

Working Group Physics of Socio-Economic Systems Arbeitskreis Physik sozio-ökonomischer Systeme (AKSOE)

Stefan Bornholdt
Institut für Theoretische Physik
Universität Bremen
Otto-Hahn-Allee
28334 Bremen
bornholdt@itp.uni-bremen.de

Overview of Invited Talks and Sessions

(lecture rooms H8 and H10; Poster D)

Invited Talks

AKSOE 1.1	Mon	9:30–10:15	H8	Dynamics of language competition: biligualism and social structure — ●VICTOR EGUILUZ
AKSOE 6.1	Tue	9:30–10:15	H8	Sociophysics of Markets — ●JÖRG REICHARDT
AKSOE 9.1	Tue	16:00–16:45	H10	Statistical Mechanics of socio-economic systems — ●MATTEO MARSILI
AKSOE 11.1	Thu	9:30–10:15	H8	Ecology of firms in a financial market — ●ROSARIO NUNZIO MANTEGNA, FABRIZIO LILLO, ESTEBAN MORO, GABRIELLA VAGLICA

Sessions

AKSOE 1.1–1.1	Mon	9:30–10:15	H8	Dynamics of Groups and Organizations I
AKSOE 2.1–2.5	Mon	10:15–12:45	H8	Financial Markets and Risk Management I
AKSOE 3.1–3.4	Mon	14:00–16:00	H8	Dynamics of Groups and Organizations II
AKSOE 4.1–4.11	Mon	16:30–18:00	Poster D	Poster Session (posters are expected to be displayed the full day (9:00-18:00))
AKSOE 5	Mon	18:00–19:00	H8	AKSOE Mitgliederversammlung (member's assembly)
AKSOE 6.1–6.1	Tue	9:30–10:15	H8	Dynamics of Groups and Organizations III
AKSOE 7.1–7.5	Tue	10:15–12:45	H8	Economic Models and Evolutionary Game Theory I
AKSOE 8.1–8.3	Tue	14:00–15:30	H8	Economic Models and Evolutionary Game Theory II
AKSOE 9.1–9.1	Tue	16:00–18:00	H10	Award Ceremony: Young Scientist Award for Socio- and Econophysics
AKSOE 10.1–10.4	Wed	13:30–18:15	H8	Social-, Information-, and Production Networks
AKSOE 11.1–11.1	Thu	9:30–10:15	H8	Social-, Information-, and Production Networks II
AKSOE 12.1–12.3	Thu	10:15–11:45	H8	Social-, Information-, and Production Networks III
AKSOE 13.1–13.2	Thu	11:45–12:45	H8	Economic Models and Evolutionary Game Theory II
AKSOE 14.1–14.7	Thu	14:00–17:45	H8	Financial Markets and Risk Management III
AKSOE 15.1–15.2	Thu	17:45–18:45	H8	Dynamics of Groups and Organizations IV
AKSOE 16.1–16.5	Fri	9:30–12:00	H8	Traffic Dynamics, Urban, and Regional Systems

Symposium: Nonlinear and Fractional Transport in Complex Systems SYNFF

Wednesday 14:30–17:15 H1
see separate program section SYNFF

Special Event: Award Ceremony of the Young Scientist Award for Socio- and Econophysics

Tuesday 16:00–18:00 H10

- Keynote talk: Matteo Marsili, Trieste
- Award Presentation
- Talk of the Awardee

There will be beer and pretzels in honour of the awardee at the end of the session.

Annual General Meeting of the Working Group Physics of Socio-Economic Systems

Montag 18:00–19:00 H8

- Bericht des Vorsitzenden des AKSOE
- Diskussion über geplante Aktivitäten
- Verschiedenes

AKSOE 1: Dynamics of Groups and Organizations I

Time: Monday 9:30–10:15

Location: H8

Invited Talk

AKSOE 1.1 Mon 9:30 H8

Dynamics of language competition: biligualism and social structure — ●VICTOR EGUILUZ — IMEDEA, (CSIC-UIB), Palma de Mallorca, Spain

In the general context of dynamics of social consensus, we study an agent based model for the competition between two languages, addressing the role of bilingualism and social structure. We restrict our work here to the case of socially equivalent languages. In a regular network, we study the formation of linguistic domains and interaction in the

boundaries. We analyze also a small world social structure, in order to capture the effect of long range social interactions throughout the network. In both cases, a final scenario of dominance of one language and extinction of the other is obtained, but with smaller times for extinction in the latter case. We compare our results to our previous work on the agent based Abrams-Strogatz model where bilingualism was not taken into account, discussing the role of bilingual individuals in the problem of language competition depending on each social structure.

AKSOE 2: Financial Markets and Risk Management I

Time: Monday 10:15–12:45

Location: H8

AKSOE 2.1 Mon 10:15 H8

There can only be one! — ●JOHANNES JOSEF SCHNEIDER, SEBASTIAN GOLKE, TOBIAS PREIS, and WOLFGANG PAUL — Institute of Physics, Johannes Gutenberg University of Mainz, Staudinger Weg 7, 55099 Mainz, Germany

Demand and offer determine the price is a commonly accepted axiom in economics. However, when studying models simulating financial markets and containing this axiom as a key ingredient, we find that a small and decreasing group of agents aggregates all the assets and the money and dictates the price, until finally only one agent remains.

AKSOE 2.2 Mon 10:45 H8

Bounds for Value at Risk of currency portfolios — ●PIOTR JAWORSKI — Institute of Mathematics, Warsaw University, ul. Banacha 2, 02-097 Warszawa, Poland

In my talk I shall deal with the following simple case. An investor operating on an emerging market, has in his portfolio several foreign currencies which are highly dependent. Let s_i be the quotients of the currency rates at the end and at the beginning of the investment. Let w_i be the part of the capital invested in the i -th currency, $\sum w_i = 1$, $w_i \geq 0$. So the final value of the investment equals

$$W_1(w) = (w_1 s_1 + \dots + w_d s_d) \cdot W_0.$$

The crucial point is to estimate the risk of keeping the portfolio. As a measure of risk I shall consider "Value at Risk" (VaR), which last years became one of the most popular measures of risk in the "practical" quantitative finance. Roughly speaking the idea is to determine the biggest amount one can lose on certain confidence level α

$$VaR_{1-\alpha}(w) = \sup\{V : P(W_0 - W_1(w) \leq V) < 1 - \alpha\}.$$

The main result, I would like to present, is the following estimate of the Value at Risk of a given portfolio w in terms of Value at Risk of one-currency portfolios e_i :

$$\sum w_i VaR_{1-\alpha}(e_i) \geq VaR_{1-\alpha}(w) \geq \sum w_i VaR_{1-\alpha'}(e_i),$$

where $\alpha' = \frac{\alpha}{L(1, \dots, 1)}$. The above estimate is valid for sufficiently small α under the mild assumption that the lower tail part of the copula C of s_i 's is homogeneous of degree 1, i.e. for sufficiently small q

$$C(q) = L(q), \quad \forall t > 0 \quad L(tq) = tL(q).$$

AKSOE 2.3 Mon 11:15 H8

Fractional relaxations superposed with oscillations and log-periodic bullish anti-bubbles on Warsaw Stock Exchange — ●MARZENA KOZŁOWSKA and RYSZARD KUTNER — Institute of Experimental Physics, Department of Physics, Warsaw University, Smyczkowska Str. 5/7, PL-02678 Warsaw, Poland

We analyse the dynamics of the Warsaw Stock Exchange indexes WIG and WIG20 at a daily time horizon before and after its well defined local maxima of the cusp-like shape decorated with oscillations. The falling paths of all indexes peaks can be described by generalised exponent or the Mittag-Leffler (ML) function superposed with various

types of oscillations while the rising paths can be mainly described by bullish anti-bubbles. The former function is a solution of our model of index dynamics defined by the nonhomogeneous fractional relaxation equation. This solution is a generalised analog of an exactly solvable model of viscoelastic materials. The latter are a kind of log-periodic oscillations of market in the bullish state initiated by a crash. However, none of considered peaks of indexes can be viewed as the "finger print" of a dynamical critical phenomenon as financial market changes its state from the bullish to bearish ones before it reaches a critical region i.e. too early. This means that the Polish emerging financial market, although anomalous, should be considered as shy which can be reminiscence of a significant risk aversion of investors.

AKSOE 2.4 Mon 11:45 H8

Measure of risk: has it to be coherent — ●ULI SPREITZER and VLADIMIR REZNIK — Dr. Dr. Heissmann GmbH, 65189 Wiesbaden

Artzner et al. [1] postulated, that a measure of risk has to be coherent, i.e. translation invariance, subadditivity, positive homogeneity and monotonicity. Homogenous measures of risk are e.g. tail VaR or lower partial moments [2-3]. The often used VaR is not a homogenous measure of risk.

But a coherent measure means, that there are some assumptions a priori, which have to be at least be discussed. E.g. the subadditivity of the homogenous means that putting two assembles - e.g. two insurance companies and their contracts - does decrease or at least not increase the risk of the two assembles. But this holds only by making some more postulates on this new larger assemble a priori.

When these postulates can not be fulfilled, a coherent measure of risk gives wrong informations on this new assemble and one should therefore use non coherent measures of risk as e.g. VaR.

[1] P. Artzner et al. Finance 9 (1999)3, 203-228 [2] V. Reznik, U. Spreitzer, talk 28th ICA, 28.5. - 2.6.2006, Paris [3] U. Spreitzer, V. Reznik, On the opt... Physica A (2007)

AKSOE 2.5 Mon 12:15 H8

A stochastic model for claim reserves in P&C insurance companies — ●MAGDA SCHIEGL — Haydnstr. 6, 84088 Neufahrn

During the last few years holistic risk management has gained importance in banking and insurance business in connection with the new EU wide regulatory framework. In insurance industry the regulatory framework is called solvency 2. It is going to implement a new, efficient supervisory basis that enables the risk - orientated and principle based calculation of the economic capital. This is the capital shareholders should invest in the company in order to limit the probability of default to a given level within a given time horizon.

In property and casualty (P&C) insurance companies the claim reserves are a very important liability position in the balance sheet. They are necessary to cover the liabilities arising from insurance contracts written in the presence and past. We introduce a stochastic model for claim reserves. The model consists of two sub - models: One for the number of active claims and one for the claim payments. Further we perform Monte Carlo simulations on the basis of this model. The result is the probability distribution of the reserves. This is the basis for further risk calculation and management in P&C insurance companies.

AKSOE 3: Dynamics of Groups and Organizations II

Time: Monday 14:00–16:00

Location: H8

AKSOE 3.1 Mon 14:00 H8

YouTube, don't you? — ●RILEY CRANE and DIDIER SORNETTE — ETH Zürich, Chair of Entrepreneurial Risks, Zürich, Switzerland

Peering into the world of online social communities, we present a study of the dynamics of the number of downloads of videos on YouTube.com - a popular online destination for viewing, contributing, sharing, and discussing videos. We show how YouTube offers a unique probe into the dynamics of networks of viewers, characterized by scale-free distributions of statistics as well as power law memory kernels.

AKSOE 3.2 Mon 14:30 H8

Spatial Structure Formation and Population Dynamics: What a Landscape Ecologist could learn from a Ferromagnet

— ●FLORIAN HARTIG and MARTIN DRECHSLER — Helmholtz Centre for Environmental Research - UFZ, Department of Ecological Modeling, Leipzig, Germany

Transferable development rights (TDRs) have been proposed to allow for market based, self organized landscape management, where agents buy and sell rights for landscape development and ecological goals are incorporated in the trading rules. Unlike in CO2 emissions trading, space is a feature of crucial importance for species and therefore for TDR trading, which makes these markets so interesting from a system theoretical point of view.

We apply ecological-economic simulations to study the effect of an agglomeration bonus on a TDR market. The resulting landscape dynamics exhibit similarities to those of a spin system with a temperature (fluctuation of costs for habitats) and a next neighbor interaction (agglomeration bonus). Subsequently, the impact of the emerging landscape structures on population networks living on the latter is examined, taking species characteristics like population growth and dispersal into account.

We show that in addition to cost fluctuations, information access of the agents has a crucial influence on structure formation and the overall effectiveness of a TDR market. The gained understanding is used to optimize the market rules in terms of costs for species conservation.

AKSOE 3.3 Mon 15:00 H8

Non-equilibrium phase transitions in negotiation dynamics —— ANDREA BARONCHELLI^{1,2}, LUCA DALL'ASTA^{3,4,5}, ALAIN BARRAT^{3,4,6}, and ●VITTORIO LORETO¹ — ¹Dipartimento di Fisica, Università "La Sapienza" and SMC-INFN, P.le A. Moro 2, 00185 ROMA, (Italy) — ²Departament de Física i Enginyeria Nuclear, Universitat Politècnicade Catalunya, Campus Nord, Mòdul B4 c. Jordi Girona 1-3 08034 Barcelona (Spain) — ³LPT, CNRS, UMR 8627, Orsay, F-91405 (France) — ⁴Univ Paris-Sud, Orsay, F-91405 (France) — ⁵Abdus Salam International Center for Theoretical Physics, Strada Costiera 11, 34014, Trieste (Italy) — ⁶Complex Networks Lagrange Laboratory, ISI Foundation, Turin, Italy

We present a model of negotiation dynamics whose aim is that of mimicking the mechanisms leading to opinion and convention formation in a population of individuals. The key elements of negotiation are memory and feedback, while processes of opinion formation are usually modeled exploiting local majority or imitation rules. The model displays a non-equilibrium phase transition from an adsorbing state in which all agents reach a consensus to an active not-frozen stationary state characterized either by polarization or fragmentation in clusters of agents with different opinions. The transition is driven by external noise, intended as an 'irresolute attitude' of the agents in making decisions. We recover analytically the critical values of this parameter for various topologies of the agents' interaction network, and find results in perfect agreement with data obtained from numerical simulations.

AKSOE 3.4 Mon 15:30 H8

Why Capitalism is so stable — ●HANS DANIELMEYER and THOMAS MARTINETZ — Institute for Neuro- and Bioinformatics, University of Luebeck, Ratzeburger Allee 160, 23538 Luebeck

The distributions of incomes, expenses, and wealth are determined for a population of owners and employees assuming that both classes make their living while the output of goods and services increases over 2 orders of magnitude by investment in two storable values per capita: The value of physical capital k for production on the factory floor, and the value of human capacity h for consumption on the home floor. The acquired part of h is quantitatively provided by education. The distribution of wealth shifts and sharpens with the capitalization ratio k/h . The income distribution stabilizes at 25 to 30 per cent for the owners. The maximum consumable share of the output is reached for $k/h = 4$. Since West Germany and Japan passed this critical ratio in 1990, further internal growth can only be achieved with better and higher education at an investment level of 7 per cent of the GDP. Germany's level decreased from 7 in 1975 to 4 per cent in 2005. These results are obtained without any adjustable parameter because the effective lifetimes of h and k are known from the industrial society's evolution, and the working orders on the factory and home floors are provided without cost by the laws of nature and our genetic outfit, respectively.

AKSOE 4: Poster Session (posters are expected to be displayed the full day (9:00-18:00))

Time: Monday 16:30–18:00

Location: Poster D

AKSOE 4.1 Mon 16:30 Poster D

Using Lower partial moments for optimization of portfolios —

— ●ULI SPREITZER and VLADIMIR REZNIK — Dr. Dr. Heissmann GmbH, 65189 Wiesbaden

We use the coherent measure of risk the so called lower partial moments to optimize a portfolio consisting of risky and non risky assets.

We compare with a portfolio optimization based on VaR or standard deviation as measure of risk.

We show results for several portfolios built from assets (DAX) and government bonds. Also we compare our results with several funds.

AKSOE 4.2 Mon 16:30 Poster D

Statistical properties of short term price trends — ●PAWEŁ

— SIECZKA and JANUSZ HOLYST — Faculty of Physics and Center of Excellence for Complex Systems Research Warsaw University of Technology, Koszykowa 75, PL 00-662 Warsaw, Poland

We have investigated properties of short term price trends (starting from 10 sec.) at various stock markets. The results point out that there is a significant difference between real markets and the random walk model. This difference is due to price autocorrelations that influence a probability of trend extending. This probability depends in a specific way on a length of the current trend period. The results for

different markets are compared.

AKSOE 4.3 Mon 16:30 Poster D

Implementation of ε -intelligence in the Bak asset market model — ●BORIS BRODDA, JOHANNES JOSEF SCHNEIDER, and WOLFGANG PAUL — Institute of Physics, Johannes Gutenberg University of Mainz, Staudinger Weg 7, 55099 Mainz, Germany

In the Bak stock market model, which can be generalized also to other kinds of assets, several agents buy and sell assets at a virtual financial market. The agents randomly update their individual conceptions of the price for buying and selling an asset, respectively, influenced only by the current market price, a drift probability, and an imitative behavior [1].

However, the agents in this model do not inherit some complex behavior or exhibit complex strategies, as can be assumed of the traders at real financial markets. Therefore, in a first step, we assign some ε -intelligence to the agents, thus enabling them to perform their actions not entirely at random but with some low-level strategies.

[1] P. Bak, M. Paczuski, and M. Shubik, *Physica A* **246**, 430, 1997.

AKSOE 4.4 Mon 16:30 Poster D

Investigating community structure in social tagging systems

— ●VITO SERVEDIO^{1,2}, ANDREA BALDASSARRI¹, CIRO CATTUTO^{2,1}, and VITTORIO LORETO¹ — ¹La Sapienza University Physics Department, Roma, Italy — ²Museo Storico della Fisica e Centro Studi e Ricerche Enrico Fermi, Roma, Italy

A social classification paradigm known as "collaborative tagging" has been successfully deployed in popular web applications designed to manage and share diverse online media. Users of these systems organize resources by associating them with freely chosen text labels, or "tags". The adoption of collaborative tagging has recently surged: Millions of users are already involved, and as a result huge human-annotated databases are becoming available for the first time. We analyze data from one of the most paradigmatic tagging systems and focus on tags associated with a given resource. Based on the frequency distribution of tags provided by users, we introduce a notion of (socially emergent) similarity among resources. By using this notion of similarity we study the community structure of the ensuing network and show that communities correspond to semantically separated areas. We relate the semantic community structure to the underlying social network of users of the tagging system.

AKSOE 4.5 Mon 16:30 Poster D

Analysis of a multi-agent-based order book model describing a financial market — ●TOBIAS PREIS, SEBASTIAN GOLKE, WOLFGANG PAUL, and JOHANNES JOSEF SCHNEIDER — Institute of Physics, Johannes Gutenberg University of Mainz, Staudinger Weg 7, 55099 Mainz, Germany

We recently introduced a realistic order book model [1] which is able to generate the stylized facts of financial markets. Now we analyze this model in detail, explain the consequences of the use of different groups of traders, and focus on the foundation of a nontrivial Hurst exponent based on the introduction of a market trend. Our order book model supports the theoretical hypothesis that a nontrivial Hurst exponent implies not necessarily long-term correlations. An additional coupling of the order placement depth to the market trend can produce fat tails, which can be described by a truncated Lévy distribution.

[1] T. Preis, S. Golke, W. Paul, and J. J. Schneider, *Multi-agent-based Order Book Model of financial markets*, *Europhys. Lett.* **75**, 510, 2006.

AKSOE 4.6 Mon 16:30 Poster D

Envy as a source of exchange in a multiagent system — ELENA RAMIREZ and ●JUAN GUILLERMO DIAZ OCHOA — Fachbereich 1, University of Bremen, Otto Hahn Allee, D-28359 Bremen

The use of statistical mechanics has changed the way in we understand, how the market dynamics is defined. The basic assumption is the existence of stochastic forces that govern a stock of exchanges. A first approach to this kind of systems is using its similitude with the concept of brownian motion. However, a market shows a critical behavior related with a kind of self organization. For example, the Donangelo-Sneppen model is a method which describes a market showing self organization by means of interaction rules defined by particular constrains for each individual.

However, real markets concern individuals that not only trade using a preference list but also try to increase their individual welfare. In such case, envy is an additional force that influences a network of trading agents. In this model we implement the dynamics of envious agents to the dynamics of trading agents in order to observe the effect of forced reallocations to achieve a welfare state.

AKSOE 4.7 Mon 16:30 Poster D

Car following model with dynamical traps — ●JULIA HINKEL¹, IHOR LUBASHEVSKY², REINHARD MAHNKE¹, and CHRISTOF LIEBE¹ — ¹Universität Rostock, Institut für Physik, Germany — ²Theory Department, A.M. Prokhorov General Physics Institute, Russian Academy of Sciences, Moscow, Russia

The dynamics of car following is under consideration. By way of example, the rather simple model of the motion of two cars is studied and its dynamics is analysed numerically. The leading car has a constant speed. The following car is specified by the system of stochastic differential equations in phase space of the headway and velocity difference with additive white noise. The equation for acceleration includes the term which describes the delay in the driver reaction with perception depending on the velocity difference. The perception determines the dynamical trap region near the headway axis where the velocity difference becomes sufficiently low.

The present investigations show numerically that the additive white

noise can cause several anomalies. A new type of noised induced phase transition in headway space is observed. The headway distribution can become bimodal and velocity distribution has the Laplace form under influence of dynamical trap effect.

AKSOE 4.8 Mon 16:30 Poster D

Networks of companies and branches in Poland — ●ANNA CHMIEL, JULIAN SIENKIEWICZ, KRZYSZTOF SUCHECKI, and JANUSZ HOLYST — Warsaw University of Technology, Faculty of Physics, Warsaw, Poland

Using a commercial data base we constructed a bipartite graph of companies and branches in Poland. The graph was transformed to create a companies network where a link means that two companies belong to at least one common trade and a link weight describes a number of common trades for a companies pair. Similarly a branches network was constructed where nodes are branches and edges represent connections if at least one company belongs to the same branch. Corresponding link weights describe numbers of companies that are active in the same pair of branches. We have observed that a weight distribution is a power law function in the branches network while the distribution shows an exponential behavior in a certain range in the companies networks. Using cutoffs of links weights we constructed networks with different filter levels and studied degree distributions for such networks. For a properly chosen cutoff values the degree distribution in the companies network is described by a power law with a characteristic exponent close one. Two regions of scaling can be observed for the branches network above some cutoff level.

AKSOE 4.9 Mon 16:30 Poster D

Homophily, Cultural Drift and the Co-Evolution of Cultural Groups — ●JUAN CARLOS GONZALEZ AVELLA¹, DAMON CENTOLA², VICTOR EGUILUZ¹, and MAXI SAN MIGUEL¹ — ¹IMEDEA (CSIC-UIB), Campus Universitat Illes Balears, E-07122 Palma de Mallorca, Spain. — ²The Institute for Quantitative Social Science, Harvard University, Cambridge, MA 02138, USA

In studies of cultural differentiation, the joint mechanisms of homophily and influence have been able to explain how distinct cultural groups can form. While these mechanisms normally lead to cultural convergence, increased levels of heterogeneity can allow them to produce global diversity. However, this emergent cultural diversity has proven to be unstable in the face of "cultural drift"- small errors or innovations that allow cultures to change from within. We develop a model of cultural differentiation that combines the traditional mechanisms of homophily and influence with a third mechanism of "network homophily", in which network structure co-evolves with cultural interaction. We show that if social ties are allowed to change with cultural influence, a complex relationship between heterogeneity and cultural diversity is revealed, in which increased heterogeneity can reduce cultural group formation while simultaneously increasing social connectedness. Our results show that in certain regions of the parameter space these co-evolutionary dynamics can lead to patterns of cultural diversity that are stable in the presence of cultural drift.

AKSOE 4.10 Mon 16:30 Poster D

Dynamics of Spatial Networks with Application to Gas and Forest Industries — ●YURI YEGOROV — Institute for Advanced Studies, Stumpergasse 56, A-1060, Vienna, Austria

For the industries that deal with products that have low price/weight ratio spatial structure is important, and space-less economic models can be misleading. Both exploitation of land-located natural resource and distribution of product across consumers have this property. Here a mathematical model is proposed for the growth of spatial networks. It can be equally applied for forest exploitation over large territory and for building gas distribution networks after construction of a pipeline. The use of forest in Russia is not sustainable. Large regions near country borders and ports have lost its forest, while large areas in Central Siberia are practically not exploited, due to high cost of access and underdevelopment of transport network. After liberalization, transportation in Russia became relatively more expensive, and this changed the pattern of forest use. Economic forces drive this production to non-sustainability, and some government control is necessary. If the prices for wood exploitation would become prohibitively expensive when it is scarce (i.e. near the border) and transport subsidies would be given for remote regions, then wood production could grow without deforestation. When a strategic gas pipeline is constructed, gas supply infrastructure around it grows. Consumers shift from other energy to gas changing demand function. The model captures these

spatial effects that modify demand function. Here spatial model allows for understanding how investment in supply can lead to demand growth.

AKSOE 4.11 Mon 16:30 Poster D

Analysis of opinion polls in Germany — •CHRISTIAN HIRTSREITER¹ and JOHANNES JOSEF SCHNEIDER² — ¹Institute of Organic Chemistry, University of Regensburg, Universitätsstr. 31, 93053 Regensburg, Germany — ²Institute of Physics, Johannes Gutenberg University of Mainz, Staudinger Weg 7, 55099 Mainz, Germany

The influence of opinion polls has grown remarkably over the last few

decades, both for daily life and for politics. Public opinion polls in Germany (so-called *Sonntagsfrage*: *for which party would you vote if there was an election next Sunday?*) are used as the main indicator for outcomes in real elections and for the acceptability of individual politicians and political parties. Although it is widely assumed that public opinion polls could reproduce election results, it turns out that the outcomes of weekly voter polls are not too reliable, due to some drawbacks in the poll system. We investigate the results of opinion polls by means of time series analysis and focus on the correlation between election and opinion poll results.

AKSOE 5: AKSOE Mitgliederversammlung (member's assembly)

Time: Monday 18:00–19:00

Location: H8

im Anschluß an die Postersitzung

AKSOE 6: Dynamics of Groups and Organizations III

Time: Tuesday 9:30–10:15

Location: H8

Invited Talk

AKSOE 6.1 Tue 9:30 H8

Sociophysics of Markets — •JÖRG REICHARDT — Universität Würzburg, Institut für Theoretische Physik III, Am Hubland, 97074 Würzburg

Markets are prototypical examples of autonomous agents acting in a network of trade relations. The study of the topology of such networks

can make a viable contribution to the understanding of how markets form, evolve and eventually function.

The talk will review recent developments in network analysis. In particular, it will focus on the detection of patterns of connectivity as expressions of specific functional roles certain agents play in a market. A number of applications to real world markets will show power and potential of such methods.

AKSOE 7: Economic Models and Evolutionary Game Theory I

Time: Tuesday 10:15–12:45

Location: H8

AKSOE 7.1 Tue 10:15 H8

Combinatorial auctions as frustrated lattice gases — •TOBIAS GALLA^{1,2}, MICHELE LEONE³, MATTEO MARSILI¹, MAURO SELLITTO¹, MARTIN WEIGT³, and RICCARDO ZECCHINA¹ — ¹International Centre for Theoretical Physics, Strada Costiera 11, I-34014 Trieste, Italy — ²SISSA-CNR-INFM, Via Beirut 2-4, I-34014 Trieste, Italy — ³ISI Foundation, Viale S. Severo 65, I-10133 Torino, Italy

Combinatorial auctions are auctions in which bidders bid on combinations of items, as opposed to single items in conventional formats. The winner-determination problem of such multi-item auctions turns out to be non-trivial and computationally complex due to overlapping bids and overall frustration. In particular, the highest bid is not guaranteed to win.

We show how combinatorial auctions can be formulated as frustrated lattice gases on sparse random graphs, allowing the determination of the optimal revenue by methods of statistical physics. Transitions between computationally easy and hard regimes are found and interpreted in terms of the geometric structure of the space of solutions. We introduce an iterative algorithm to solve intermediate and large instances, and discuss competing states of optimal revenue and maximal number of satisfied bidders. The algorithm can be generalized to the hard phase and to more sophisticated auction protocols.

AKSOE 7.2 Tue 10:45 H8

Game dynamics in finite populations — •ARNE TRAUlsen — Program for Evolutionary Dynamics, Harvard University, USA

For the study of evolutionary game dynamics in finite populations, the Fermi function from statistical physics is chosen to govern strategy changes. The inverse temperature controls the intensity of selection, leading from random drift to imitation dynamics. This framework results in a closed analytical expression for the probability that a certain type will take over the population [1]. In this process, one can also relax the usual assumption that two individuals of the same type have the same fitness. Instead, each individual has a randomly distributed number of interactions with other individuals. This increases the temperature of selection [2]. Finally, the process can be utilized to describe limiting cases of games on dynamical networks. We assume that in-

dividuals differ in the rate at which they seek interactions. Links are formed and broken off according to their productivity. If this active linking process is fast compared to strategy changes, it introduces a simple transformation of the payoff matrix [3]. For slow active linking, the system is equivalent to strategy dynamics on a static network. For intermediate ranges, a numerical investigation of the detailed interplay determined by these two time-scales shows that the analytical results extends to a much wider ratio of time scales than expected [4].

- [1] Traulsen, Nowak, and Pacheco, *Phys.Rev.E* 74, 11909 (2006).
- [2] Traulsen, Nowak, and Pacheco, *J.Theor.Biol.*, 244, 349 (2007).
- [3] Pacheco, Traulsen, and Nowak, *J.Theor.Biol.* 243, 437 (2006).
- [4] Pacheco, Traulsen, and Nowak, *Phys.Rev.Lett.*, in press.

AKSOE 7.3 Tue 11:15 H8

Noether Theorem of Monetary Systems — •DIETER BRAUN — Angewandte Physik, Amalienstr. 54, 80799 München

Contrary to common belief, monetary systems can be implemented by bookkeeping in various ways. I classify the implementations by the symmetry properties of their transactions. Each symmetry relates to a conservation law in close analog to the Noether theorem:

- Symmetry of time asks for constant quantity of money
- Symmetry between transaction partners asks for zero profit
- Inclusion of the money issuer asks for internal exchange rates

Above relations can be directly visualized with a Feynman-Graph mapping of bookkeeping to mechanics. I give real world examples on how above symmetries are not implemented by modern monetary systems. Obeying the symmetries would implement monetary systems more stably with less inertial feedback loops.

References:

- Physica A* 290:491-500 (2001)
- Physica A* 321:605-618 (2003)
- Physica A* 324:266-271 (2003)
- Physica A* 369:714-722 (2006)
- www.bookkeepingmechanics.com
- www.biophysik.physik.uni-muenchen.de/Braun

AKSOE 7.4 Tue 11:45 H8

Agents under pressure: Altruism before the transition to extinction — ●KONSTANTIN KLEMM — Bioinformatics, Leipzig University, H²artelstr. 16-18, D-04107 Leipzig

We study the evolution of altruism in spatially extended populations at the survival-extinction transition. At contrast with earlier spatial models, e.g. [Nowak and May, *Nature* (1992)], we consider variations in the population density by allowing lattice sites to be empty. As the selective pressure p , defined as the death rate of agents in the absence of cooperating neighbors, approaches the critical value p_c from below, the dominance of defectors becomes unstable at a value $p_u < p_c$. Cooperators can invade and become dominant. This effect — cooperation before extinction — is observed whenever the total benefit is larger than the cost incurred by the altruistic act. For a sufficiently large benefit-cost ratio, the increase in the number of cooperators is larger than the decrease in the number of defectors as p rises from p_u to p_c . Thus the overall population density increases as a function of the pressure. These properties of the phase diagram are derived analytically using pair approximation.

AKSOE 7.5 Tue 12:15 H8

Impacts of Information Use and Stochastic Effects on the Dynamics of an Evolutionary Game — JUERGEN JOST¹ and ●WEI LI²

— ¹MPI for Math. in the Sci, Leipzig, Germany — ²MPI for Phy. Compl. Sys., Dresden, Germany

We once introduced an evolutionary complementarity game where in each round a member of population 1 plays with a member of population 2. In this work, systematic analysis through simulations and partly mathematics are given on what kind of roles information use and stochastic effects may play in the dynamics of our game.

Generally we find that players who use the information more efficiently can gain advantages over those who do less or not. There are several ways to use the information more efficiently. For example, players can have shorter generation times which enable them to update more frequently and thus have many more chances to access the information. Players may also determine their present-round offers on the basis of average of offers of all their previous encounters, no matter by direct copying or evolving the look-up table.

Stochastic effects have very complicated impacts on the dynamics of the game, based on the levels of evolution. Individually it is better for each player to have less randomness. Collectively, this is also better for the population as a whole when all its members are uniform. However, it is better for the population to have some members with higher randomness because they seem to confuse the opponent.

AKSOE 8: Economic Models and Evolutionary Game Theory II

Time: Tuesday 14:00–15:30

Location: H8

AKSOE 8.1 Tue 14:00 H8

The Role of Social Structure in the Emergence of Cooperation — ●CARLOS P. ROCA¹, JOSÉ A. CUESTA¹, ÁNGEL SÁNCHEZ^{1,2}, VÍCTOR M. EGÚLUZ³, and MAXI SAN MIGUEL³ — ¹Grupo Interdisciplinar de Sistemas Complejos (GISC), Departamento de Matemáticas, Universidad Carlos III de Madrid, Spain — ²Instituto de Biocomputación y Física de Sistemas Complejos (BIFI), Universidad de Zaragoza, Spain — ³Instituto Mediterráneo de Estudios Avanzados (IMEDEA), CSIC-UIB, Palma de Mallorca, Spain

The emergence of cooperation is currently one of the most fundamental open questions in evolutionary game theory. Since the seminal work of Nowak and May [1] it has been widely accepted that cooperative behavior is favored by the social structure of a population. However, more recent studies [2,3] have limited or contradicted this result, showing that this enforcement varies largely with the specific game or network considered. It is then natural to ask to what extent does social structure support the emergence and stability of cooperation. To answer this, we have performed an extensive and systematic simulation of evolutionary games on networks, taking into account the different possibilities of social dilemmas, population dynamics (updating rules) and network structures. We show that the support of cooperative behavior is not universal but only occurs in particular combinations of games, updating rules and networks.

[1] M. A. Nowak and R. M. May, *Nature* **359**, 826 (1992)

[2] C. Hauert and M. Doebeli, *Nature* **428**, 643 (2004)

[3] F.C. Santos, J.M Pacheco et al, *PNAS* **103**, 3490 (2006)

AKSOE 8.2 Tue 14:30 H8

A multi-level selection model for the emergence of social norms — ●FRANCISCO SANTOS — IRIDIA, CoDE, Université Libre de Bruxelles, Brussels, Belgium

We develop a multi-level selection model in the framework of indirect reciprocity[1]. Using two levels of selection, one at the individual level and another at the group level, we propose a competitive scenario among social norms, in which all individuals in each group undergo

pairwise interactions, whereas all groups also engage in pairwise conflicts, modeled by different games. Norms evolve as a result of groups* conflicts whereas evolution inside each group promotes the selection of best strategies for each ruling social norm.

Different types of inter-group conflict are considered[2]. The proposed evolutionary model leads to the emergence of one of the *leading eight* social norms, obtained recently by Ohtsuki and Iwasa[3], irrespective of the type of conflict between groups employed. This reputation assignment rule gives rise to a stern and unambiguous response to each individual behavior, where prompt forgiving coexists with implacable punishment.

[1] Chalub, Fabio A. C. C., Santos, F. C., Pacheco, J.M., *J Theor Biol* 271(2) (2006).

[2] Pacheco, J. M., Santos, F. C., Chalub, F. A. C. C., *PLoS Comput. Biol.* (in press).

[3] Ohtsuki H, Iwasa Y, *J Theor Biol* 239(4) (2006).

AKSOE 8.3 Tue 15:00 H8

Evolutionary learning in auctions — ●KONRAD RICHTER — Gardegasse 3/9 1070 Vienna; konrad.richter@mckinsey.com

Current auction theory relies crucially on the assumption that all bidders are perfectly rational and therefore bid homogeneously according to their Nash Equilibrium bidding strategies. This paper investigates computationally via an Agent Based Model whether evolutionary learning - in particular Best Response Learning - in repeated auctions could justify this assumption of NE bidding.

The simulations show that evolutionary Best Response learning does only lead for auction formats with dominant strategies to the NE. In general, however, the NE is not reached. Instead, repeated auctions show non-trivial dynamics such as clustered volatility and autoregressive behavior. This dynamics leads to greater risks for sellers and buyers and to a suboptimal allocation of goods.

In conclusion, the paper argues that auction theory could benefit from focusing more on the dynamics of repeated auctions than only on the properties of Nash Equilibria and highlights some potential future research fields

AKSOE 9: Award Ceremony: Young Scientist Award for Socio- and Econophysics

Time: Tuesday 16:00–18:00

Location: H10

Invited Talk AKSOE 9.1 Tue 16:00 H10
Statistical Mechanics of socio-economic systems — ●MATTEO MARSILI — Abdus Salam International Centre for Theoretical Physics, Strada Costiera 10, 34014 Trieste, Italy

The interest of statistical physicists for collective phenomena in the socio-economic sciences is not new, specially among German physicists. What is new is that socio-economic collective phenomena themselves have increased in their pervasiveness and complexity at a very fast rate. Phenomena such as web communities or e-commerce, for instance, grow and change at a rate which is probably much faster than our ability to understand their collective behavior and, in case, how they will change our societies.

In this talk, I will take financial markets as a prototype system of interacting agents, and I will review the non-trivial statistical properties which characterize their collective behavior. In particular, I will focus

on multi-asset markets and discuss their complexity in terms of the correlation matrix of stock returns at different time-scales. This clearly reveals that, as in classical mechanics, it makes sense to separate the dynamics of the “center of mass” from that of relative coordinates. Finally I will offer a simple phenomenological model for the center of mass dynamics which accounts for the impact of optimal portfolio strategies. This is able to reproduce the main statistical features observed in empirical data and suggests that real markets operate close to a critical point which marks the onset of a dynamical instability.

— **Presentation of the Young Scientist Award for Socio- and Econophysics 2007** —

— **Awardee’s Talk** —

AKSOE 10: Social-, Information-, and Production Networks

Time: Wednesday 13:30–18:15

Location: H8

AKSOE 10.1 Wed 13:30 H8
Collective behaviour in clustered social networks. — ●MACIEJ WOŁOSZYN¹, DIETRICH STAUFFER², and KRZYSZTOF KUŁAKOWSKI¹ — ¹Faculty of Physics and Applied Computer Science, AGH University of Science and Technology, al. Mickiewicza 30, PL-30059 Kraków, Poland — ²Institute of Theoretical Physics, University of Köln, Zùlpicher Str. 77, D-50937 Köln, Germany

A hierarchy of groups forming the network model of community (D.J. Watts et al., *Science* 296 (2002) 1302) is investigated in search for the order-disorder phase transition. Each group consists of 5 individuals endowed with a spin-like variables $s_i = \pm 1$ with Ising interaction $J > 0$. Links between individuals are created with probability proportional to $\exp(-\alpha x)$, where x is the distance in the hierarchy and α is a clustering parameter. The Metropolis algorithm is used to calculate the ordering temperature T_c from the relaxation time of the average value of spins. As a result, T_c was found to be close to 3.3 for $\alpha < 1.0$ and falling down to zero above this value, which provides a mathematical illustration of the social ability to a collective action via weak ties, as discussed by M. Granovetter (*Am. J. of Sociology* 78 (1973) 1360).

AKSOE 10.2 Wed 14:00 H8
Stochastic models for social tagging behavior — ●CIRO CATTUTO^{1,2}, VITTORIO LORETO², and LUCIANO PIETRONERO² — ¹Museo Storico della Fisica e Centro Studi e Ricerche Enrico Fermi, Roma, Italy — ²La Sapienza University Physics Department, Roma, Italy

A new paradigm has been quickly gaining ground on the World Wide Web: Collaborative Tagging. In web applications like del.icio.us, Flickr, Connotea, users manage their personal collection of online resources by enriching them with semantically meaningful information in the form of freely chosen tags. Despite the anarchic nature of users’ behavior, the global dynamics of these systems leads to a self-organised categorization (folksonomy) of a large and evolving body of information. Here we collect data from a popular online system and select a semantic context by extracting all the resources associated with a given tag. On studying the distribution of tags co-occurring with the selected one, we find a heavy-tailed behavior and observe properties that point to an emergent hierarchy of tags. We introduce a stochastic model embodying two main aspects of collaborative tagging: (i) a multiplicative character related to the exposure of users to each other’s activity; (ii) a notion of long-term memory. Remarkably, our model is able to account quantitatively for the measured properties of tag association, providing a clear indication that collaborative tagging is able to recruit the uncoordinated actions of web users to create a coherent and predictable semiotic dynamics at the emergent level.

— **SYNF Symposium “Nonlinear and Fractional Transport in Complex Systems” 14:30 - 17:15 in H1** —

AKSOE 10.3 Wed 17:15 H8
Efficient Recovery from Cascading Failures in Complex Networks — ●LUBOS BUZNA¹, KARSTEN PETERS², and DIRK HELBING¹ — ¹Chair for Traffic Modelling and Econometrics, TU Dresden, Dresden, Germany — ²Chair for Logistics and Transport, TU Dresden, Dresden, Germany

Most infrastructures, organisations and communication systems in modern societies are based on large complex networks. The possibility of cascading failures is an “Achille’s heel” of these complex systems and reflects their vulnerability. If an initial failure affects other elements of the network, it may multiply its impact and can result in disastrous problems. Using a recently developed generic model for failure spreading mechanisms, we have studied the dynamic evolution of failures for sample networks. Based on computer simulations of failure spreading scenarios, we have investigated the efficiency of different strategies to fight the spreading of disasters. Our investigations are focused on the comparison of strategies under different conditions. The results indicate that, for certain parameter regions, the success of recovery measures and disaster containment depends crucially on the chosen management strategy. We have demonstrated that, under certain circumstances, optimization techniques can be employed to improve the performance of recovery strategies.

AKSOE 10.4 Wed 17:45 H8
Robustness and Dynamical Behaviour of Small-Scale Manufacturing Networks — ●REIK DONNER¹, UWE HINRICHS², and BERND SCHOLZ-REITER² — ¹Institute of Transport and Economics, Technical University Dresden, Andreas-Schubert-Str. 23, 01062 Dresden — ²BIBA, University of Bremen, Hochschulring 20, 28359 Bremen, Germany

Intrinsic instabilities of production networks are a serious economic danger especially for small companies. On the one hand, random fluctuations of processing times cause an immediate instability which can lead to production breakdowns due to a lack of material and result in an intermittent accumulation of orders. On the other hand, event-discrete simulations indicate that such fluctuations may also have a constructive effect on the dynamics: If a push strategy is applied for the production process, long down times of the machines after each processed workpiece may lead to a successive increase of the stocks of semi-finished material. This increase is found to be decelerated by fluctuating processing times. In the more realistic case of a pull control, improper lot sizes result in an aperiodic behaviour even for constant processing times. The critical parameters associated with the different effects are identified for two different network topologies: linear supply chains and symmetrically interacting manufacturers. For a quantitative characterization of the dynamics, we apply sophisticated nonlinear methods of time series analysis, such as concepts basing on a symbolic dynamics description as well as recurrence quantification analysis.

AKSOE 11: Social-, Information-, and Production Networks II

Time: Thursday 9:30–10:15

Location: H8

Invited Talk

AKSOE 11.1 Thu 9:30 H8

Ecology of firms in a financial market — ●ROSARIO NUNZIO MANTEGNA¹, FABRIZIO LILLO^{1,2}, ESTEBAN MORO³, and GABRIELLA VAGLICA¹ — ¹Dipartimento di Fisica e Tecnologie Relative, Università di Palermo, Palermo I-90128, Italy — ²Santa Fe Institute, 1399 Hyde Park, Santa Fe, NM 87501, USA — ³Departamento de Matemáticas, Universidad Carlos III de Madrid, E-28911, Leganes, Spain

The understanding of complex systems is an important scientific challenge. Despite many agent-based models have been proposed to explain the emergence of market properties, only in few cases the available data permits an empirical investigation of agents strategies. Here

we present a comprehensive study of the Spanish Stock Exchange (BME) during the time period 2001-2004. The BME is special since is a complete transparent market in which the identities of the financial firms participating in the trading are publicly released. Our study shows that financial firms are self-organized in a complex ecology in which different degrees of specialization are seen. Specifically, few large firms push the price in a given direction demanding liquidity to the market on a long time scale, whereas many heterogeneous firms provide liquidity on a short time by reverting the direction of the price. Our results allow to build one of the first empirically grounded agent based models of financial markets.

AKSOE 12: Social, Information-, and Production Networks III

Time: Thursday 10:15–11:45

Location: H8

AKSOE 12.1 Thu 10:15 H8

Evolving R&D Networks — ●MICHAEL KÖNIG, STEFANO BATTISTON, and FRANK SCHWEITZER — Chair of Systems Design, ETH Zurich, Kreuzplatz 5, 8032 Zurich, Switzerland

We model economic network interactions related to R&D (research and development) activities of firms. Firms can increase each others productivity e.g. by providing a new technology or transferring knowledge, which is modeled as catalytic processes on a directed dynamic network. Specifically, we study the way firms select their interactions with other firms and the impact on the network structure. Our model considers the costs for R&D interactions, and firms optimize their interactions as utility-maximizing agents. We show that (i) the time horizon in which firms evaluate their utility and (ii) the emergence of cycles are critical factors for obtaining viable R&D networks. For the emergence of cycles, two cases are discussed: Firms can either mutually exchange technologies (direct reciprocity, 2-cycle) or share a technology with other firms and hope that they will benefit from the support of another firm (indirect reciprocity, cycle of order $k \geq 3$). Therefore, investigating the role of direct/indirect reciprocity is deeply connected to the investigation of the emergence/stability of cycles in the network.

AKSOE 12.2 Thu 10:45 H8

A Trust-based Recommendation System on a Social Network — ●STEFANO BATTISTON, FRANK WALTER, and FRANK SCHWEITZER — Chair of Systems Design, ETH Zurich, Kreuzplatz 5, 8032 Zurich, Switzerland

Recommender systems are today widely spreading in web services. They are mostly based on centralized collaborative filtering, where an agent is recommended items which were chosen by other agents similar to her. In contrast, we present a model of a recommendation system based on trust relationships among agents of a social network. Trust evolves in time through a learning process and as a result agents can use their social network to reach information and their trust relation-

ships to filter it. We identify the impact of network density, preference heterogeneity among agents, and knowledge sparseness on the performance of the system. We demonstrate that the system selforganises into a state close to the optimum. This is an emergent property of the system, achieved without explicit coordination from the local interactions of the agents.

AKSOE 12.3 Thu 11:15 H8

Quantifying autonomy and differentiation in social networks - an information theoretic approach — ●ECKEHARD ÖLBRICH, NILS BERTSCHINGER, NIHAAT AY, and JÜRGEN JOST — Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany

The modern theory of social systems achieves substantial insights through abstract concepts like differentiation and integration, operational closure or autonomy as exemplified in particular by the work of Niklas Luhmann. Yet these concepts, including the fundamental one of complexity, are only verbally defined and therefore do not yet readily connect with newer developments from network analysis and other mathematically formulated complex systems approaches.

We present a tentative proposal for a quantitative measure of autonomy. This is something that, surprisingly, seems to be missing from the literature, even though autonomy is considered to be a basic concept in many disciplines, including social systems. We work in an information theoretic setting for which the distinction between system and environment is the starting point. As a measure for autonomy, we propose the conditional mutual information between consecutive states of the system conditioned on the history of the environment. Levels of differentiation can be distinguished by using iterated differences of (conditional) entropies that reveal finer and finer distinctions between the behaviors of elements of an interaction network.

In simulations using an abstract model of a social network we show how these measures can be used to study the interrelation between the differentiation of a system and the autonomy of its subsystems.

AKSOE 13: Economic Models and Evolutionary Game Theory II

Time: Thursday 11:45–12:45

Location: H8

AKSOE 13.1 Thu 11:45 H8

Finite-size fluctuations and macroscopic equations in agent-based models: Mutations and extended number of strategies

— ARNE TRAUlsen¹, ●JENS CHRISTIAN CLAUSSEN², and CHRISTOPH HAUERT¹ — ¹Program for Evolutionary Dynamics, Harvard — ²Institut f. Theoret. Physik & Astrophys., Univ. Kiel, Germany

Agent-based behavioral models of social or economic behaviour are widely investigated by Monte Carlo simulations as well as by differential equations. However, macroscopic stochastic equations can in quite general cases be derived from microscopic behavioral processes [1]. We point out three aspects: First, finite-size fluctuations in coevolutionary dynamics in general differ from additive white noise [2]. Second, it can

be shown that the Moran process and a local update process can be identified as microscopic models leading to the adjusted and standard replicator equations, respectively [3]. As a consequence, the direction of evolutionary drift can reverse due to a finite-size effect [3]. Third, the approach can be extended to many strategies and including mutations [4]. Depending on mutation rate, population size, and location of the equilibrium points, the stationary distributions can be localized at the borders, or exhibit interior peaks. We illustrate some of these scenarios by considering neutral selection, the Prisoner's Dilemma, and the snowdrift game [4].

[1] D. Helbing, *Physica A* 181,29(1992); 193,241(1993); 196,546(1993) [2] J. C. Claussen & A. Traulsen, *Phys. Rev.E* 71,

025101 (R) (2005) [3] A. Traulsen, J. C. Claussen, C. Hauert, PRL 95, 238701 (2005) [4] A. Traulsen, J. C. Claussen, C. Hauert, PRE 74, 011901 (2006)

AKSOE 13.2 Thu 12:15 H8

Efficient control in a multi-agent stock market model — ●ULRICH CHERDRON¹, ROLF PAWELZIK², ROLAND ROTHENSTEIN³, and KLAUS PAWELZIK¹ — ¹Institut für Theoretische Physik, Universität Bremen, Otto-Hahn Allee 1, D-28334 Bremen. — ²Feldstr. 68, 24105 Kiel. — ³56, Avenue de Cailles, 1170 Bruxelles, Belgium.

Simulations demonstrate that the exchange of stocks and money dur-

ing trade in an order book market balances external influences on the return which are induced by fundamental traders. Here we present a novel formalization of order book price determination in stock markets from which we derive gradient based learning rules that optimize the dynamic parameters (stocks and money held by each agents) for control. We analyse the dynamics of both the returns and the internal dynamical parameters in a minimal model by comparing on-line versions of these learning rules with the natural adaptation caused by trading. Our results explain the emergence of control by trading which might contribute to the apparent efficiency of real stock markets.

AKSOE 14: Financial Markets and Risk Management III

Time: Thursday 14:00–17:45

Location: H8

AKSOE 14.1 Thu 14:00 H8

Noise Reduction by Power Mapping for Improved Portfolio Optimization — ●RUDI SCHÄFER, NILS FREDRIK NILSSON, and THOMAS GUHR — Mathematical physics, LTH, Lund university, P.O. Box 118, 22 100 Lund, Sweden

To construct an optimal portfolio it is of vital interest to know the correlations between different stocks. However, due to the finiteness of recorded time series the true correlations are covered by a considerable amount of noise [1]. This leads to a systematic underestimation of risk.

In 2003 Guhr and Kälber [2] introduced the *power mapping* to suppress this noise and thereby effectively “prolong” the time series. This method raises the absolute value of each matrix element to a power q while preserving the sign. There is a trade-off between suppressing the noise and destroying the true correlations in the matrix. We use the Markowitz portfolio optimization as a criterion for finding the optimal value for q . In particular, we investigate how this value is effected by changing the underlying correlation structure and the tail behavior of the random processes used to simulate the stock prices.

[1] L. Laloux *et al*, Phys. Rev. Lett. 83, 1467 (1999)

[2] T. Guhr, B. Kälber, J. Phys. A 36, 3009 (2003)

AKSOE 14.2 Thu 14:30 H8

Downside Risk metrics for Hedge Funds: an empirical and a theoretical approach — ●JOSEP PERELLÓ — Departament de Física Fonamental, Universitat de Barcelona, Spain

Hedge Funds are considered as one of the portfolio management sectors which shows a fastest growing for the past decade. An optimal Hedge Fund management requires an appropriate risk metrics. The classic CAPM theory and its Ratio Sharpe fail to capture some crucial aspects due to the strong non-Gaussian character of Hedge Funds statistics. A possible way out to this problem while keeping CAPM simplicity is the so-called Downside Risk analysis. One important benefit lies in distinguishing between good and bad returns, that is: returns greater or lower than investor’s goal. We revisit most popular Downside Risk indicators and provide new analytical results on them. We compute these risk measures by taking the Credit Suisse/Tremont Investable Hedge Fund Index Data. A rather unusual transversal lecture of the existing Downside Risk measures is also provided. We study the Gaussian, the Laplace and the power law distributions in the Downside Risk framework and comment their abilities to get a proper picture of the Hedge Fund universe.

AKSOE 14.3 Thu 15:00 H8

An evolving Potts model of financial markets with threefold input agents — ●GEORGES HARRAS and DIDIER SORNETTE — ETH Zürich, Chair of Entrepreneurial Risks, Zürich, Switzerland

We study a model of financial price dynamics based on the Potts model with trading agents which, at every time step, can act in three possible ways: sell, buy or remain inactive. The price dynamics result from the aggregation of these actions. The agents base their decision on three different kinds of information: personal information, public information (news) and information from their neighbors (imitation). The impact of these latter two on the decision making process are coupled to their past prediction power and evolve in time. Our model is able to reproduce the major stylized facts, relating them to the subtle interplay of the endogenous factors and exogenous information.

AKSOE 14.4 Thu 15:30 H8

Endogenous drawdown outliers in the limit-order-book — ●GILLES DANIEL and DIDIER SORNETTE — ETH Zürich, Chair of Entrepreneurial Risks, Zürich, Switzerland

We investigate by means of computer simulations the intra-day dynamics of stock markets. The main statistical properties of price changes exhibited by real markets can be recovered with a zero-intelligence model of agents. Their origin is found in the subtle interplay between limit orders, which supply liquidity, and market and cancellation orders, which remove it.

We then propose a parsimonious model of self-referential agents grounded on documented behavioral finance, in which rational bubbles can emerge, grow and burst endogenously, with no need for a reference to an exogenous fundamental value, and no need for communication between agents. These bubbles and crashes correspond to a regime shift in the system, are quantified by robust measures of drawdowns, and can be distinguished from the rest of the distribution of returns: they are statistical outliers. Thus the statistics reveals the existence of transient collective organizations of the self-referential agents which create particular market phases associated with the bubbles and crashes. These results are very similar to previous studies on the statistics of drawdowns in real financial time series, suggesting a common origin.

15 min. break

AKSOE 14.5 Thu 16:15 H8

Scaling behavior of Student-Lévy processes — ●OLIVER GROTHE¹ and RAFAEL SCHMIDT² — ¹Research Training Group Risk Management, University of Cologne, Germany — ²Department of Economic and Social Statistics, University of Cologne, Germany

Student’s t-distributions are widely used in financial studies as fat-tailed alternatives to normal distributions. However, as Student’s t-distributions are not invariant under convolution, there are no Lévy processes with Student’s t-marginals at all time points. As Oliveira et al. (2000) show, the convolution of two Student’s t-distributions can well be approximated by Student’s t-distributions with other parameters. Extending their approximation to a generalized Student-Lévy process, however, violates the typical variance scaling property of the process. Following Heyde and Leonenko (2005), we focus on Lévy processes with Student’s t-marginals at certain time points. We show, that a Student’s t-approximation for the marginals is also suitable for other time horizons, while not exact. Using this approximation, we are able to describe the scaling behavior of the resulting generalized Student-Lévy processes. We provide an application of our approximation in the context of modelling high-frequency price returns.

AKSOE 14.6 Thu 16:45 H8

Correlation matrices of synthetic continuous time random walks — ●DANIEL FULGER¹, ENRICO SCALAS², and GUIDO GERMANO¹ — ¹Philipps-University Marburg, 35032 Marburg, Germany — ²Amedeo Avogadro University of East Piedmont, 15100 Alessandria, Italy

We present a method for the simulation of anomalous diffusion processes governed by time and space fractional differential equations. Processes of this kind are used e.g. to model high-frequency financial time series. The method is based on Monte Carlo simulation of continuous time random walks with Mittag-Leffler distributed waiting times

and Lévy distributed jumps. Our new combination of fast techniques for the generation of Mittag-Leffler and Lévy deviates outruns previous simulation methods by orders of magnitude. This enables to generate a great number of synthetic time series in a short time and thus to perform on a large scale a new kind of null-hypothesis tests within random matrix theory, that is a useful theory to analyze and de-noise time series employing empirical correlation matrices. The latter are also important in financial risk analysis.

AKSOE 14.7 Thu 17:15 H8

Theoretical predictions and empirical observations of eigenvalue spectra of time-lagged correlation matrices — ●CHRISTOLY BIELY^{1,2} and STEFAN THURNER^{1,2} — ¹Complex Systems Research Group, HNO, Medical University of Vienna, Währinger Gürtel 18-20, A-1090 Vienna, Austria — ²Atominstytut d. österr. Universitäten, Stadionallee 2, A-1020 Vienna, Austria

Recently, the study of eigenvalue spectra of financial correlation matrices has attracted considerable interest due to its applications in financial engineering. We contribute a theoretical understanding of the case of time-lagged correlation matrices, which can be seen as real, asymmetric matrices with a special structure superimposed due to the shifting of the individual time-series: We prove that the respective eigenvalue spectra are circular symmetric in the complex plane under the assumption of time-series being (finite) Brownian random walks. Further, we solve the problem of determining their radial eigenvalue density via an inverse Abel-Transform of the solution of the eigenvalue density of the symmetrized problem. We then compare the theoretical results with empirical 5 minute returns of the S&P500 and discuss the observed deviations. Non-trivial patterns such as 'causal industry sectors' and non-random structures indicated by eigenvalues departing from the theoretical spectrum are discussed in some detail.

AKSOE 15: Dynamics of Groups and Organizations IV

Time: Thursday 17:45–18:45

Location: H8

AKSOE 15.1 Thu 17:45 H8

Log-periodic oscillations due to discrete effects in complex networks — ●JULIAN SIENKIEWICZ, PIOTR FRONCZAK, and JANUSZ HOLYST — Faculty of Physics and Center of Excellence for Complex Systems Research, Warsaw University of Technology, Koszykowa 75, 00-662 Warszawa

We show how discretization of distances affects two major characteristics in complex networks: internode distances (measured as the shortest number of edges between network sites) and average path length. Direct effects of such discretization are log-periodic oscillations of above quantities. The effect occurs both in numerical network models as well as in such real systems as coauthorship, language, food and public transport networks. Analytical description of these oscillations based on the properties of the hidden variables in complex networks fits well numerical simulations. We consider a simple case of network optimization problem, arguing that discrete effects lead to a nontrivial solution that can be important for real-world systems.

AKSOE 15.2 Thu 18:15 H8

About Unified Mathematical Approach for Different Ideologies — ●YURI YEGOROV — Institute for Advanced Studies, Vienna,

Austria

In order to build a formal link between neoclassical economics and alternative social structures and ideologies (nationalism, Marxism), it makes sense to extend individualistic utility function by capturing some altruism. Individual utility in a nationalist society can be modelled is a weighted sum of own utility plus the sum of utilities of all members of the nation. In Marxist society, there is also care about common interest, but instead of average, this should be the utility of its poorest member. These utilities allow for non-linear interaction between members of the society. The distribution of wealth matters for both nationalist and Marxist societies, while it does not matter for liberal society. Altruism can bring more stability to the concept of social equilibrium and lead to more robust structures, and it also can explain possible mechanism of emergence of social group. It is possible to show that the prisoner*s dilemma has a good equilibrium when everybody cares also about utility of a partner. If the level of altruism depends on social distance between people, we get the emergence of cooperative zones where the motivation for purely egoistic behaviour disappears. This can explain such historical phenomena as the emergence of ethnic groups, communities and nations.

AKSOE 16: Traffic Dynamics, Urban, and Regional Systems

Time: Friday 9:30–12:00

Location: H8

AKSOE 16.1 Fri 9:30 H8

Crowd Turbulence: The Physics of Crowd Disasters — ●DIRK HELBING and ANDERS JOHANSSON — Institute for Transport and Economics, TU Dresden, Andreas-Schubert-Str. 23, 01062 Dresden

In the past, physicists have discovered various self-organized phenomena in pedestrian crowds such as the formation of lanes of uniform walking direction, oscillations at bottlenecks in bi-directional flows, the formation of stripes in cross-flows, or "freezing-by-heating" and "faster-is-slower" effects in panicking crowds. These phenomena have all been successfully described by driven many-particle models, as will be demonstrated by animated computer simulations and video recordings of real crowds.

Panic stampedes are a serious concern during mass events. However, despite huge numbers of security forces and crowd control measures, hundreds of lives are lost in crowd disasters each year. A high-performance tracking analysis of unique video recordings of the Muslim pilgrimage in Mina/Makkah, Saudi Arabia, has now revealed that high-density flows can even turn "turbulent", which causes people to fall. The occurring eruptions of pressure release bear analogies with earthquakes and are de facto uncontrollable. This talk presents an analysis and interpretation of our recent discoveries and presents a quantity that is suitable for an advance warning of critical crowd conditions.

AKSOE 16.2 Fri 10:00 H8

Brain activity during simulated driving and three-phase traffic theory — ●ANDRÉ BRESGES — Universität Duisburg-Essen, Didaktik der Physik, 47048 Duisburg.

We have volunteers participating in our simulated car traffic environment, driving in situations with different complexities. While learning to drive, we monitor their brain activity with a 1,5 Tesla Siemens Avanto functional Magnet Resonance Imager. Results show, that with increased routine the control of the car is transferred to lower and - in evolutionary perspective - "older" parts of the brain, namely the cerebellum. This makes the behavior of car drivers more uniform, less error-prone and more predictable, compared to the complex behavior humans usually show when using higher brain areas. The neurologic evidence may serve as a foundation for microscopic or multi-agent-approaches in the field of dynamic car traffic simulation.

Possible implications regarding three-phase traffic theory (B. Kerner et al.) will be demonstrated using a freeway traffic simulator running on a modified two-Lane Lee-Algorithm (H.K. Lee et al., 2004).

AKSOE 16.3 Fri 10:30 H8

Modelling traffic flow with Fokker-Planck equations — ●FRIEDRICH LENZ and HOLGER KANTZ — Max Planck Institute for the Physics of Complex Systems, Nöthnitzer Strasse 38, 01187 Dresden, Germany

Traffic flow gives rise to interesting phenomena and problems, e.g.

jams and synchronized flow. We take data measured in Germany on the ring of motorways around Cologne for a macroscopic modelling approach. A Fokker-Planck equation in two dimensions with coefficients which depend on the time of day is used to model the dynamics at every gauging station. We estimate the time-dependent drift- and the diffusion coefficients from the measured data. In order to assess the quality of this model we integrate a corresponding Langevin equation and compare the histogram in phase space of the model data with the original data. The model allows us to obtain information about dynamical properties of the transition from synchronized flow to free flow and vice versa.

AKSOE 16.4 Fri 11:00 H8

Model-Creation by Analysing NGSIM-Vehicular-Datasets —
•CHRISTOF LIEBE — Universität Rostock, Institut für Physik, Germany

Within the american Next Generation Simulation Program (NGSIM) several vehicular datasets were recorded. The first dataset was published in 2003 and provide trajectories with a length of about 900 m. Three more datasets were published in 2005, showing shorter trajectories including a jam. They can be used to calibrate and validate traffic models.

In order to analyse the single car time series data and to compare it with traffic models, we show how significant quantities can be extracted. For this purpose we have investigated space-time plots and flow diagrams in the headway-velocity space.

The abrupt appearance of jams, which are stable over several minutes, is visible in space-time plots. Flow diagrams are investigated to get new insights in traffic modeling. A model including dynamical traps will be presented. It takes into account, that a driver is able to control its velocity much better then its headway.

AKSOE 16.5 Fri 11:30 H8

Global traffic analysis reveals geographical modules across political boundaries — •D. BROCKMANN¹, F. THEIS¹, and L. HUFNAGEL² — ¹MPI for Dynamics and Self-Organization, 37018 Göttingen — ²Kavli Institute for Thoretical Physics, Santa Barbara, CA 93106

Geographical boundaries are key determinants of various spatially extended dynamical phenomena. Examples are migration dynamics of species, the spread of infectious diseases, bioinvasive processes, and the spatial evolution of language. As political boundaries have become less important, it is difficult to quantify their impact on spatially extended human dynamics. The evolved complexity of contemporary human travel may exhibit intrinsic modularities and effective boundary structures, which not necessarily coincide with existing political boundaries.

We investigate a large scale complex network of human travel between the approx. 3000 counties in the US. We construct the network by analyzing the flux of over 10 million dollar bills reported at the bill-tracking website wheresgeorge.com which extends the dataset of a previous study (Brockmann et al., Nature 2006) by a factor of 20. We investigate to what extend geographical information is intrinsically encoded in the topology of the network by applying two graph cutting algorithms (Newman&Girvan, Phys.Rev.E 2004 and an extension of Lee&Seung, Nature 1999) in order to identify effective clusters. Although both algorithms employ two completely different paradigms they identify approx. 10, nearly identical effective clusters in the network. Surprisingly, these clusters are spatially compact regions, although both algorithms have no prior knowledge of geographical information. Most importantly, the geographic boundaries between the clusters only partially overlap with the political state boundaries. We conclude that graph cutting algorithms can efficiently determine effective clusters in geographically embedded transport networks. The results may aid the development of models for dynamical phenomena evolving on these networks.