	<b>Roundtable: Equilibrium</b>  Chair: Mary Morgan, LSE Sam Bowles, Santa Fe Institute, "Another case of the emperor's clothes: The liberal trilemma" ( <i>by video</i> ) Ed Hopkins, Edinburgh University, "Non-Equilibrium Analysis: Variations on Themes by Cournot and Edgeworth" Rama Cont, University of Oxford, "Economics out of equilibrium: bubbles, crashes and crises"
11:10 – 11:30	<b>Tea and coffee break</b>
11:30 – 13:00	<b>Roundtable: Coordination</b>  Chair: Misa Tanaka, Bank of England Nick Vriend, Queen Mary University of London, "Learning to Co-ordinate" Jean-Pierre Nadal, EHESS, "The Curse of Co-ordination: Entanglement between supply and demand in markets with bandwagon goods" ( <i>by video</i> ) Paul Pezanis Christou, University of Adelaide, "Sequential descending-price auctions with asymmetric buyers: Evidence from the Sète fish market"
13:00 – 14:00	<b>Lunch</b>
14:00 – 15:30	<b>Roundtable: Complexity</b>  Chair: Carolina Alves, UCL Robert Axtell, George Mason University, "Alan Kirman, Complexity Economist before there was Complexity Economics" Giovanni Dosi, Scuola Sant Anna Pisa, "Why is economics the only discipline with so many curves going up and down? And are they of any use?" Mauro Gallegati, Ancona, "From Equilibrium to Complexity Economics: The Route of Alan Kirman"
15:30 – 16:00	<b>Tea &amp; coffee break</b>



**Friday 17 March 2023, cont.**

**16:00 – 17:30 Roundtable: Interaction**

Chair: Andi Joseph, Bank of England

Matteo Marsili, ICTP Trieste, “On the determinants and unintended consequences of inequality”

Robin Cowan, University of Maastricht, “Far from random? The role of homophily in student supervision”

Pia Andres, LSE, “Stranded nations? Transition risks and opportunities towards a clean economy”

**17:30 – 17:50 Closing remarks**

Mary Morgan, LSE

Angus Armstrong, Rebuilding Macroeconomics, UCL

Alan Kirman, Ecoles des Hautes Etudes en Science Sociales (EHESS)

**18:00 Drinks (venue to be announced)**

For full details and registration please click here:

<https://www.rebuildingmacroeconomics.ac.uk/event-details/festschrift-for-alan-kirman>

Further enquiries contact: [angus.armstrong@ucl.ac.uk](mailto:angus.armstrong@ucl.ac.uk)



**Programme Notes**

**Alan's Intellectual Journey**

**How Science can Improve Understanding of the Economy**

16<sup>th</sup> March 2023:16:45 – 18:00

Chair: Rachana Shanbhogue, The Economist

Alan Kirman, Ecoles des Hautes Etudes en Science Sociales (EHESS)

Joseph Stiglitz, Winner of the Nobel Memorial Prize in Economic Sciences, Columbia University  
Audience Discussion

**Alan Kirman**

Alan Kirman obtained his PhD from Princeton, and he has been professor of economics at Johns Hopkins University, the Université Libre de Bruxelles, Warwick University, and the European University Institute in Florence, Italy. He was elected a fellow of the Econometric Society and of the European Economic Association and was awarded the Humboldt Prize in Germany. He is member of the Institute for Advanced Study in Princeton. He was elected as a foreign member of the Accademia dei Lincei in Rome, the oldest academy in the world in 2016.

He has published 150 articles in international scientific journals and on the editorial board of several international journals. He also is the author and editor of fifteen books, most recently *Complex Economics: Individual and Collective Rationality*, which was published by Routledge in July 2010 and *Complexity and Evolution: Toward a New Synthesis for Economics* edited with David S. Wilson published by MIT Press in 2016.

**Joseph Stiglitz**

Joseph E. Stiglitz is an American economist and a professor at Columbia University. He is also the co-chair of the High-Level Expert Group on the Measurement of Economic Performance and Social Progress at the OECD, and the Chief Economist of the Roosevelt Institute. Stiglitz was awarded the Nobel Memorial Prize in Economic Sciences in 2001 and the John Bates Clark Medal in 1979. He is a former senior vice president and chief economist of the World Bank and a former chair of the U.S. Council of Economic Advisers. In 2000, Stiglitz founded the Initiative for Policy Dialogue, a think tank on international development based at Columbia University. In 2011 Stiglitz was named by Time magazine as one of the 100 most influential people in the world. Known for his pioneering work on asymmetric information, Stiglitz's research focuses on income distribution, climate change, corporate governance, public policy, macroeconomics and globalization. He is the author of numerous books including, most recently, *People, Power, and Profits*, *Rewriting the Rules of the European Economy*, and *Globalization and Its Discontents Revisited*.



### Roundtable: Equilibrium

Chair: Mary Morgan, LSE

Sam Bowles, Santa Fe Institute, "Another case of the emperor's clothes: The liberal trilemma"

Ed Hopkins, Edinburgh University, "Non-Equilibrium Analysis: Variations on Themes by Cournot and Edgeworth"

Rama Cont, University of Oxford, "Economics out of equilibrium: bubbles, crashes and crises"

#### Sam Bowles

[SAMUEL BOWLES](#), (PhD, Economics, Harvard University) is Research Professor at the Santa Fe Institute where he heads the Behavioral Sciences Program. He taught economics at Harvard from 1965 to 1973 and since then at the University of Massachusetts, where he is now emeritus professor and at the University of Siena from 2002 to 2010 where he continues to occasionally teach.

Bowles' current research also includes theoretical and empirical studies of political hierarchy and wealth inequality and their evolution over the very long run. His studies on cultural and genetic evolution have challenged the conventional economic assumption that people are motivated entirely by self-interest. Recent papers have also explored how organizations, communities and nations could be better governed in light of the fact that altruistic and ethical motives are common in most populations. He has served as an economic advisor to the governments of Cuba, South Africa and Greece, to U.S presidential candidates Robert F. Kennedy and Jesse Jackson, to the Legislature of the State of New Mexico, to the Congress of South African Trade Unions, and to South African President Nelson Mandela.

#### Abstract: Another case of the emperor's clothes: The liberal trilemma

Inspired by Alan Kirman's "The intrinsic limits of modern economic theory: The emperor has no clothes," I demonstrate a similar case of missing clothes, in which a common "result that economic theory has demonstrated" -- what I term the liberal trinity -- is just not there once you look carefully. By the liberal trinity I mean the claim that barring contractual incompleteness and the other commonly recognized sources of market failure, the following desiderata will jointly obtain: a) individuals may have any preferences whatsoever, including unmitigated self-interest; b) their actions, including participation in any particular economic activity, are uncoerced, that is, motivated solely by whatever these preferences happen to be, and c) the allocations resulting from exchange among these individuals are Pareto efficient. In economics terminology the claim is that under unrestricted preferences, the Nash equilibria satisfying both the participation and incentive compatibility constraints would be Pareto efficient.

To underscore the normative content of this claim I will call these three liberal desiderata respectively, preference neutrality, liberty, and efficiency. Drawing on results in the field of mechanism design and my joint work with Sung-ha Hwang, I demonstrate what we call the "Liberal Trilemma" confirming the impossibility of jointly realizing the desiderata of efficiency, preference neutrality, and liberty that constitute the liberal trinity: Any two can simultaneously be met but only by violating the third. The critical theoretical flaw accounting for the trilemma is identical to that which Kirman identified in his critique of Walrasian general equilibrium theory: "... in the standard framework we have too much freedom in constructing individuals."



## Ed Hopkins

[Ed Hopkins](#) studied at Oxford University, LSE and the European University Institute, in Florence, Italy.

He has been at Edinburgh since 1995, but in that time he has also been a visitor at the EUI, the University of Pittsburgh, the University of California, Santa Barbara, the California Institute of Technology and the University of British Columbia. Ed's research is in game theory and more generally microeconomic theory. He has worked on several aspects of behavioural and social economics, including status concerns, tournaments, learning, inequality and marriage matching. He has also worked on experiments to test some predictions of learning theory.

### **Non-Equilibrium Analysis: Variations on Themes by Cournot and Edgeworth**

One of Alan Kirman's many interests has been the process by which prices are set in markets and whether they settle into equilibrium. This paper is a brief overview of some fundamental ideas in oligopoly theory and contrasts the approach of Cournot and Edgeworth with modern game theoretic approaches to oligopoly. It then confronts these different approaches with the results from recent laboratory experiments. I argue that the earlier approach, although less formally developed, is superior in explaining behaviour. Further, recent developments in the theory of learning and adaptive behavior can reconcile modern and 19th century approaches and can explicitly address when and if over time prices will reach equilibrium.

In the 19th century, economists including Cournot and Edgeworth approached the issue of oligopoly as a repeated process taking place over time. More modern treatments choose to distinguish between repeated and static games. Cournot equilibrium is now seen as the Nash equilibrium of a static oligopoly game. While this is more rigorous, there is no empirical support in the experimental literature for human players being able to play Nash equilibrium in one-shot encounters. Recent theory on learning in oligopoly in contrast provides a formal basis for how equilibrium can be achieved over time and conditions for when this will not happen. Perhaps more strangely it even provides a theory of how an illusion of an equilibrium can occur while the learning process continually cycles. Experimental tests of these hypotheses support the theory.

## Rama Cont

Rama Cont is the Professor of Mathematical Finance at the University of Oxford. He is known for contributions to probability theory, stochastic analysis and mathematical modelling in finance, in particular mathematical models of systemic risk. He was awarded the Louis Bachelier Prize by the French Academy of Sciences in 2010.

Cont started his career as a CNRS researcher in applied mathematics at Ecole Polytechnique (France) in 1998 and held academic positions at Ecole Polytechnique, Columbia University and Imperial College London. He was appointed 'Directeur de Recherche CNRS' (CNRS Senior Research Scientist) in 2008 and was chair of mathematical finance at Imperial College London from 2012 to 2018. He was elected Statutory Professor in Mathematical Finance at the Oxford Mathematical Institute and professorial fellow of St Hugh's College, Oxford in 2018.

### **Economics out of equilibrium: bubbles, crashes and crises**

Economic theory's focus on the concept of equilibrium leaves out many interesting and important economic phenomena related to out-of-equilibrium dynamics. Yet excursions out of equilibrium are not mere curiosities, but are important both from a theoretical perspective and from a policy perspective. We discuss how Alan Kirman's early work on the foundations of general equilibrium theory fueled his insights on the shortcomings of the equilibrium approach in economics and provide examples of modelling approaches for out of equilibrium phenomena in economics and finance.



### Roundtable: Coordination

Chair: Misa Tanaka, Bank of England

Nick Vriend, Queen Mary University of London, “Learning to Co-ordinate”

Jean-Pierre Nadal, EHESS, “The Curse of Co-ordination: Entanglement between supply and demand in markets with bandwagon goods” [virtual]

Paul Pezanis Christou, University of Adelaide, “Sequential descending-price auctions with asymmetric buyers: Evidence from the Sète fish market”

#### Nick Vriend

[Nick Vriend](#) is Professor of Microeconomics at Queen Mary and currently the Director of Undergraduate Studies.

Nick's research field is microeconomics (microeconomic and game theory) with a main research interest economic dynamics, in particular the dynamics of interactive social processes involving (boundedly) rational, learning agents. In relation to this, his main research methods, besides verbal and mathematical analysis, are experimental economics and Agent-based Computational Economics (ACE). He has worked on models of price dispersion and consumer loyalty and of the phenomenon of information-contagion, and he has investigated a range of learning theories both in theory and in experimental setups (including various oligopolistic markets, a location game, and ultimatum games).

Nick has been working recently in particular on coordination problems. He studied experimentally the role of non-equilibrium focal points and the role of smiles, winks, and handshakes as coordination devices, as well as the roles of punishment and social identity. He has also been working on models of categorization in individual decision problems and in coordination games, and on models of segregation, as well as on the topic of electoral competition. Nick's undergraduate studies in Economics were at the University of Amsterdam, and he received his PhD from the European University Institute in Florence (Italy).

#### Learning to Co-ordinate

Daskalova & Vriend (2022) presented a model of players who categorize their strategies and learn through reinforcement which categories to use. In this paper we apply this framework to a coordination game studied by Blume & Gneezy (2010). In their disc game, Blume & Gneezy highlighted, with the help of a novel experimental design, the importance of aspects such as the players' cognition levels, the beliefs about their opponents' cognition levels, as well as higher order beliefs in this respect. In this paper we investigate how a model based on a combination of categorization and reinforcement learning can handle these aspects. and how this may help our understanding of the behaviour of the players in such a game.





## Jean-Pierre Nadal

[Jean-Pierre Nadal](#) is Director of Studies at ESHS in Paris. He has a general maths and physics background, and a specialisation in theoretical physics, his earliest research works are in the domain of the statistical physics of disordered systems. In the mid 80's he turned to the modelling of neural networks, following the pioneering work of J. J. Hopfield on attractor neural networks. Since then, his main contributions in the domains of neural networks and computational neuroscience have been in the modelling of short-term memory in the human brain, the theory of supervised and unsupervised learning, and neural coding making use of both statistical physics and information theoretic tools.

In the recent years Jean-Pierre has been involved in collaborations with biologists. Some of his most recent works are motivated by problems at the boundary between linguistics and neuroscience (in collaboration with psycholinguists). His first work in the field of economic and social science dates to the mid 90's, a collaboration on the topic of market organization with Gérard Weisbuch at the ENS and Alan Kirman, EHESS. Since 2002, he works on collective phenomena in economic and social sciences in collaboration with physicists, mathematicians, economists and other social scientists.

### **The Curse of Co-ordination: Entanglement between supply and demand in markets with bandwagon goods**

This contribution will review results on the modelling of collective outcome when customers' choices (e.g. to buy or not a given good) depend on others choices (cases coined 'positive externalities' or 'bandwagon effect'). The model we study mathematically is related to both standard models in theoretical economics, models in statistical physics (the so call "Random Field Ising Models"), and is equivalent to a model introduced in social sciences by Schelling in the 70's.

A first key result is that, with heterogeneous agents, the demand may be multiply valued: for a same posted price, there is either a small number of buyers, or a large one – that is when the customers coordinate. Such multiple equilibria exist in a large domain in parameter space. This creates a dilemma for the seller: should he sell at a high price, targeting a small number of buyers, or at low price targeting a large number of buyers? We have shown that the interaction between demand and supply is even more complex than expected, leading to what we call the 'curse of coordination': the pricing strategy for the seller which aimed at maximizing his profit corresponds to posting a price which, not only assumes that the customers will coordinate, but also lies very near the critical price value at which such high demand no more exists.

## Paul Pezanis Christou

[Paul Pezanis Christou](#) is Associate Professor of Economics in the School of Economics and Public Policy at the University of Adelaide. Paul joined the School in November 2012 and previously held positions at the Institute of Economic Analysis (CSIC, Barcelona), the University of Strasbourg and the University of New South Wales. He holds a PhD in Economics from the European University Institute and his research interests are in Experimental and Behavioural Economics, Applied Game Theory, Auction markets, Market Design

### **Sequential descending-price auctions with asymmetric buyers: Evidence from the Sète fish market**

The paper reports an analysis of price behaviour at a fish market which is organised as a sequence of descending-price auctions, and which is attended by two different types of buyers: retailers and wholesalers. The main outcome of this study is that although each type of buyer paid different prices for quality-corrected lots of fish, the trends of prices are not significantly affected by buyers' asymmetric preferences and behaviours. In addition, the observed trends are best explained by Milgrom and Weber (1982) benchmark model which assumes symmetric risk neutral buyers and by its variations which assume risk averse buyers or an uncertain supply.

Bank of England | MOORGATE AUDITORIUM  
+44 (0)20 3461 4444 | [www.bankofengland.co.uk](http://www.bankofengland.co.uk)





## Roundtable: Complexity

Chair: Carolina Alves, IPP, UCL

Robert Axtell, George Mason University, “Alan Kirman, Complexity Economist before there was Complexity Economics”

Giovanni Dosi, Scuola Sant Anna Pisa, “Why is economics the only discipline with so many curves going up and down? And are they of any use?”

Mauro Gallegati, Ancona, “From Equilibrium to Complexity Economics: The Route of Alan Kirman”

### Robert Axtell

[Robert Axtell](#) works at the intersection of the computational, social, behavioural and economic sciences. His research group combines agent-based computing with micro-data to build large-scale models having high verisimilitude with the real-world. They have worked on a variety of policy issues, from housing to fisheries, behavioural aspects of retirement and science policy. Rob has been visiting Professor at the University of Oxford (UK), the New School for Social Research (NY), and Middlebury College (Vermont) and his research has been published in leading general interest journals ("Science," "Nature" and "Proceedings of the National Academy of Sciences"), in field journals (e.g., "American Economic Review," "Economic Journal", "Computational and Mathematical Organization Theory," "Journal of Industrial Ecology"), and reprised in newspapers (e.g., "Wall St. Journal," "Washington Post") and technology publications (e.g., "Scientific American," "Technology Review," "Wired").

### Alan Kirman, Complexity Economist before there was Complexity Economics

In “Growing Artificial Societies” Joshua Epstein and I identified four main ways that agent-based modeling and complexity ideas could be useful to economics: agent heterogeneity, bounded rationality, social networks, and out of equilibrium dynamics. To make our point more forcefully we deemed it useful to cite examples of such ideas in the extant economics literature of that era, knowing that there were few.

What we did not really expect to find was one scholar’s name associated with most of the examples. Alan’s attack on the representative agent (JEP, 1992) was the perfect companion to our advocacy of heterogeneous agents. His ingenious paper on ants (QJE, 1993) argued for bounded rationality in principle, aside from behavioral arguments based on experiments with human subjects, a perspective much closer to Herbert Simon’s original conception. His “Economies with Interacting Agents” paper, destined for a Santa Fe Institute volume and available to us in working paper form, mediated such interactions with networks, extending Föllmer’s early work on this subject, and providing further ammunition for our claims about the usefulness of social networks in economics.

Finally, his “Intrinsic Limits of Economic Theory” article (EJ, 1989) pointed out the important yet neglected role of disequilibrium in economic theory. Thus, in the work of a single great economist we found the basis, in analytical models that are his wont, for most of the critique that we were rendering with a novel computational approach, one that we hoped could serve as a methodology for a new kind of economics. Showing up in Europe with version 1 of the Sugarscape model c. the mid 1990s, imagine our pleasant surprise to find Alan in the audience. What we learned from Alan is that many of the things we were thinking about, he had already anticipated.



## Giovanni Dosi

[Giovanni Dosi](#) is professor of economics at the Institute of Economics. He also serves as co-director of the 'Intellectual Property Rights' task force at the *Initiative for Policy Dialogue* at Columbia University. Additionally, Professor Dosi is a continental Europe editor of the journal *Industrial and Corporate Change*. He is included in the ISI Highly Cited Research list, denoting those who made fundamental contributions to the advancement of science and technology, and is a corresponding member of the Accademia Nazionale dei Lincei, the first academy of sciences in Italy.

His major research areas - where he is author and editor of several works - include Economics of Innovation and Technological Change, Industrial Economics, Evolutionary Theory, Economic Growth and Development, Agent-Based Macroeconomics, Organization Studies and Theory of the Firm. He has been involved in a number of major international research projects.

His book *The Foundation of Complex Evolving Systems* has been published in early 2023. This manual seeks to offer an integrated analysis of the *anatomy and physiology of the capitalist engine* of generation and exploitation of technological organizational and institutional innovations - from the drivers of knowledge accumulation to the modes in which such knowledge is incorporated into business firms, all the way to the processes of innovation-driven "Schumpeterian competition" and macroeconomic growth. In that, it advances the interpretation of such patterns, in terms of economies seen as complex evolving systems.

### **Why is economics the only discipline with so many curves going up and down? And are they of any use?**

Even the most rudimentary training from Economics 101 starts with demand curves going down and supply curves going up. They are so "natural" that they sound even more obvious than the Euclidian postulates in mathematics. But are they? What do they actually mean? Consider demand curves. Are they hypothetical "psychological constructs" on individual preferences? Propositions on aggregation over them? Reduced forms of actual dynamic proposition of time profiles of prices and demanded quantities?

Alan Kirman is among the very few who has asked this type of subversive questions (another one has been Werner Hildenbrand). In a shorthand, my argument, fully in line with Alan Kirman, is that the forest of demand and supply curves is basically there to populate the analysis with double axiomatic notions of equilibria, both "in the head" of individual agents, and in environments in which they operate. Getting rid of them will be a major step toward making economics more similar to all empirically based "sciences" – as Herb Simon advocated - and more distant from theology.



## Mauro Gallegati

[Mauro Gallegati](#) obtained his Ph.D. in Economics in 1989 at the University of Ancona. He is professor of Economics at the Polytechnic University of Marche, Ancona. He has been visiting Professor in several Universities and research institutes, including Cambridge, Stanford, MIT, Columbia, Santa Fe Institute, Brookings Institution and ETH.

Prof. Gallegati is on the editorial board of several economic journals, among which the Journal of Economic Interaction and Coordination. His research includes business fluctuations, nonlinear dynamics, models of financial fragility and heterogeneous interacting agents. Mauro Gallegati is well known from his widely cited work with Joseph E. Stiglitz, developing theory of asymmetric information and heterogeneous agents and their applications. He published papers in the top journals on economic, economic history and history of economic analysis, nonlinear mathematics, applied economics, complexity and econophysics.

The research group lead by prof. Gallegati studies agent-based models of economic phenomena, with a special focus on the performance of heterogeneous, interacting agents, generating aggregate fluctuations, coordination failures and emerging phenomena in general. The group has extensive knowledge in simulation design and analysis of complex economic phenomena.

### **From Equilibrium to Complexity Economics: The route of Alan Kirman**

Economics was formed using classical physics as a model. To form the scientific status of economics, the insight of the neoclassicists was to transfer the ideas and mathematical apparatus of physics of the time into economics. The result was that economics, favouring the formalistic approach, did not care too much about “reasoning about economics”, preferring mathematical deduction. Thus, mainstream economists have ended up being more concerned with the characteristics of the states of an economy than with how those states are achieved.

The relationship between economics and physics is very dangerous especially when it neglects the relevance of time ignores the interaction by describing an ergodic system and forgets that the former is a social science while the latter is a natural science. One of the weaknesses of the practical application of the mainstream is the impossibility of determining the value to parameters in its models.

The standard theory of economics assumes that markets are always in equilibrium. Deviations from equilibrium are merely adjustments to external events. A direct cause-effect relationship is expected between a given event and its occurrence. A different viewpoint is that markets can evolve spontaneously towards an unstable situation. In this case, the triggering event becomes irrelevant, while the key point is the identification of the intrinsic instability elements. The loss of the cause-effect relationship and the importance of interactions between agents lead us naturally into the area of Complex Systems.

The new ideas developed by Kirman and other “complexity” economists indicate that markets and economies tend to operate in far from equilibrium conditions, and that different agents should be individually modelled as autonomous, active, and interactive entities, capable of making decisions. Strategic behaviour among heterogeneous interacting agents with incomplete information generates a network. Complexity economics can be read as an evolution of equilibrium economics to non-equilibrium.



## Roundtable: Interaction

Chair: Andi Joseph, Bank of England

Matteo Marsili, ICTP Trieste, "On information and interaction in financial markets"

Robin Cowan, University of Maastricht, "Far from random? The role of homophily in student supervision"

Pia Andres, London School of Economics "Stranded Nations? Transition risks and opportunities towards a clean economy"

### Matteo Marsili

Matteo Marsili is a theoretical physicist who gained his PhD from SISSA, Trieste in 1994. After postdoctoral positions in Manchester University, Fribourg University and SISSA, he first joined INFN as a researcher and later the Abdus Salam ICTP, a research center in theoretical physics in Trieste, as a Research Scientist. There, he's currently the coordinator of the Quantitative Life Sciences Section.

He is interested in understanding how collective behaviour results from the interaction of simple units, be them particles in physics, neurons in a brain tissue or traders in financial markets. He exploits techniques that have been developed in statistical physics to unveil the "un-intended consequences" of interdependencies in other domains of life sciences.

His research interests range from non-equilibrium statistical physics and critical phenomena to economics and finance. Lately, his interest has focused on statistical inference from high dimensional data, in e.g., systems biology and neuroscience, and its connection with critical phenomena.

#### On information and interaction in financial markets

In finance, information moves prices through the interaction of market participants. Information and interaction are two sides of the same coin. Market efficiency provides a convenient shortcut that made it possible to build the edifice of mathematical finance without taking interaction into account. We owe it to Alan, as well as to many others, if this is no longer the case. Yet finance still has no solid information theoretical foundation.

I will revisit the Glosten-Milgrom model to dig deeper in the relation between information and interaction. First, I will show how Bayesian learning by the market allows one to explain the full phenomenology of market impact. Second, I will show that the maximal expected gain that an informed trader can extract from the market is bound by the same relation that governs the maximal work that can be extracted from a cyclic transformation, when some information on the microscopic state is known. This not only shows, in this case, a strong analogy between market efficiency and the second law of thermodynamics, but it also suggests that an information theoretic approach to finance is possible.



## **Robin Cowan**

Robin Cowan is Professor of the Economics of Technical Change at the University of Maastricht, and Professor of Management at the Faculty of Economics and Management at the University of Strasbourg. He began his official affiliation with UNU-MERIT in 1997 as a Professorial Fellow. He is currently the Director of the PhD programme in Economics, Innovation and Governance for Development and UNU-MERIT. He studied at Queen's University in Canada and at Stanford University where he received a PhD in economics and an MA in philosophy.

Robin Cowan was Assistant Professor of Economics at the University of Western Ontario until 1998. His current research includes several topics: the changing economics of knowledge; social networks and innovation; network structure and network performance; universities and science in emerging economies; interacting agents models. In the past he has done consulting research for the OECD on the economics of standards, the European Commission on innovation policy, and the National Renewable Energy Laboratory on technological lock-in and renewable energy technologies.

In 2004 he won one of 15 prestigious Chaires d'Excellence of the Ministry of research and Education in France, and in 2013 was made a Senior Member of the Institut Universitaire de France.

### **Far from random? The role of homophily in student supervision**

The apartheid history of South Africa has left a legacy of segregation in many walks of life, including education, and transformation towards an integrated society has been an explicit goal of post-apartheid governments. Segregation is often coupled with the concept of "homophily", the tendency for connections to form between pairs of similar individuals. This paper studies race- and gender-based homophily in student-supervisor relationships in higher education.

Observed homophily can arise due to preferences: people prefer to associate with similar others. But it can also be induced by surroundings: if in a locale one group is over-represented relative to the general population, one might observe an "excess" of relationships between people of that group. Integration or segregation can be observed at many levels of aggregation, from the entire society down to pairs of individuals, and in this paper, we take advantage of that to develop a technique which separates choice homophily from that induced by an uneven distribution of groups and use it to examine student-advisor data in South Africa. The method uses permutation tests repeated at two levels of aggregation, system and departments, to create null models of random and unbiased ties formation that control for supervision capacity and small sample bias.

We find clear evidence of homophily in student supervision, both along racial lines and along gender lines. Roughly half of the observed homophily is induced by department composition and stays constant over time. Overall, choice homophily observed in racial and gender dimensions have similar magnitudes. We also find, though, that observed (choice) homophily (measured using a variant of "assortativity") changes over time. Asking whether this indicates some underlying change in preferences, we show that under some conditions homophily can mechanically increase during the transition phase of integration simply due to changes in the relative sizes of the different sub-groups.



## **Pia Andres**

[Pia Andres](#) is an economist working on issues related to the technological shift towards a low carbon and increasingly digital economy. She is particularly interested in the inter-dependencies between technological change, trade and geopolitics, and what they imply for the just transition towards a low carbon economy, as well as technological transitions more broadly.

She is currently completing her PhD in Environmental Economics at the London School of Economics and she is a researcher at the Future of Work Programme at the Oxford Martin School, which focuses on topics related to the rise of digital technologies and their implications for workers and organisations.

### **Stranded nations? Transition risks and opportunities towards a clean economy**

The transition away from a fossil-fuel powered economy towards a cleaner production system will create winners and losers in the global trade system. We compile a list of 'brown' traded products whose use is highly likely to decline if the world is to mitigate climate change, and explore which countries are most at risk of seeing their productive capabilities 'stranded'. Using methods from economic geography and complexity, we develop novel measures of transition risk that capture the extent to which countries' export profiles are locked-in to brown products.

We show that countries exporting a high number of brown products, especially technologically sophisticated ones, could find it relatively easy to transition. Conversely, countries with exports highly concentrated in a few, low-complexity brown products have much fewer nearby diversification opportunities. Our results suggest that export complexity and diversity play a key role in determining transition risk. Path-breaking diversification strategies are needed to prevent nations from becoming stranded.

## **Closing Remarks**

Mary Morgan, LSE

Angus Armstrong, Rebuilding Macroeconomics, UCL

Alan Kirman, Ecoles des Hautes Etudes en Science Sociales (EHESS)

