Book of Abstracts

Econophysics Colloquium 2017

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Welcome

Physics, economics, sociology, mathematics, and computer science are fields of science which, as a result of cross-fertilisation, have created the multi-, cross-, and interdisciplinary areas of science and research such as econophysics and sociophysics, thriving in the last two and a half decades. They use knowledge, methodologies, methods and tools of physics for modeling, explaining and forecasting economic and social phenomena and processes. The (thirteenth) Econophysics Colloquium (EC2017) jointed with (ninth) Polish Symposium on Physics in Economy and Social Sciences (Polish acronym FENS2017) is a meeting on these new areas bringing together physicists, economists, market practitioners, and researchers from many other fields. This meeting has among speakers some of the most influential reserachers in the area of econophysics and inspiring very active practitioners. It provides an opportunity to discuss, from various points of view, the socio-economical reality. This is extremely important at the present turbulent time, when reality is characterized by unusually high volatility making a major impact on our everyday life.

The list of previous Econophysics Colloquia (EC), containing detailed informations, are located on the webpage: Econophysics Colloquia (http://www.econophysics-colloquium.org/). EC started at 2005 in Canberra (Australia) and in subsequent years were held in the following locations: Tokyo (Japan 2006), Ancona (Italy 2007), Kiel (Germany 2008), Erice (Italy 2009), Taipei (Taiwan 2010), Vienna (Austria 2011), Zürich (Switzerland 2012), Pohang (Korea 2013), Kobe (Japan 2014), Prague (Czech Republic 2015), São Paulo (Brazil 2016). Selected papers of these Econophysics Colloquia were published, e.g., in Physica A: Statistical Mechanics and its Applications Vol. 370, Issue 1, Pages 1-162 (1 October 2006).

The FENS Symposia, partially inspired by Econophysics Colloquia, contributed to build of the Polish econo- and sociophysics society. The current Symposium FENS is a continuation of the previous eight symposium editions that were held in Warsaw (2004), Kraków (2006), Wrocław (2007), Rzeszów (2009), Warsaw (2010), Gdańsk (2012), Lublin (2014), and Rzeszów (2015) (corresponding links are given at archive https://science24.com/event/ec2017/), selected papers of which were published in Acta Physica Polonica B and Acta Physica Polonica A jounals.

We have great pleasure to announce that the forthcoming joint event (EC&FENS2017) that is, 13th Econophysics Colloquium 2017 (EC2017) and 9th Symposium on Physics in Economy and Social Sciences 2017 (FENS2017) will take place in Warsaw, Poland. We wish all of you a very active and fruitful participation in the EC&FENS2017 and an impressive stay in Warsaw the capital of Poland.

Organizers

Main organisers

Faculty of Physics University of Warsaw

Polish Physical Society

Sponsors

Ministry of Science and Higher Education

Programme

Presentation of methodologies, theories, methods and models developed in physics, mathematics, and computer science that can be successfully applied in economics and social sciences.

Meeting of people representing different scentific fields who are interested in multi-, cross-, and interdisciplinary cooperations.

Strengthening the interaction between the academia and the industry, including business people, bank representatives, insurance institutions, IT companies, and the stock exchange.

Popularization of the relatively new, quickly developing fields of multi-, cross-, and interdisciplinary sciences like econophysics and sociophysicsamong graduate students, Ph.D. students, and anyone interested in such subjects.

Multi-, cross- and interdisciplinary programme

- Financial time series: equilibrium and non-equilibrium statistical physics analysis
- Fractal and multifractal effects in real data
- Random matrix theory and its applications
- Algorithmic trading
- Thermodynamic formalism in economic research
- Nonextensive effects on financial markets
- The role of extreme and superextreme events
- Risk management and risk contagion vs portfolio analysis; financial engineering
- Models of market dynamics, in particular agent-based ones, in micro- and macroscales
- Structure and behavior of economical and social networks
- Complex adaptive systems in economical and social phenomena and processes
- Conflicts' dynamics
- Modeling of changes of the opinions and innovation spreading
- Complex systems and their applications: networks in economics and social sciences
- Game theories
- Computing in economics and social sciences

Plenary speaker

H. Eugene Stanley (Boston University),***Are organizing principles from physics of relevance to economic and social sciences?***

Invited Speakers

Macroeconomy

- Marcel Ausloos (University of Leicester), ***SME investment best strategies***
- Sonia M. Bentes (Universitário de Lisboa), ***Modelling the asymmetric behaviour of stock market volatility: New evidence***
- Ladislav Kristoufek (Charles University in Prague), ***Fractal methods for fractional cointegration***
- Mateusz Pipień (Cracow University of Economics), ***Some recent advances in empirical analyses of economic cycles***
- Rafał Weron (Wrocław University of Technology), ***Probabilistic forecasting in energy markets: Why? When? How?***
- Fabrizio Lillo (University of Bologne), ***Systemic risk due to fire sale spillover and portfolio overlaps***

Financial markets & microstructures

- Dariusz Grech (University of Wrocław), ***Asymmetry of price returns - analysis and perspectives from non-extensive statistical physics point of view***
- Vygintas Gontis (Institute of Theoretical Physics and Astronomy, Vilnius University, Lithuania), ***The first passage time statistics as empirical test of observed long-range memory in the financial markets***
- Thomas Lux (Christian-Albrechts-Universität Kiel & Universitat Jaume I), ***Estimation of Agent-Based Models of Financial Markets: A State-Space Approach***
- Silvio Queirós (Brazilian Center for Research in Physics), ***The not so stylised shapes of financial markets: Intraday profiles of returns and trading volume***

Sociophysics

- Stanisław Drożdż (Institute of Nuclear Physics of Polish Academy of Sciences & Cracow University of Technology), ***Volatility correlations in narrative***
- Janusz Hołyst (Warsaw University of Technology), ***Hierarchical Partitions of Social Networks Between Rivaling Leaders***
- Jãnos Kertesz (Central European University & Budapest University ofTechnology andEconomics), ***Multiplex Modeling of the Society***
- Krzysztof Kułakowski (AGH University of Science and Technology), ***Paradox of integration - a computational model***
- Tobias Preis (University of Warwick), ***Sensing human activity using online data***
- Peter Richmond (The University of Dublin), ***On the relationship between income, fertility rates and the state of democracy in society***
- Boris Podobnik (University of Rijeka), ***Estimating the tipping point of right-wing populism in response to unbalanced immigration***
- Enrico Scalas (University of Sussex), ***Stylised models for the distribution of wealth***
- Sitabhra Sinha (The Institute of Mathematical Sciences, Chennai), ***Is it rational for Homo Economicus to be "nice" to others ? The co-action solution resolves social dilemmas***
- Zbigniew Struzik (Tokyo University), ***Should we (try to) understand life?***
- Katarzyna Sznajd-Weron (Wrocław University of Technology), ***Conformity in numbers: How to validate social agent-based models***

Networks

- Shlomo Havlin (Bar-Ilan University), ***Cascading Failures and Recovery in Networks: applications to finance***
- Rosario N. Mantegna (Palermo University & Central European University), ***Bootstrap validation of proximity based networks***
- Misako Takayasu (Center for TDB-Advanced Data Analysis and

Modeling Tokyo Institute of Technology, Japan), ***Network Fragility of Business Firms***

General

- Tiziana Di Matteo (King's College London), ***Multiscaling: real source and consequence***
- Hideki Takayasu (Sony Computer Science Laboratory & Meiji University), ***Construction of mathematical models of bankruptcy of firms from the big data***
- Arkadiusz Orłowski (Warsaw University of Life Sciences & Polish Academy of Sciences), ***Methods of machine learning and pattern recognition with applications to econophysics***

Committees

Scientific Committee

- Tomaso Aste (University College London)
- Marcel Ausloos - Mentor of Round-Table Discussion (University of Leicester)
- Dariusz Grech (University of Wrocław)
- Shlomo Havlin (Bar-Ilan University)
- Janusz Hołyst (Warsaw University of Technology)
- Ryszard Kutner – Chairman of Conference (University of Warsaw)
- Rosario N. Mantegna (Central European University & Palermo University)
- Tiziana Di Matteo (King's College London)
- Maciej Nowak (Jagiellonian University)
- Arkadiusz Orłowski (Warsaw University of Life Sciences & Polish Academy of Sciences)
- Silvio Queirós (Brazilian Center for Research in Physics)
- Peter Richmond (The University of Dublin)
- Enrico Scalas (University of Sussex)
- Christophe Schinckus (University of Leicester; RMIT University, Vietnam)
- Didier Sornette (ETH Zürich)
- Zbigniew Struzik (Tokyo University)
- Katarzyna Sznajd-Weron (Wrocław University of Technology)
- Wei-Xing Zhou (East China University of Science and Technology)

Organizing Committee

- Agata Dębska (Faculty of Physics, University of Warsaw)
- Tomasz Gubiec (Faculty of Physics, University of Warsaw)
- Jarosław Klamut (Faculty of Physics, University of Warsaw)
- Ryszard Kutner – Chairman of Conference (Faculty of Physics, University of Warsaw)
- Tomasz Raducha (Faculty of Physics, University of Warsaw)
- Mateusz Wiliński (Faculty of Physics, University of Warsaw)

Symposia

Plenary session

Announcement

Two subsequent obligatory poster sessions were (for all posters) established on 5 July from 11:00 to 11:30 and from 15:30 to 16:15 both located in the Main hall. Remaining poster sessions require from authors leaving posters on the boards only.

Programme

Tuesday, 4 July

EARLY REGISTRATION
Tuesday afternoon, 4 July, 15:00
Main hall

END OF EARLY REGISTRATION
Tuesday evening, 4 July, 20:00

Wednesday, 5 July

REGISTRATION
Wednesday morning, 5 July, 8:00
Main hall

WELCOME
Opening
Wednesday morning, 5 July, 9:00
Room A + Room B
Chair: Ryszard Kutner

LECTURE
Physics vs economy and social sciences
Wednesday morning, 5 July, 9:15
Room A + Room B
Chair: Ryszard Kutner

9:15	Invited Oral

Are organizing principles from physics of relevance to economic and social sciences?

Eugene Stanley

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Recent analysis of truly huge quantities of empirical data suggests that classic economic theories not only fail for a few outliers, but that there occur similar outliers of every possible size. Specifically, if we analyze only a small data set (say 10^4 data points), then outliers appear to occur as "rare events." However, when we analyze four orders of magnitude more data (10^8 data points), we find four orders of magnitude more outliers---so ignoring them is not a responsible option. We find that the statistical properties of these "outliers" are identical to the statistical properties of everyday fluctuations.

Two unifying principles that underlie much of the finance analysis we will present are scale invariance and universality. Scale invariance is a property not about algebraic equations but rather about functional equations, which have as their solutions not numbers but rather functional forms---e.g., the solution of the functional equation

$$f(\lambda x)=\lambda^p f(x)$$

is $f(x)=x^p$. The key idea of universality is that the identical set of "scaling laws" hold across diverse markets, and over diverse time periods.

We demonstrate the principles of scaling and universality by describing very recent work. Financial market fluctuations are characterized by many abrupt switchings on very short time scales, from increasing "microtrends" to decreasing "microtrends"---and vice versa. We ask whether these ubiquitous switching processes have quantifiable features analogous to those present in phase transitions, and find striking scale-free behavior of the time intervals between transactions both before and after the switching occurs.

Recent disasters ranging from financial "shocks" to large-scale terrorist attacks dramatically exemplify the fact that the most dangerous vulnerability is hiding in the many interdependencies among different networks. Specifically, we have uncovered new empirical laws governing the nature of switching phenomena in coupled networks, and found that phenomena that are continuous "second order" phase transitions in isolated networks become discontinuous abrupt "first order" transitions in interdependent networks. We find that the same laws governing the formation and bursting of the largest financial bubbles also govern the tiniest finance bubbles, over a factor of 1,000,000,000 in time scale.

Finally, we analyze changes in Google query volumes for search terms related to finance and find patterns that may be early warning signs of stock market moves. We conclude by discussing the network basis for understanding sudden death in the elderly, and the possibility that financial "flash crashes" are not unlike the catastrophic first-order failure incidents occurring in interdependent networks.

This work was carried out in collaboration with a number of colleagues, most especially T. Preis, H.S. Moat, S. Havlin and S.V. Buldyrev.

END OF PLENARY SESSION
Wednesday morning, 5 July, 10:00

Symposium A

Announcement

Two subsequent obligatory poster sessions were (for all posters) established on 5 July from 11:00 to 11:30 and from 15:30 to 16:15 both located in the Main hall. Remaining poster sessions require from authors leaving posters on the boards only.

Programme

Wednesday, 5 July

INVITED TALKS

Correlations and networks
Wednesday morning, 5 July, 10:00
Room A
Chair: Boris Podobnik

10:00	Invited oral

Volatility correlations in narrative

Stanisław Drożdż[1,2], Jarosław Kwapień[1], Paweł Oświęcimka[1]

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In human's communication using short sentences is considered efficient. However, a text composed exclusively of such sentences looks technical and reads boring. The one composed of long ones, on the other hand, demands significantly more effort for comprehension. Studying characteristics of the sentence length variability (SLV) in a large corpus of world famous literary texts shows that an appealing and aesthetic optimum appears somewhere in between and involves self-similar, cascade-like alternation of various length sentences - much like volatility changes in the financial
markets. Majority of studied texts obey the related fractal attributes but especially spectacular in this respect are literary texts belonging to the 'stream of consciousness' literary style, known also as the 'internal monologue'. These develop patterns characteristic to multifractals very much resembling the ones generated by the financial volatility. This coincidence parhaps suggests that the degree of multifractality in markets reflects the level of endogeneity involved in the corresponding financial dynamics.

10:30	Invited oral

Business firms networks: From basic properties to advanced application

Misako Takayasu

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Nation-wide economic activities are generally characterized by complex networks consisted of business firms, and such data for Japanese firms are provided for academic use by Teikoku Databank, which is the largest corporate credit research company in Japan. It is known that the transaction network has a scale-free structure [1] and non-trivial scaling rela-tions hold among firm sizes such as annual sales, number of employees and number of busi-ness partners [2]. Direct observation of preferential attachment is confirmed and a simple model of time evolution of network structure has been introduced [3]. As for money flow between interacting firms so-called the gravity law is known to hold [4], and a set of equations describing the whole monetary flow on the network has been introduced [5], and those results are already implemented in RESAS (Regional Economy Society Analyzing System) [6], which is a big-data analysis platform provided by the government of Japan. Percolation properties [7] and anatomical decomposition [8] are applied to quantitative description of network rigidity. From the viewpoint of data assimilation we are establishing methods to tune the frequency of 3-body motifs by generalizing the network construction model [9].

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JSTAT, to appear.

POSTERS & COFFEE

Econo- and Sociophysics
Wednesday morning, 5 July, 11:00
Main hall

ORAL TALKS

Market correlations
Wednesday morning, 5 July, 11:30
Room A
Chair: Fabrizio Lillo

11:30 Oral

Integration in time among European stock markets

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We follow the integration of European stock markets from the 70's up to today. We do this by using the time series of the stocks that are part of the major European stock market indices in order to calculate the correlations between them and to build graphs where separation between stocks is given by a distance obtained from correlation. The US stocks of the S&P 500 and the Japanese stocks of the Nikkei 225 are used as control parameters. What we see is that European stocks of different countries begin to merge in the same cluster in time.

11:52 Oral

Intraday correlation structure for high frequency financial data

Mateusz J. Wilinski[1], Tomasz Gubiec[1,2], Ryszard Kutner[1]

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Correlation structure of the nancial market is a subject that draws attention of both scientists and market practitioners. It is very important in understanding the way market works and may be applied in risk management among other nancial issues. Recently, we developed a novel method of estimating correlations when dealing with high frequency data. It is based on the algorithm shown in [1], it does not require evenly spaced series and it can be used with different types of data (jump functions, step functions and other). This method also allows us to calculate correlation in different timescales what makes it suitable to analyze Epps effect and compare it with other methods, like it was done in [2]. Along with this new estimator, we propose a new ltering method, which allows us to create structured networks out off full correlation matrices. Using both mentioned tools we analyzed the intraday market structure at different time scales similarly to how it was done in [3]. We found some interesting features in recent data which are different from those found in older intraday quotations. These results support the statement that nancial markets are getting more and more efficient, especially in high frequency domain. As a next step, we expand our research by analyzing spectral properties of data and we apply Complex Principal Component analysis, which was used before for daily data in [4]. With this methodology, adapted to our correlation algorithms, we were able to determine which forces drive the market most and at which time-scales. Moreover, complex correlations were used in order to find the lead lag relations among stocks and among principal components. Most of our ndings seem to be in accordance with economical reasoning but there are some less intuitive results as well. Finally, we show how noise and data aggregation affect all methods used both in our work and in previous papers connected to the subject of nancial correlation. As a result, we are able to distinguish between meaningful, robust results and effects which are mainly consequences of increasing noise. [l] Gubiec, Kutner, Physical Review E 82, 046119 (2010). [2] Iori, Precup, Physical Review E 75, 036110 (2007). [3] Bonanno, Lillo, Mantegna, Quantitative Finance 1, 96-104 (2001). [4] Arai, Iyetomi, FAIA 255, 111-119 (2013).

12:15 Oral

Causality Link Prediction analysis in OECD stock market indices

Ji Hwan Park, Minhyuk Lee, Sungyoon Choi, Woojin Chang

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Link prediction in multi-relational networks has become an important area in network analysis and is widely used in social network analysis. However, applying this method to financial market is limited. For this reason, we construct networks using the link prediction method. In this research, we analyze the changes of financial networks between OECD countries over five categories of period: pre-crisis, global-crisis, inter-crisis, European-crisis, post-crisis. We apply a mechanism called knowledge dissemination to measure the power of a node by computing the H-index of the node. We analyze explanatory power of the constructed network by observing the change of benchmark minimum spanning tree network. Through this network constructing process, we can obtain the converged stationary network and use the related outcomes for individual institutions' decision making or predicting market crash.

12:37 Oral

Equity markets correlation universalities and multi-asset market states

Yuriy A. Stepanov[1,2], Rudolf Schäfer[1], Thomas Guhr[1], Joachim Peinke[3], Philip Rinn[3]

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We combine geometric data analysis and stochastic modeling to identify financial correlation dominating variables and extract its explicit stochastic model. We analyze dynamically distinct market states and quantify system behavior within the states [1,2]. We apply these methods to correlation dynamics of European equities and iBoxx® bond indices. We recover our earlier results for equities, which are therefore universal. We use the multi-asset market states and study real economy dynamics [3]. As an application of equity universalities, we use correlation extreme values for trading equity index futures.

[1] **YS**, Rinn P, Guhr T, Peinke J and and Schäfer R, *J. Stat. Mech.* **2015** (2015) P08011

[2] Rinn P, **YS**, Peinke J, Guhr T and Schäfer R, *EPL*, **110** (2015) 68003

[3] **YS**, Erik Wellner and Tarek Abou-Zeid, "Quant.Capital Management",
c15-Dezember-2015, http://www.quantcapital.de/en/news/

LUNCH

Wednesday afternoon, 5 July, 13:00
Main hall

INVITED TALKS

Integration, immigration, and human activity
Wednesday afternoon, 5 July, 14:00
Room A
Chair: Tiziana Di Matteo

14:00 Invited oral

Paradox of integration - a computational model

Małgorzata Krawczyk, Krzysztof Kułakowski

AGH University of Science and Technology, Faculty of Physics and Applied Computer Science (AGH), Mickiewicza 30, Kraków 30-059, Poland

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The paradoxical aspect of integration of a social group has been highlighted by Peter
Blau (Exchange and Power in Social Life, Wiley and Sons, 1964). During the integration process, the group members simultaneously compete for social status and play the role of the audience. Here we show that when the competition prevails over the desire of approval, a sharp transition breaks all friendly relations. However, as was described by Blau, people with high status are inclined to bother more with acceptance of others; this is achieved by praising others and revealing her/his own weak points. In our model, this action smooths the transition and improves interpersonal relations [1]. Results obtained within a mean-field formulation are also discussed.

[1] M. J. Krawczyk, K. Kułakowski, *Paradox of integration - a computational model*, Physica A 468, 409 (2017)

14:30 Invited oral

Estimating the tipping point of EU right-wing populism in response to unbalanced immigration

Marko Jusup[3], Dejan Kovac[2], Boris A. Podobnik[1], Eugene Stanley[4]

1. *ZSEN (ZSEM), Jordanovac 110, Zagreb 10000, Croatia* **2.** *Princeton University, New Jersey, NJ 08544, United States* **3.** *Sapporo University, Sapporo 062-8520, Japan* **4.** *Center for Polymer Studies and Department of Physics, Boston University, 590 Commonwealth Ave, Boston, MA 02215, United States*

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Among the central tenets of globalization is the free migration of labor. Although much has been written about the benefits of globalization, little is known about its limitations and how anti-globalist sentiment can be strongly affected by high levels of immigration. Analyzing poll data from a group of EU countries affected by the recent migrant crisis, we find that over the last three years the percentage of right-wing (RW) populist voters in a given country depends on the prevalence of immigrants in this country's population and the total immigration inflow into the entire EU. The latter is likely due to the perception that the EU functions as a supranational state in which a lack of inner borders means that "someone else's problem" can easily become "my problem." We find that the increase in the percentage of RW voters substantially surpasses the percentage of immigration inflow, implying that if this process continues ongoing democratic processes will cause RW populism to prevail and globalization to rapidly decrease. We locate tipping points between the fraction of immigrants and the rise of RW-populism, and we model our empirical findings using a complex network
framework in which the success of globalization rests on a balance between immigration and immigrant integration.

15:00 Invited oral

Some recent advances in empirical analyses of economic cycles

Mateusz Pipień

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We develop two nonparametric approaches to test the empirical properties of the credit cycle. The first one is based on Almost Periodically Correlated (APC) time series utilizing the idea of Flexible Fourier Form and subsampling procedure. The second approach is based on spectral analysis provided the stationarity assumption of cyclical fluctuations. Based on the monthly series of credit aggregate and industrial production from selected eighteen EU countries, we show that the empirical properties of the credit cycle differ

We contribute to the existing literature in both, theoretical and empirical, aspects. From theoretical viewpoint we develop methods of formal statistical inference about the main properties of elements of the financial cycle. The statistical uncertainty assessed within both

approaches complements standard procedure applied in the macro-prudential literature. Our empirical findings show substantial diversity of the credit cycle across analysed countries. Also cyclical component in the credit series is identified much stronger then in case of the series of industrial production. Also the production cycles are much more synchronized across countries compared to the credit.

POSTERS & COFFEE

Econo- and Sociophysics
Wednesday afternoon, 5 July, 15:30
Main hall

ORAL TALKS

General
Wednesday afternoon, 5 July, 16:15
Room A
Chair: Tobias Preis

16:15 Oral

A multiplicative process for generating a beta-like survival function with application to the UK EU referendum results - An abstract

Trevor Fenner[1], Eric Kaufmann[2], Mark Levene[1], George Loizou[1]

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Human dynamics and sociophysics suggest statistical models that may explain and pro-vide us with better insight into social phenomena. Contextual and selection effects tend to produce extreme values in the tails of rank-ordered distributions of both census data and district-level election outcomes. Models that account for this nonlinearity generally outperform linear models. Fitting nonlinear functions based on rank-ordering census and election data can therefore improve the fit of aggregate voting models. This may help improve ecolo gical inference, as well as election forecasting in majoritarian systems.

We propose a generative multiplicative decrease model that gives rise to a rank-orderdistribution, and facilitates the analysis of the recent UK EU referendum results. We supply empirical evidence that the beta-like survival function, which can be generated directly from our model, is a close fit to the referendum results, and also may have predictive value when covariate data are available.

To obtain a rank ordering, assume that there are s voting districts, and that f (i, s) represents the expected proportion of the popular vote in the ith district, where the districts are ordered in descending order of their vote. We specify a multiplicative process, where μ(i, s), called the attrition function, is the probability that a potential vote is lost in the ith district. From this process we obtain the well-know renewal equation, whose solution is given by

$$f(i, s) = \exp\left(-\int_0^i \mu(i-t, s-t)\,dt\right) \quad (1)$$

Moreover, when μ(i, s) is a mixture of preferential and uniform attrition, we can derive a closed form for f (i, s), given by

$$f(i, s) = C\,[0.5/(i+0.5)]^{\alpha}(1-i/s)^{\beta} \quad (2)$$

which we call the beta-like survival function as it can be viewed as a discrete version of the beta distribution, noting that the constant 0.5 is to prevent the first term being undefined when i = 0.

In our analysis of the per district Remain and Leave votes of the 2016 UK EU referendum, we demonstrate very good fits to the beta-like survival function for both Remain and Leave. We noticed that the power-law exponent α for Leave is significantly lower than that for Remain, while the decay exponent β for Leave is somewhat higher than that for Remain. This may indicate that the proportions of votes for Leave were more “stable” across thecountry than those for Remain. In other words, it is feasible that positive feedbacks driven by contextual effects on individual vote choice mattered more in Remain than Leave areas.

We also analysed, with the beta-like survival function, four census covariates, which theliterature suggests are associated with the Leave vote. The R2 values of the beta-like survival fits are much higher than those obtained from traditional linear regression, indicating that our methodology using beta-like survival functions may yield better predictive models than traditional ones based on linear regression of the raw covariate data.

A full version of the paper can be found in [FKLL17].

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16:36 Oral

Statistical mechanics of coevolving Ising model

Tomasz Raducha[1], Mateusz J. Wiliński[1], Tomasz Gubiec[1,2]

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We propose a statistical mechanics approach to a coevolving spin system with adaptive network of interactions.
The dynamics of nodes' states and network connections is driven by both spin configuration and network topology.
We consider a hamiltonian that merges the classical Ising model and the statistical theory of correlated random networks.
As a result, we obtain rich phase diagrams with different phase transitions both in the state of nodes and in the graph topology.
We argue that the coupling between the spin dynamics and the structure of the network is crucial in understanding complex behavior of the real-world systems, and omitting one of the approaches renders the description incomplete

16:57 Oral

What does the h-index actually mean?

Anna Cena[1], Marek Gagolewski[1,2], Grzegorz Siudem[3], Barbara Żogała-Siudem[1]

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We present an agent-based model which explains the citations obtaining process based on the preferential attachment rule. In fact, the model is a variation of the recently discussed Ionescu-Chopart model. The simulation of the model and its exact solution not only allows to get the citations vectors (with an agreement with the real data) for each scientists based - among others - on the number of their publications and the total number of citations they received, but also posseses a very simple and appealing interpretation of its parameters. With this model we try to explain what Hirsch's and other indexes realy measure.

17:18 Oral

Improvement of numerical option pricing methods based on the Hilbert transform using spectral filtering

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We show how the convergence of numerical schemes which use discrete Hilbert transforms based on a sinc function expansion and thus ultimately on the fast Fourier transform can be improved with spectral filtering techniques. This is relevant e.g. in the computation of fluctuation identities, which give the distribution of the maximum or the minimum of a random path, or the joint distribution at maturity with the extrema staying below or above a barrier. We use as examples the schemes by Feng and Linetsky (2008) and Fusai, Germano and Marazzina (2016) to price discretely monitored barrier options modelled with Lévy processes. Both methods show exponential convergence on the grid size in most cases but are limited to polynomial convergence under certain conditions. We relate these rates of convergence to the widely studied issue of the Gibbs phenomenon for Fourier transforms and achieve improved results with spectral filtering.

17:39 Oral

Analysis of times between events by methods of statistical physics

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One of the most significant questions in the analysis of losses in financial market time series, closely related to an economic concept of value at risk (VaR), is description of times between subsequent losses of a particular magnitude (called *interevent times*). We provide such a description under two complementary approaches.

First, we present a model of superstatistics founded on the continuous-time random walk (CTRW) model and the extreme value theory (EVT). The model provides a closed analytic formula for the universal distribution of interevent times valid for excessive losses and profits (irrespective of the asset type or the time resolution of data) as well as for some geophysical data of earthquakes [1]. Our description is an alternative to the approach involving q-exponential functions [2].

Secondly, we propose an agent-based model of financial markets being a generalization of the Potts model from statistical mechanics [3]. A value of the spin variable in the model represents a short (–1), neutral (0), or long (+1) position taken by the investor on the market. The action, or decision, of the investor, i.e., buying or selling a stock is, in turn, defined as a *change* of the spin value (positive for buying and negative for selling). Thus, we identify the state of a spin with the actual market *state* of the investor (the position taken on the market), not the market *action* (buying or selling) as in the previous works. The model reproduces, inter alia, the empirical shapes of the autocorrelation function of both usual and absolute market returns, as well as the distribution of interevent times [4].

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Thursday, 6 July

COFFEE
Thursday morning, 6 July, 9:00
Main hall

INVITED TALKS

Nonextensivity, intraday processes, and systemic risk
Thursday morning, 6 July, 9:30
Room A
Chair: Peter Richmond

9:30 Invited oral

Asymmetry of price returns - analysis and perspectives from non-extensive statistical physics point of view

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We study how the approach grounded on non-extensive statistical physics can be applied for a description of the current state of the stock and money market. Particular attention is given to asymmetric behavior of fat tailed distributions of positive and negative returns. We propose a new quantifier based on asymmetry between these tails in terms of the Tsallis parameters q+, q- to analyze the effect of memory in data caused by nonlinear autocorrelations. The presented analysis takes into account data of separate stocks from the main developing stock market in Europe - Warsaw Stock Exchange (WSE) in Poland and, for comparison, data from the most mature money market (Forex). Our search is extended also to study memory effects and their dependence on the quotation frequency for similar large companies - owners of food-industrial retail supermarkets acting on both Polish and European markets (Eurocash, Jeronimo-Martins, Carrefour, Tesco) but traded on various European stock markets of diversified economical maturity. It is argued that the proposed quantifier is able to describe the stage of market development and its robustness to speculation. The main strength is put on a description and interpretation of the asymmetry of positive and negative returns in terms of Tsallis statistics for various stocks and for diversified time lags Δt of data collection. Our search indicates that the stocks from the same economic sector acting in European Union (EU) may be a target of diversified level of speculations involved in trading independently on the true economic situation of the company. The influence of the coming Brexit on the values of new quantifier, specifically for the British financial market, is also discussed.

10:00 Invited oral

The not so stylised shapes of financial markets: Intraday profiles of returns and trading volume

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Partially aiming at having larger datasets in complex systems analysis, we are frequently pushed to either consider the data quasi-stationary or apply some filter and jettison nonstationarities. Nevertheless, that sort of dynamical evolution can contain important information about the system under study as well as it is now understood that the analysis of higher-order statistical moments is crucial for an accurate description, namely when we are talking about complex systems.

In my presentation, I will revisit the classical problem of intrady seasonalities in financial trading introducing a new perspective: the analysis of higher-order moments and the assessment of the nonstationarity of those statistical features.

The results of that analysis allow understanding to what extent the market has modified its tradingdynamics since 2003 and how changes in regulation (namely short-selling/uptick rules) and the 2008 subprime crisis have affected opening and closure behaviour of market agents.

Moreover, I show that the morning part of the trading session is dominated by the trading of a couple of stocks that input information and volatility in the market whereas the second part of the business day is ruled by significantly more concerted behaviour between stocks.

Last, I will lift the veil on the impact of liquidity on these results, especially regarding structure of the correlation matrices.

10:30 Invited oral

Systemic risk due to fire sale spillover and portfolio overlaps

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Monitoring and assessing systemic risk in financial markets is of great importance but it often requires data that are unavailable or available at a very low frequency. For this reason, systemic risk assessment with partial information is potentially very useful for regulators and other stakeholders. In this paper we consider systemic risk due to fire sales spillovers and portfolio rebalancing by using the risk metrics defined by Greenwood et al. (2015). By using the Maximum Entropy principle we propose a method to assess aggregated and single bank's systemicness and vulnerability and to statistically test for a change in these variables when only the information on the size of each bank and the capitalization of each investment asset are available. We prove the effectiveness of our method on 2001-2013 quarterly data of US banks for which portfolio composition is available.

POSTERS & COFFEE

Econo- and Sociophysics
Thursday morning, 6 July, 11:00
Main hall

ORAL TALKS

Agent Based Modeling and Networks
Thursday morning, 6 July, 11:30
Room A
Chair: Katarzyna Sznajd-Weron

11:30 Oral

Investigating random, 50/50 symmetric weighted, competitive and cooperative fully connected networks: the random matrix approach.

Gurjeet Dhesi[1], Marcel Ausloos[2,3]

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We consider random competitive or cooperative symmetric interactions of N agents, thus N(N-1)/2 links,on a fully connected network. A constraint is introduced such that the network contains an equal number of competitive and cooperative interactions. This constraint imposes an additional implication: only (square)matrix sizes (4k x 4k) or ((4k+1) x (4k+1)), where k is a positive integer, can be considered. The full configuration structures of this ensemble of networks is investigated. This is carried out by analysing the averaged eigenvalue distribution of the finite N sized random sign symmetric matrix ensemble (RSSME). The results from simulation studies are presented and compared to simulation results for the average eigenvalue distribution of the RSSME without the equality (50/50) constraint. Applications in the domain of competitive and cooperative interaction structures of agents on financial markets are outlined.

11:52 Oral

Modeling of Lithuanian parliamentary elections using ABM

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While each vote counts, the probability that any single vote would be significant is extremely small. Thus from the rational agent's perspective there are few reasons to vote, as the others will either way make decision for you. Would all agents be this rational, then holding an election and competing for votes would be impossible. Few early game theoretic approaches [1] seemed promising, but later works showed that game theoretic model might be impossible [2] unless certain specific conditions are met [3]. But people are seldom rational in this game theoretic sense.

In the past 30 years physicists have used tools and models from statistical physics to analyze socio-economic systems giving birth to an interdisciplinary field of sociophysics [4]. Today opinion dynamics, and voting dynamics as its proxy, remain one of the major research topics in sociophysics [5]. We contribute to this research trend by analyzing publicly available Lithuanian parliamentary election data. We consider votes cast for the parties and disregard voting for the individuals. We find that party vote share distribution, across polling stations, is very well fitted by the Beta distribution. We propose a multi-state agent-based herding model, derived from earlier proposed financial market model [6], to reproduce this observation. We draw comparisons between the proposed model and well known Voter model [7].

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4. D. Stauffer, Journal of Statistical Physics 151: 9 – 20, 2013.
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12:15 Oral

Mean-field theory for the ordering transition in the majority-vote model on multiplex networks

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Mean-field theory for the ordering transition in the majority-vote model on multiplex networks with two independently generated layers in the form of scale-free networks is presented. In this model two-state agents (spins) located in the nodes update their states according to the opinions of the majorities of their neighbors in both layers with certain probability related to the degree of the internal noise. If the opinions of the majorities of the agent's neighbors in both layers coincide the agent adjusts her opinion to them with higher probability; otherwise, she acts independently and makes the decision for or against randomly, with equal probability. An interesting property of the model is that within the mean-field approach the nodes with odd and even number of neighbors within each layer should be taken into account in a different way. The critical values of the internal noise evaluated theoretically for the layers with different degree distributions agree quantitatively with those obtained from Monte Carlo simulations.

12:37 Oral

Asymmetric return rates and wealth distributions induced by introduction of technical analysis into a behavioral agent-based model

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Behavioral Finance has become a challenge to the scientific community. Based on the assumption that behavioral aspects of investors may explain some features of the Stock Market, we propose an agent based model to study quantitatively this relationship. In order to approximate the simulated market to the complexity of real markets, we consider that the investors are connected between them through a small world network; each one has its own psychological profile (Imitation, Anti-Imitation, Random); two different strategies for decision making: one of them is based on the trust neighborhood of the investor and the other on considers a technical analysis, the momentum of the market index technique. We analyze the market index fluctuations, the wealth distribution of the investors according to their psychological profiles and the rate of return distribution. Besides, we analyze the influence of changing the psychological profile of the hub of the network and report interesting results which show how and when anti-imitation become the more profitable strategy for investment. Moreover, an intriguing asymmetry of the return rate distribution is explained considering the behavioral aspect of the investors. This asymmetry is quite robust and it has been observed when even a completely different algorithm to calculate the decision make of the investors was applied to it.

LUNCH

Thursday afternoon, 6 July, 13:00
Main hall

INVITED TALKS

Multiplex modeling, best strategies, ABM social validation
Thursday afternoon, 6 July, 14:00
Room A
Chair: Janusz Hołyst

14:00	Invited oral

Multiplex Modeling of the Society

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The society has a multi-layered structure, where the layers represent the different contexts resulting in a community structure with strong overlaps. To model this structure we begin with a single-layer weighted social network (WSN) model showing the Granovetterian correlations between link strength and topology. We find that when merging such WSN models, a sufficient amount of inter-layer correlation is needed to maintain these correlations, but they destroy the enhancement in the community overlap due to multiple layers. To resolve this, we devise a geographic multi-layer WSN model, where the indirect inter-layer correlations due to the geographic constraints of individuals enhance the overlaps between the communities and, at the same time, the Granovetterian structure is preserved.

The network of social interactions can be considered as a multiplex from another point of view too: each layer corresponds to one communication channel and the aggregate of all them constitutes the entire social network. However, usually one has information only about one of the channels, which should be considered as a sample of the whole. We show by simulations and analytical methods that this sampling may lead to bias. For example, while it is expected that the degree distribution of the whole social network has a maximum at a value larger than one, we get with reasonable assumptions about the sampling process a monotonously decreasing distribution as observed in empirical studies of single channel data. We analyse the far-reaching consequences of our findings.

14:30	Invited oral

SME investment best strategies

Marcel Ausloos

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The relation between investments and business performance is a standard question. Due to the recent financial crisis, the effect of investments on the growth, productivity, and performance of companies after the crisis is of interest for managerial and planning purposes. Some study of a well defined case will not only bring some quantitative measure, but also may lead to further discussion. A priori, one expects some positive correlation. What are the findings, - a posteriori? Thus, a search is implemented for finding correlations between relevant variables, pertaining to i investment implemented before a crisis, and those measuring companies performance thereafter. The case of SME on the Italian STAR market is studied. Practically, the indicators, representing: the level of investments are (1) total intangible assets (excluding goodwill) and (2) total tangible assets. The financial/economic indicators representing business performance, defining "growth", are (3) sales variations, (4) total assets variations, (5) labour" variations; for "profitability", one considers (6) returns on investments and (7) returns on sales; finally for "productivity" the measures are (8) asset turnover and (9) sales/employee. The data distributions are statistically analyzed and relevant histograms presented.

It is argued that the outlier companies are those giving a better view of the success or failure of the investment strategies. It is found that the outlier companies with positive performance are those with the lowest TTA, the outlier with negative performance has also a low TTA, but the company which did not increase its TTA, before the crisis, becomes "negative outlier". It is concluded that extreme performance forecasted from investment strategies, for SMEs, at time of financial crisis, there is no question: it is "To be, - Not to do". Thus the findings are not those a priori expected.

15:00 Invited oral

Conformity in numbers: How to validate social agent-based models

Piotr Nyczka[1], Katarzyna Byrka[2], Paul Neil[3], Katarzyna B. Sznajd-Weron[4]

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Ample empirical evidence shows that descriptive norms, understood as "how most people behave in a given situation", are a powerful means to influence compliance. The problem is what does it mean "most" and this is far from being clear. Is it just an absolute majority, unanimity or maybe a certain threshold like 75%? Although effectiveness of normative messages have been studied thoroughly, researchers operationalize norms and select their numerical representations according to undefinedrules. In most studies, numerical representations of norms come from real data. When the access to real data is limited, the decision about numbers representing norms is taken arbitrary. The question that naturally arose here is the following: Is there anything like the critical threshold for the majority and if yes, what the value of this critical threshold?

Usually, ABMs are defined as computer simulations of social interaction between agents (e.g., individuals, firms, or states), embedded in social structures. Such models are aimed to observe, analyze and understand the emergence of aggregate outcomes, such as public opinion, results of voting, diffusion of innovation, cultural or political revolutions, international terrorism, social inequality, urban ethnic segregation etc. Although, the origins of ABMs in sociology can be traced back to the 1960s, it was only from the 1990s that ABM applications reached a critical mass. Almost simultaneously, yet somehow independently a new field of sociophysics, i.e. applications of statistical physics in social sciences, emerged.

The essence of statistical physics is to understand collective phenomena (macroscopic level) on the basis of interactions between basic elements of the system (microscopic level). Therefore, all models of statistical physics can be viewed as ABMs, although in physics this type of approach has been known for years under the name of microscopic modeling. Because physicists have gained much experience and developed many computational and analytical tools to study collective phenomena, the temptation arose to apply methods of statistical physics outside of physics.

As in physics, most of sociophysics models are relatively simple and often can be viewed rather as toys than tools. Although the role of the toy models in the development of statistical physics cannot be overestimated, yet the main challenge that persists with social ABMs is the describing properly of complex social systems in terms of a relatively simple approach. In other words, our main goal is not to draw the precise portraits of real social systems but rather caricatures. However, these caricatures should be as good as possible and therefore there is a strong need of validation not only of the model's assumptions but also outcomes.

During this lecture we show how ABM's can be validate on the basis of social experiments. Asan example we will discuss a model of opinion dynamics with three different types of social response: conformity, anticonformity and independence. We show how to build a model in agreement with social theories and experiments, but first of all we will show how to validate results given by the model. Finally, we show how ABM's can help to answer the questions pose by social psychologists, such as one on the existence of the critical threshold for the majority.

POSTERS & COFFEE

Econo- and Sociophysics
Thursday afternoon, 6 July, 15:30
Main hall

ORAL TALKS

Financial Markets
Thursday afternoon, 6 July, 16:15
Room A
Chair: Ladislav Kristoufek

16:15 Oral

Confidence and the Self-Attribution Bias in an Artificial Stock Market

Mario Bertella[1], Felipe Pires[2], Henio Rego[3], Jonathas Silva[1], Irena Vodenska[4], Eugene Stanley[5]

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Using an agent based model we examine the dynamics of stock price fluctuations and their return rates in an artificial financial market composed of fundamentalists and chartists with and without confidence. Our goal is to create an agent based model in which the agents exhibit confidence in their decision making in accordance with the behavioral finance approach, and we assume the level of agent confidence evolves during the simulation time. A small number of papers in the literature incorporate psychological biases into the agents, such as: Takahashi and Terano (2003), Lovric (2011), and Bertella et al. (2014). Our study is similar to this last work, but it differs in the way we model confidence and how we verify the robustness of our model. We find that chartists who are confident generate higher price and return rate volatilities than those who are not. We also find that kurtosis and skewness are lower in our simulation study of agents who are not confident. We show that the stock price and confidence index - both generated by our model - are cointegrated and the stock price affects confidence index but confidence index does not affect stock price. To estimate the robustness of our model, we compare its results in two cases: (i) the S&P 500 index

and the stock market confidence calculated by Yale School of Management, and (ii) the growth rate of both the S&P 500 and its confidence index. As in our model, Engle-Granger and Johansen tests indicate there is cointegration between stock prices and stock market confidence indices, and between price growth and confidence growth rate. Besides, the Granger causality test indicates that price or its growth rate affects confidence and its growth rate whose results corroborate the predictions of our model.

16:41 Oral

A novel speculation game with higher reproducibility of stylized facts for financial markets

Kei Katahira, Yu Chen

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The financial time series of asset returns have several qualitative properties such as volatility clustering and heavy tails, collectively called **stylized facts** [1]. They are quite nontrivial features and observed in studies of different markets and instruments.

The reproducibility of the stylized facts is the prerequisite for a market model. However, despite the qualitative properties, they are so constrained that it is not easy to reproduce even with an ad hoc stochastic process. There are some successful procreative models such as GARCH process, yet most currently existing models fail to reproduce all the stylized properties at once.

The situation in agent-based models is similar; for example, Grand Canonical Minority Game [2] can reproduce only 2~3 of the stylized facts. Thereby, this research proposes a novel agent-based model named “Speculation Game” which has the better reproducibility of the stylized facts, making used of the structure of Minority Game.

Speculation Game is a repeated game where players in a game market compete with each other to increase their investing cash by yielding capital gains through round-trip trades. Roughly speaking, this new model has three remarkable differences from previously advocated agent-based models for the financial market: the existence of **holding periods**, strategic evaluation with **capital gains and losses**, and allowance of an order with **variable quantities**.

Multi-agent simulation with Speculation Game can reproduce 8 out of 11 stylized facts reported by Cont [1] under the same parameter setting. Moreover, introducing knowledge from behavioral economics or heterogeneity of players to the model may sufficiently reproduce the rest of three stylized facts.

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17:07 Oral

The Action Principle in Market Mechanics

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This paper explores the possibility that asset prices, especially those traded in large volume on public exchanges, might comply with specific physical laws of motion and probability. The paper first examines the basic dynamics of asset price displacement and finds one can model this dynamic as a harmonic oscillator at very local 'slices' of elapsed time. Based on this finding, the paper theorizes that price displacements are constrained, meaning they have extreme values beyond which they cannot go when measured over a large number of sequential periods. By assuming price displacements are also subject to the principle of stationary action, the paper explores a method for measuring specific probabilities of future price displacements based on prior historical data. Testing this theory with two prevalent stock indices suggests it can make accurate forecasts as to constraints on extreme price movements during market 'crashes' and probabilities of specific price displacements at other times.

17:33 Oral

Empirical study on random cascades among different time horizons in stock markets

Jun-ichi Maskawa[1], Koji Kuroda[2], Joshin Murai[3]

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Large price movements have been frequently derived endogenously without any definite information out of markets, any negotiation nor any consent among market participants. Recent large price declines of less than -5\% during the last decade are concentrated within the two months after the market crash on 8 October 2008. Those heavy price falls occurred in a pessimistic mood for the world economy. Neither is related to specific news that might justify the magnitude of the subsequent drop-off. Instead, news including the words "financial crisis" came out every day. They did not impact stock prices severely alone, but they exacerbated the pessimistic mood prevailing among stock market participants. Such news increased after the Lehman shock preceding the market crash. Many authors pointed out that the co-movement of stock markets or the correlation among stock returns increased before and after the major market crash such as ``Black Monday'' in 1987 . In the earlier papers, we have analyzed the multivariate time-series of stock returns of the constituents of the FTSE100 listed on the London Stock Exchange and also those of the Nikkei 225 Index listed on the Tokyo Stock Exchange for the period from May 2007 to January 2009 to study precursors to the global market crashes in 2008. We reported that a sharp rise in a measure of the collective behavior of stock prices was observed before the

market crash. It is natural to think that this phenomenon reflects a collective behavior among market participants. In stock markets, different types of market participants with different strategies and different time horizons, e.g., hedge fund, investment trust, pension fund, day trader and program, compete with each other. The interactions among such market participants with different time horizon create a nonlinearity, i.e., structure along the time scale axis, so called multifractality. It is known that such structure in time series of stock returns are well described by random cascade model as in the study of fully developed turbulence. In this paper, analyzing the multivariate time-series of stock returns and orders in stock markets around the crash in 2008, we empirically investigate random cascades among wavelet coefficients for different time scales.

Friday, 7 July

COFFEE

Friday morning, 7 July, 9:00
Main hall

INVITED TALKS

Proximity based networks, pattern recognition
Friday morning, 7 July, 9:30
Room A
Chair: Janos Kertesz

9:30 Invited oral

Bootstrap validation of proximity based networks

Federico Musciotto, Luca Marotta, Salvatore Miccichè, Rosario N. Mantegna

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Proximity based networks are widely used in many econophysics investigations. Here we evaluate the robustness of minimum spanning trees and of planar maximally filtered graphs by performing bootstrap sampling of the analyzed data. The bootstrap validation confirms the robustness of the proximity based network estimation and highlights both the links that are statistically robust and the links that have a poor bootstrap frequency, i.e. those links that are not often detected in bootstrap replicas. The bootstrap is performed with two distinct approaches and the difference between them is discussed.

10:00 Invited oral

Methods of machine learning and pattern recognition with applications to econophysics

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Selected methods of machine learning and pattern recognition are elaborated and applied to various nontrivial problems of econophysics. Usefulness of presented artificial intelligence based techniques in the context of economy-inspired problems is proven. Some comparisons with other approaches to the investigated issues are performed.

ORAL TALKS

Fractal Tools and Analysis
Friday morning, 7 July, 10:30
Room A
Chair: Hideki Takayasu

10:30 Oral

Stability of calibration procedures: fractals in the Black-Scholes model

Yiran Cui[1], Sebastian Del Baño Rollin[3], Guido Germano[1,2]

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Usually, in the Black-Scholes pricing theory the volatility is a positive real parameter. Here we explore what happens if it is allowed to be a complex number. The function for pricing a European option with a complex volatility has essential singularities at zero and infinity. The singularity at zero reflects the put- call parity. Solving for the implied volatility that reproduces a given market price yields not only a real root, but also infinitely many complex roots in a neighbourhood of the origin. The Newton-Raphson calculation of the complex implied volatility has a chaotic nature described by fractals.

10:50 Oral

Correlation structure decomposition through scale- and amplitude-dependent qMST methodology

Paweł Oświęcimka[1], Jarosław Kwapień[1], Stanisław Drożdż[1,2]

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Many natural systems can be considered as a collection of interacting elements forming networks with non-trivial topologies. Nodes of the network can represent dynamical units (observables) whereas the weighted edges quantify correlations between the nodes. In many cases, the structure of such networks reveals high degree of complexity and some optimization procedures concentrating on key network properties are recommended. One example of such methodology is the minimal spanning tree (MST) which is a subgraph of a weighted network that minimizes sum of the edges weights spanning the network. Crucial in this context is determination of the correlations measure (edges weights) between the network nodes. In the

standard MST approach weights are expressed by metric using the Pearson coefficient. This, however, imposes some limitations related to linearity and stationarity of the considered time series.

In this contribution we propose generalization of the MST methodology and call it the q-dependent minimum spanning tree (qMST). In the proposed approach the r_q coefficient is applied to quantify the cross-correlation between time series with respect of the considered time scale and amplitude of the analysed signals. In effect, we are able to construct graphs reflecting variability of correlation structure with time and amplitude resolution selected by the r_q coefficient. Moreover, the methodology of estimation of the r_q based on the multifractal cross-correlation analysis (MFCCA) algorithm, makes qMST capable to deal with nonlinearity and nonstationarity of the time series. We demonstrate performance of the proposed methodology by applying it to the analysis of correlations between the American companies quoted on the New York Stock Exchange in the period 1998-1999. Our findings show that the topology of obtained qMST graphs strongly depends on the considered time scale and amplitude of the signals. In particular, analysis of the topological properties of the graphs estimated for different scale values show evolution of the correlation arrangement of the stocks from strongly centralized structure identified on the minute scales to sectorial organization on the monthly one. Moreover, amplitude filtering indicates that the strongest collective behaviour characterizes intermediate-amplitude fluctuations whereas the largest one have more independent dynamics.

In conclusion, the qMST methodology offers a novel range of possibilities to study the hierarchical structure of the system with respect to time scales and amplitudes of the signals. The proposed technique can be of particular interest in financial engineering where it can be directly used to investment portfolio optimization.

11:10 Oral

Multifractal cross-correlation and casual direction between energy and financial markets in 2014-2016

Marcin Wątorek[1], Paweł Oświęcimka[1], Stanisław Drożdż[1,2]

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In this contribution we analyse statistical and multiscaling properties of WTI Crude oil prices expressed in US dollar in relation to the most traded currencies as well as to gold and to the SP500 futures prices. We show that in most of the cases the tails of the returns distribution of the considered financial instruments follow inverse cubic power law. The only exception is the Russian ruble for which the distribution tail scales with the exponent close to 2 which indicates dynamics closely related to the Lévy processes. From the perspective of multiscaling the analysed time series can be considered as multifractal structures with strongly left-sided asymmetry of the spectrum. However, the most interesting results we obtain in the case of multifractal cross-correlation analysis which is carried out by means of the multifractal cross-correlation analysis (MFCCA) and detrended cross-correlation coefficient r_q. Our results clearly show that all the considered instruments are multifractally cross-correlated with the oil prices and the strongest relationship with oil characterizes currencies of the countries extracting crude oil. Moreover, strength of the multifractal coupling depends on the considered time span. In the analysed time period the level of the cross-correlation increases systematically during the bear phase on the oil market and it saturates after the trend reversal in 1st half of 2016. MFCCA methodology is also applied to identify possible causal relations between considered observables. Analysis of the asymmetry in multifractal cross-correlation characteristics estimated for different variants of synchronization of the time series indicates dependence of the oil prices on the analysed currencies exchange rates. Likewise in the case of statistical analysis, exception is the Russian ruble rate which is influenced by oil prices. The causal connections are also analysed by means of the Granger causality test which confirms causal direction identified by multifractal methodology.

POSTERS & COFFEE

Econo- and Sociophysics
Friday morning, 7 July, 11:30
Main hall

ORAL TALKS

Foreign Exchange Market
Friday afternoon, 7 July, 12:00
Room A
Chair: Sonia Bentes

12:00 Oral

Causal Inference of Market Event Rates in Foreign Currency Market

Jean-Francois Boilard[1], Kiyoshi Kanazawa[1], Hideki Takayasu[1,2], Misako Takayasu[1]

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In recent years, the technological development directly have impact on the interaction between market participants. In most financial markets, automatic execution systems have shown presence over 95% in Electronic Broking Services (EBS) Foreign Currency Market. One of the main consequence is the increase in speed of the decision making process of the market as a whole. These days, researchers have now access to precise dataset and study the detail of fluctuation dynamic of the order book. In this research, we analyze the entire order book of EBS Currency Market in isolating incoming limit orders, transactions triggered by market orders, and annihilation of queuing limit orders. More specifically, we inferred the causal interaction between those market events.

We use a database provided by EBS/NEX, which is one of the most active interdealer brokers in Spot Foreign Exchange Market. This database covers three weeks of 2011 with time granularity of one

millisecond. Moreover, we have access to order identification which permits us to track orders from their submission to annihilation. In this research, we focus on the Euro(EUR)/US dollar(USD), USD/ Japanese yen(JPY), and EUR/JPY currency pairs in particular.

We calculate the frequency rate per unit time of market events using a time window of one hour. Figure 1 compares the cancellation and submission rates. The blue (bid) and red (ask) points are the the one hour rate for the USD/JPY currency pair. We observe a clear linear scaling relation between both events. We follow the same procedure for every interaction for market events, and we isolate the real impact of one parameter on another in using Granger Causality techniques.

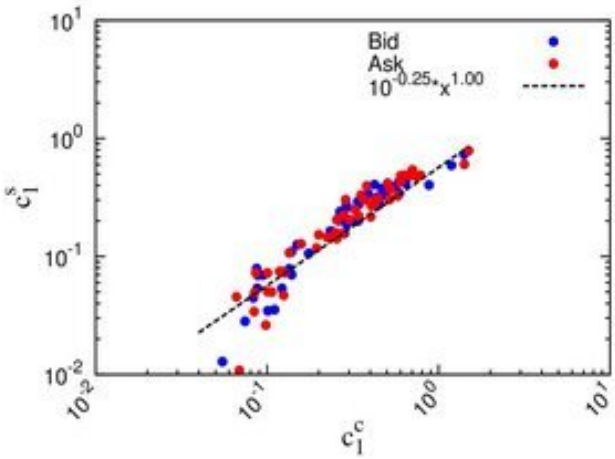

Figure 1: Log-log plot of the cancellation parameter (x-axis) and submission parameter (y-axis). The blue and red points are respectively the bid and ask with one hour time window. The dashed line is the approximation of the scaling relation.

12:20 Oral

Consistency of local-stochastic volatility models in the FX market with respect to spot inversion and multiplication

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We investigate the consistency of classes of local-stochastic volatility (LSV) models with respect to spot inversion and multiplication, and hence their applicability in the foreign exchange market. We consider two main classes, one based on the Heston model and one based on the SABR model. Then we embed them in a more general superclass of LSV models. We give general conditions the models in the superclass must satisfy to be invariant with respect to inversion and check these conditions for a collection of popular LSV models. We also investigate affine diffusion processes, showing that the symmetry conditions for inversion are automatically fulfilled. We draw conclusions on the arbitrage opportunity in variance swaps. With respect to multiplication, we consider a Heston-based class only and show that, in order for consistency to be preserved, an adjustment in the drift of the exchange rate dynamics is required.

12:40 Oral

Entropy Risk Factor Model of Exchange Rate Prediction: Test on Chilean Peso

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Entropy Risk Factor Model of Exchange Rate Prediction: Test on Chilean Peso

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Abstract

Currencies are used by many investors as a speculative or investment instrument. Their movements are complex and there are several fundamentals based models that suggest how to predict long and short term fluctuations. In this paper we investigate the predictability of an exchange rate with an entropy risk factor model. Considering that recent studies suggest that financial markets have complex systems characteristics, we explore the usefulness of sample entropy as a risk factor for currency fluctuations. The empirical testing of sample entropy is based on the data of the Chilean peso (CLP) exchange rate for the period of January 1, 2005 and November 25,

2016. We find evidence that Chilean peso market has enough market inefficiencies that can be profitably exploited by the sample entropy based algorithm developed in this paper. Although our results are based on out-of-sample performance of the active strategies, there could still be a chance that the level of effectiveness is sample specific.

JEL Category: 14

Keywords: Exchange Rate, Currency Trading, Market Timing, Entropy, Chilean Peso, Asset Pricing, USD/CLP

LUNCH

Friday afternoon, 7 July, 13:00
Main hall

INVITED TALKS

Asymmetry of SM volatility
Friday afternoon, 7 July, 14:00
Room A
Chair: Zbigniew Struzik

14:00 Invited oral

Modelling the asymmetric behaviour of stock market volatility: New evidence

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This paper focuses on the asymmetric behaviour of stock market volatility. Usually, good and bad news do not have the same impact in stock prices. Therefore, we assess how markets react to good and bad news. We employ the TGARCH and EGARCH models to asses these feature of the data. We use a long time span from 1995 to 2016 covering several financial crises. Our results show that for the developed countries there is evidence of asymetric behavior in stock indices.

Posters

Wednesday, 5 July

POSTERS & COFFEE

Econo- and Sociophysics
Wednesday morning, 5 July, 11:00
Main hall

11:00 Poster 1

The Mathematics of Human Contact

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We revisit the data previously collected by the SocioPatterns collaboration (http://www.sociopatterns.org/) and we compare the distributions of several network properties to the results of Monte Carlo simulations of a dynamic graph model.

The dynamic graph model assigns on-off durations to each link from an appropriate probability distribution. Even if the model does not capture all the important features of the real-world network, it provides a useful first approximation.

Primary school temporal data were published in:

V. Gemmetto, A. Barrat and C. Cattuto, Mitigation of infectious disease at school: targeted class closure vs school closure, BMC Infectious Diseases 14:695 (2014).

J. Stehlé, N. Voirin, A. Barrat, C. Cattuto, L. Isella, J.-F. Pinton, M. Quaggiotto, W. Van den Broeck, C. Régis, B. Lina, P. Vanhems, High-Resolution Measurements of Face-to-Face Contact Patterns in a Primary School, PLOS ONE 6(8): e23176 (2011).

High school temporal data were published in:

R. Mastrandrea, J. Fournet, A. Barrat, Contact patterns in a high school: a comparison between data collected using wearable sensors, contact diaries and friendship surveys. PLoS ONE 10(9): e0136497 (2015).

This is joint work with N. Georgiou and I.Z. Kiss.

11:00 Poster 2

Insider trading and acceleration reflected in the price of confidential information stock indexes

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Insider trading and fraud is one of the main violations of the symmetry of information on the stock market. insider trading is therefore regulated by law in many countries. For example Directive 2003/6/EC of the European Parliament and of the Council of 28 January 2003 on insider dealing and market manipulation (market abuse) lists two types of entities for which it is forbidden to make transactions insider trading. First are that are related the company whose shares are buying or selling in the stock market (for example: managers, employees and so on). But on the other hand are “any person (…) who possesses inside information while that person knows, or ought to have known, that it is inside information.” (article 4 Directive 2003/6/EC).

While insider trading carried out by insiders of enterprises is studied

in a few papers but insider trading carried out by all the other people practically is not tested. This caused due to extremely difficult proving that such a crime occurred.

Our studies show that insider trading carried out by private insiders can increase the efficiency of the market and accelerate the change of the share price to reflect the confidential information. The study is based on the verification of the means of propagation of information in networks of private investors. The study was conducted using data from the Stock Exchange in Warsaw.

11:00	Poster	3

Percolation in communication network of soaring agents

Marta Bigus, Piotr Fronczak

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Birds and UAVs (Unmanned Aerial Vehicles) are able to fly continuously large distances taking advantage of conditions of the environment. The main goal is to use thermals - rising masses of hot air, forming usually over warm areas, e.g. rocks or roofs. Agents climb on thermals and sink in chosen direction to save energy and stay in the air. Speed of a flight of an agent depend on the environment. One of the important features is density of thermals - enabling agents to reach next thermal after gliding down from previous one. What is more, position of thermals can change over time, due to wind or temperature fluctuations. Adjusting speed and move direction to environmental conditions can extend duration of flight and save the energy of an agent.

On the other hand, it is difficult to predict the environment and position of thermals. While reaching a next thermal by a single UAV is possible in favorable conditions, it is much easier to continue flight in a swarm of communicating UAVs. Sending information of a current thermal position to other UAVs extends their knowledge of the environment what results in increase of an average speed of the swarm. What is more, the patterns of UAVs paths change - their tend to form groups of different size and range. Grouping, speed and percolation effect depend on a number of UAVs and communication range adjusted to environment conditions. Here we present a model for the swarm of communicating UAVs in changing environment with focus on flight characteristics in given conditions.

11:00	Poster	4

Reaction-diffusion processes and pattern formation in biological structures.

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Reaction-diffusion model describes changes in time and space densities of two or more substances. It can be used to describe chemical reactions, biology pattern-formation, ecology systems and more. The main goal of the study was to recapture patterns which appears in nature using mathematical equations of reaction-diffusion.

In performed simulations two ingredients reacion-diffusion model has been used. Also three reaction models - Mimura-Murray, Brusselator and Scott-Gray have been implemented. Some ranges of reaction and diffusion parameters can lead to spontaneous pattern-formation. Some of the patterns are similar to these appearing in nature.

Generated patterns has been compared to these appearing in nature on animals fur and skin. Many similarities have been found. It shows that by using pure mathematical equations it is possible to recapture complex natural processes.

11:00	Poster	5

Hyperbolic geometry and real life networks

Dorota Celińska[1], Eryk Kopczyński[2]

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Drawing graphs as nodes connected by links is visually compelling but computationally difficult [1]. In hyperbolic plane, the amount of space in distance *d* from the given point is exponential in *d*. Recently it was shown that hyperbolic geometry is intrinsic in many real world networks, and especially useful while modeling large scale-free networks based on similarity and popularity [2]. An efficient embedding algorithm has been recently shown [3]. Unfortunately, this algorithm does not deal with weighted networks, and may not give visually appealing results. Furthermore, no powerful tools exist to visualize such embeddings of graphs. In this article, we present and discuss the goodness of fit of the hyperbolic embeddings of selected networks. RogueViz, a novel tool, based on the Open Source game HyperRogue, is used to map the network and navigate the hyperbolic graph.

- Trees embedded in hyperbolic plane

Hyperbolic trees employ hyperbolic space, which intrinsically has ``more room'' than Euclidean space. The result usually reduces visual clutter and helps focus. We present two visualizations of trees embedded in hyperbolic plane: an evolution tree of life on Earth (Tree of Life web project) with 94309 nodes, and an infinite tree of Collatz Conjecture. In the visualization of Collatz Conjecture, the descendants of each number are the possible numbers which precede it (e.g. 8 could be immediately preceded by 5 or 16).

- Programming languages in GitHub

We present aa visualization of a weighted network of programming lanugages used by the registered users of GitHub repository hosting service as of December 2016. GitHub is currently the largest software repository hosting service devoted to Open Source software that incorporates social media functionalities to writing and assessing source code. Since the complete download of GitHub data is impossible, our dataset is combined from three sources: GHTorrent project, GitHub Archive project, and our own dataset obtained by

web-scrapping GitHub. The resulting dataset contains information about the activity of 10,620,313 users in 42,636,285 repositories.

- Games discussed on r/roguelikes

We present a visualization of the games discussed in r/roguelikes, constructed upon the posts and comments from Jul 6, 2016 to Mar 11, 2017 which have been downloaded via the Reddit API. For each Reddit user and each game the number of posts/comments where the given user has mentioned the given game is counted. If a user U mentions game A n_a times and game B n_b times, the games A and B attract themselves with force $n_a n_b / f_U$, where f_u is chosen so that the total contribution of user U is proportional to the square root of his total number of mentions.
The algorithm we use to embed the networks is based on simulated annealing. Our findings suggest that modeling social networks embedded in hyperbolic plane can improve knowledge about the latent communities. Vertices sharing similar properties tend to be mapped close together. The Poincare model enables sort of ``fish-eye'' view at the whole network, comfortable for quick investigation of popularity of nodes. Analyses of log-likelihood reveal that hyperbolic embeddings predict noticeably better the existence of edges in the networks compared to the predictions made by their Euclidean counterparts.

1. [1] Munzner, T. 1998. Exploring large graphs in 3d hyperbolic space. IEEE Computer Graphics and Applications 18(4):18–23.
2. [2] Papadopoulos, F.; Kitsak, M.; Serrano, M. A.; Boguna, M.; and Krioukov, D. 2012. Popularity versus Similarity in Growing Networks. Nature 489:537–540.
3. [3] Blasius, T.; Friedrich, T.; Krohmer, A.; and Laue, S. 2016. Efficient embedding of scale-free graphs in the hyperbolic plane. In European Symposium on Algorithms (ESA), 16:1–16:18.

11:00	Poster	6

q - Ising model on a duplex and a partially duplex clique

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We analyze a modified kinetic Ising model, so called q- neighbor Ising model, with Metropolis dynamics on a duplex clique and a partially duplex clique. In the q-Ising model each spin interacts only with q spins randomly chosen from the whole neighborhood. In the case of a duplex clique the change of a spin is allowed only if both levels simultaneously induce this change. Due to the mean-field like nature of the model we are able to derive the analytic form of transition probabilities and solve the corresponding master equation. The existence of the second level changes dramatically the character of the phase transition. In the case of the monoplex clique, the q-neighbor Ising model exhibits continuous phase transition for q=3, discontinuous phase transition for $q \geq 4$and for q=1 and q=2 the phase transition is not observed. On the other hand, in the case of the duplex clique continuous phase transitions are observed for all values of q, even for q=1 and q=2. Subsequently we introduce a partially duplex clique, parametrized by r [0,1], which allows us to tune the network from monoplex (r=0) to duplex (r=1). Such a generalized topology, in which a fraction r of all nodes appear on both levels, allows to estimate a critical value of r=r*(q) at which a switch from continuous to discontinuous phase transition appears. We observe oscillatory behavior of r* with increasing q for odd and even values of q.

11:00	Poster	7

How are World Events Similar to Contagions?

Jan Chołoniewski[1], Janusz A. Hołyst[1,2], Julian M. Sienkiewicz[1,2], Gregor Leban[3], Robert M. Paluch[1,2]

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An abundance of online news outlets enables a large scale statistical analyses of news circulation. Using the EventRegistry system (www.eventregistry.org), we made an attempt to describe and model phenomena observed in a global news sphere (such as heavy-tailed distributions of events coverage or publishers activity).

Our results indicate that a number of news items mentioning given keyword published by observed news sources follows the Temporal Fluctuation Scaling (TFS) law with two regimes. We show that analysis of scaling exponents provides information about coverage of selected concepts and entities, and a publisher's position in an activity mean-variance log-log plot allows to extract its' writing policy toward the concepts (stable vs. reactive).

A possible usage of epidemic models (namely, SIR) as a null model has been studied showing that certain mechanisms of news industry can be modelled this way. Moreover, results of SIR model simulations on random graphs and Barabasi-Albert networks also follow TFS, although with only one regime.

The results suggest that there is underlying network of publishers observing and copying each other. We propose a possible way to reverse engineer it, and analyse its structural characteristics.

11:00	Poster	8

Tight-binding model: a quantum mechanical tool to study economic time series.

Hector Cruz

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We study the localization properties of the tight-binding equation $u_{n+1}+u_{n-1}+V_n=Eu_n$, where the on-site potential V_n is neither periodic nor random, but is aperiodic or pseudorandom. We carry out numerical work involving direct diagonalization to study localization properties of the model.

H. Cruz and S. Das Sarma, J. Phys. I France **3,** 1515-1522 (1993).

H. Cruz, J. Appl. Phys. **113**, 153706 (2013).

11:00	Poster	9

Modelling and Forecasting the Kurtosis of Financial Markets: insights provided using Irrational fractional Brownian Motion.

Gurjeet Dhesi[1], Marcel Ausloos[2,3]

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The usual returns fat-tailed distributions show power law decay in the tails. A subsequent question thus pertains to the forecast of the numerical value (of the exponent) describing the fat tail(s). The irrational fractional Brownian Motion (IfBM) modifies the Geometric Brownian Motion (GBM) by including an extra functional form which contains two parameters namely c and K.

Parameter c identifies the onset of the fat tails and K provides a measure for the weight of fat tails. Optimal estimation of the parameters through simulations allows the IfBM to model the leptokurtic return distribution of financial asset prices. In this study, optimal c and K parameters are fitted to consecutive daily two-year period returns of S&P500 index from 1956 to 2016, generating 30-time series estimations of c and K. Through an econometric model specification analysis, the empirical kurtosis of returns distribution is modelled as multiplicative function of c and K. Subsequently a vector auto regression (VAR) analysis on c and K advances the understanding of modelling and forecasting Kurtosis of return distributions. Furthermore, the power law of fat tails in the returns distribution is investigated using this approach.

11:00	Poster	10

Analysis of building trading strategy based on price oscillations model.

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Building an effective trading strategy on capital markets should start with finding a market inefficiency which is reflected in some price pattern or anomaly. There are two main approaches to identify and eventually exploit such inefficiencies. One of them is to apply some sophisticated data-mining tools and the other is based on creating a mathematical model of the phenomenon. This research is focused on the second approach which means that a model is created and used to develop a trading strategy.

One of such inefficiencies which can be observed in many markets is price oscillations caused by feedback from the price curve which occurs when it reaches some particular level or after a big change in quotations when it takes some time to stabilize the price curve. Such levels are called resistance or support levels in technical analysis. In control engineering such phenomenon when signal change exceeds its target level is called overshoot and may cause decreasing signal oscillations before it stabilizes on the target level.

Identifying and modeling market inefficiency does not lead directly to an effective trading strategy. In order to be useful it must be predictable and significant enough to provide profits which overcome costs. Validating trading strategy requires considering conditions close to real trading. In order to achieve that it is needed to take into account not only loses but also other costs like slippage or transaction costs. In this research I study the described phenomenon and the possibility of building an effective trading strategy based on its model and make the attempt to determine conditions which impacts the strategy performance.

11:00	Poster	11

A minimal spin model of hybrid transition in social systems

Agata Fronczak[1], Piotr Fronczak[1], Tomasz Ryczkowski[2]

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We present and analyze a minimal exactly solved diffusion-based model that exhibits mixed-order phase transition. We call the model "diffusion-based" because its hamiltonian can be recovered from a simple dynamic procedure, which can be seen as an equilibrium statistical mechanics representation of a biased random walk. We analyze the model within both: canonical and grand canonical ensembles. In the canonical ensemble, the model exhibits first order transition with power-law fluctuations. In the grand-canonical approach, phase diagram of the model is much more complicated. We outline derivation of the phase diagram, in which the triple point has the hallmarks of the hybrid transition: discontinuity in the average magnetization and algebraically diverging susceptibilities. At this point, two second-order transition curves meet in equilibrium with the first-order curve, resulting in a prototypical mixed-order behavior. Finally, we show that, given fixed system size, our model can be seen as a highly simplified version of the dynamic social network model discussed by K.E. Bassler et al. (Phys. Rev. E 91, 042102 (2015)). In the network model mentioned, nodes are separated into two groups representing opposing interests. Members of the first group (introverts) seek to get rid of their connections, whereas these who belong to the second group (extroverts) want to accumulate their highest possible number. It was suggested that the model exhibits the extreme Thouless effect in which the density of connections between introverts and extroverts jumps from a value which is close to zero, to a value close to unity, when the number of extroverts becomes larger than the number of introverts. Results obtained for the minimal spin model suggest that the phenomenon observed in these networks is a discontinuous phase transition with power-law fluctuations.

11:00 Poster 12

How transfer flights shape structure of the airline network

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Here, we present the analysis of the gravity model in the world passenger air-transport network. We show that in the standard form the model is inadequate to correctly describe the relationship between passenger flows and typical geo-economic variables that characterize connected countries. We propose a model of transfer flights which allows to exploit these discrepancies to discover hidden subflows in the network. We illustrate its usefulness by retrieving the distance coefficient in the gravity model which is one of the determinants of the globalization process. Finally, we discuss the correctness of the presented approach by comparing the distance coefficient to several well known economical events.

11:00 Poster 13

Multiple propagation paths in locating the source of diffusion in complex networks.

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Understanding how information propagates in a system is an old and important field of study in complex networks physics. The information can be of a various nature - e.g. it could be a virus or a tweet - and often we are interested in locating the source of that diffusion, i.e. "patient zero". Big impact on this field of research had a paper by P.C. Pinto et al.[1] in which the authors had presented a method to estimate which node in a network is most likely the source we are looking for. We investigate the consequences of some assumptions of that method finding that it overestimates propagation time from one node to another due to single shortest path approach. We also propose a modification that takes multiple propagation paths into account and consequently increases the accuracy of the algorithm.

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11:00 Poster 14

Heider balance in bilayer networks

Piotr J. Górski[1], Krzysztof Kułakowski[2], Przemysław Gawroński[2], Janusz A. Hołyst[3,4]

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Links in a social network may describe friendly or hostile interpersonal relations. According to Heider balance theory these relations are changing in order to obtain balanced link triads. A triad is balanced when four axioms are fulfilled, e.g. "a friend of my enemy is my enemy" [1].

We analyze the formation of the Heider balance [2,3] in a bilayer network forming a *link multiplex*, i.e. when interlayer connections exist only between copies of the same **link** in different layers. Strengths of interlayer coupling are described by a pair of positive or negative parameters (β_1, β_2). The system dynamics is a link dynamics. Each link is described by a continuous variable between (-1) and (+1) and its evolution depends on neighbor links from the same layer and its replica from the other layer.

There are two processes driving system dynamics: a tendency to achieve Heider balance between links in a given layer and a tendency to follow the same or the opposite state of a corresponding link in the other layer. As a result, three types of solutions are possible: a non-stationary solution, a stationary solution with Heider balance and a stationary solution without Heider balance. For a given pair (β_1, β_2) there are phases where only one solution type is achieved and there are intermediate regions where, depending on the initial conditions, two solution types are possible. For instance, when both coupling coefficients are strong enough and of different signs the system always experiences oscillations. The obtained results comprise rich diagrams of model parameters that allow us to identify the areas of coupling coefficients leading to high probability of attaining Heider balance.

[1] F. Heider, The Psychology of Interpersonal Relations (Psychology Press, 1958).

[2] K. Kulakowski, P. Gawroński, and P. Gronek, Int. J. Mod. Phys. C 16, 707 (2005)

[3] P.J. Górski, K. Kulakowski, P. Gawroński, and J.A. Hołyst, (to be published)

11:00 Poster 15

Application of Multiscale Multifractal Analysis method to financial data

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Multiscale Multifractal Analysis (MMA) is a time series analysis method, that was first proposed by Gieraltowski et al in 2012. It is designed to describe scaling properties of fluctuations in analysed signal. As a result, it gives so called Hurst surface h(q,s), which is a dependence of the local Hurst exponent h on the multifractal parameter q and scale s, defined as data window width.

Until now the method was mainly applied in Medical Physics field e.g. to analyse time series such as heart rate variability (HRV) signals. It proved to be very effective in diagnosing patients with severe heart conditions.

The MMA method is very versatile and easily applicable. The main requirement it poses for the signal is that it has to consist of at least 15 000 samples. The other condition is that the signal cannot contain repeating fragments with high number of exactly the same values. As these are the only restrictions of the MMA method it makes it a perfect tool to analyse financial data. Some of the studies were already conducted by Pengjian Shang et al in 2014 and 2015.

Our main goal is to present the results of analysis of the financial data with the Multiscale Multifractal Analysis method and show the wide applicability MMA has in the field of economics. Although these are one of the first attempts of applying this method in such area, it allows us to draw a conclusion that MMA is suitable for analysis of financial time series, however it still requires further research.

11:00 Poster 16

Analysis of stability of operational risk models

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The definition of operational risk applied in banks is based on a very high distribution percentile: 99.95%. Derivation of risk estimators goes along with their high error which in turn is connected with models' instability. The authors present various approaches to that error, from statistical based on estimation of distribution parameters to data mining that operates on algorithms predicting the responses. Presented results were obtained on both real and simulated data.

11:00 Poster 17

The mechanism of transformation of global business cycles into dynamics of regional real estate markets

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The aim of this article is the identification of the occurrence mechanism of sudden quantitative changes in real-estate market prices, which were observed during the global financial crisis. Since such phenomena did not occur to such an intensity during previous crises, it can be assumed that a new economic dynamic type has emerged in real-estate markets. The most promising of the methods of studying such phenomena seems to be the bifurcation method and particularly the catastrophe theory. This study analyzes changes in the prices of residential property based on cusp catastrophes. Empirical data were fit to a stochastic cusp model to visualize the evolutionary path of real estate market. Two other popular models (linear and logistic) were also estimated to compare results. A comparative analysis proved that the cusp model can best explain structural price instabilities in real-estate markets. The results confirmed that the evolution of the real estate market combines two processes: long-term evolution in the area of non-degenerate stability and discontinuous changes in the area of degenerate stability. Structural changes take place in the system only in the area of degenerate stability. The theoretical and practical results show that the catastrophe theory may have predictive potential, which could support traditional methods of predicting changes on real estate markets.

11:00 Poster 18

Determinants of mass poverty in the contemporary global economy

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The concept of mass poverty was defined by J.K. Galbraith in late 1970s and it applies to societies with agriculture as the dominant branch of the economy. This paper examines the importance of this phenomenon and factors affecting it in the contemporary world. There are a growing number of studies supporting the claim that the use of electricity method is a key factor of economic growth which makes it possible to leave the sphere of mass poverty. Such factors as grants and subsidies, as well as national governance quality also matter. Moreover, in order to solve the problem, it is necessary to determine access to capital in such countries and societies, understood as M2 aggregate. In this manner, the problem at hand is reduced to determination of the relationships between the following variables: percentage of rural population, rules of managing electric-

al energy and M2 aggregate. These findings were used to formulate three study hypotheses. According to the first hypothesis, the effect of the electricity use method on M2 varies from one country to another, with several identifiable patterns. According to the second hypothesis, the process of leaving the mass poverty sphere follows either the Bose-Einstein distribution or the Boltzmann distribution. The third hypothesis indicates that effects of efforts aimed at eliminating mass poverty in certain conditions are not permanent. Verification of these three hypotheses indicates the adequacy of the theory of mass poverty in the contemporary world.

11:00	Poster	19

Application of the four colour theorem to identify regional poles and main lines of economic growth

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This paper presents a method for identifying regional poles and the main lines of growth based on the following foundations: four colour theorem, wikinomics business model in the form of platforms for participation, evaluation of the functionality of websites run by public administration municipal offices and dual graph reduction. The province of Warmia and Mazury, which is the subject of the study, is one of the poorest provinces in Poland in terms of economic development. It is therefore natural that the growth of this region requires external enterprise sources. This role can be best performed primarily by websites run by municipal offices, which initiate business activity in their corresponding areas, and consequently, can be regarded as wikinomics platforms of participation. Using the *k*-means clustering method, these websites were divided into four separate quality classes. These classes were assigned four various colours, which were subsequently used for preparing the map of the province. Each municipality was marked with a colour corresponding to the quality class of the website run by the state administration unit operating in a given area. The system of colours resulting from the four colour theorem and a corresponding dual graph serve as a frame of reference with regard to each empirical colour distribution and to another, related, dual graph. Thus, the four colour theorem describes the largest diversity of regional growth poles. The measure of the economic growth of the region is a degree of reduction of the dual graph corresponding to the empirical colour distribution, which identifies actual growth poles and determines the main lines of growth. The ultimate development objective, although not always achievable, is a reduction of the dual graph to a single node, when all municipal offices in the province have websites of the highest quality.

11:00	Poster	20

Logistic map in economics

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The logistic map constitutes one of the most well-known maps in science. It has peculiar characteristics, it is able to generate topological chaos and ergodic chaos, and it reveals various routes to chaos. The transition to chaos is made by way of the period-doubling bifurcations, the type-I intermittency appears, too. The logistic map is a perfect generalization of numerous classical economic models covering economic growth, monopoly rules, inflation, or the theory of consumer choice. Consequently, it can be regarded as a kind of a portal through which the chaos and complexity theories have been introduced to economics. This eventually leads to the creation of a new trend – the complexity economics which has been successfully competing with the mainstream economics.

11:00	Poster	21

Influence of temporal aspects and age-correlations on the process of opinion formation based on Polish contact survey

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On the basis of the experimental data concerning interactions between humans the process of Ising-based model of opinion formation in a social network was investigated. In the paper the data concerning human social activity, i.e. frequency and duration time of interpersonal interactions as well as age correlations - homophily are presented in comparison to base line homogeneous, static and uniform mixing. It is known from previous studies that number of contact and average age of nearest neighbors are highly correlated with age of an individual. Such real, assortative patterns usually speed up processes (like epidemic spread) on the networks, but here it only plays a role for small social temperature values (by reducing `freezing by heating' effect). A real structure of contacts affects processes in many various studies in different way, however here it causes stronger (dynamic) and smoother (durations) susceptibility on external field. Moreover, our research shows that the cross interactions between contact frequency and its duration impose the significant increase in critical temperature.

Symposium C

Announcement

Two subsequent obligatory poster sessions were (for all posters) established on 5 July from 11:00 to 11:30 and from 15:30 to 16:15 both located in the Main hall. Remaining poster sessions require from authors leaving posters on the boards only.

Programme

Wednesday, 5 July

INVITED TALKS

ABM & multiscaling
Wednesday morning, 5 July, 10:00
Room C
Chair: Rosario Mantegna

10:00	Invited oral

Estimation of Agent-Based Models using Sequential Monte Carlo Methods

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Estimation of agent-based models is currently an intense area of research. Recent contributions have to a large extent resorted to simulation-based methods mostly using some form of simulated method of moments estimation (SMM). There is, however, an entire branch of statistical methods that should appear promising, but has to our knowledge never been applied so far to estimate agent-based models in economics and finance: Markov chain Monte Carlo methods designed for state space models or models with latent variables. This later class of models seems particularly relevant as agent-based models typically would consist of some latent and some observable variables since not all the characteristics of agents would mostly be observable. Indeed, one might often not only be interested in estimating the parameter of a model, but also to infer the time development of some latent variable. However, agent-based models when interpreted as latent variable models would be typically characterized by non-linear dynamics and non-Gaussian fluctuations and, thus, would require a computational approach to statistical inference. Here we resort to Sequential Monte Carlo (SMC) estimation based on a particle filter. This approach is used here to numerically approximate the conditional probabilities that enter into the likelihood function of the problem. With this approximation we simultaneously obtain filtered state probabilities for the unobservable variable(s) that drive(s) the dynamics of the observable time series. In our examples, the observable series will be asset returns (or prices) while the unobservable variables are some measure of agents' aggregate sentiment as well as fundamental shocks. We will apply SMC to two selected agent-based models of speculative dynamics with somewhat different flavor exploring the performance of this method for parameter estimation and state extracting in these cases and providing an empirical application on to a selection of financial data including a model contest.

10:30	Invited oral

Multiscaling: real source and consequence

Tiziana Di Matteo

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The multiscaling behaviour of the financial time-series is one of the acknowledged stylized facts in the literature [1]. The source of the measured multifractality in financial markets has been long debated and it has been attributed to mainly two sources: the power law tails and the non linear autocorrelation of the analysed time-series [2,3]. In this talk we discuss the origin of multiscaling in financial time-series and investigate how to best quantify it [4,5].

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[2] J. W Kantelhardt, Stephan A Zschiegner, Eva Koscielny-Bunde, Shlomo Havlin, Armin Bunde, and H Eugene Stanley, Physica A 316 (2002) 87-114.

[3] Jozef Barunik, Tomaso Aste, T. Di Matteo, Ruipeng Liu, Physica A 391 (2012) 4234–4251.

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[5] R. J. Buonocore, T. Di Matteo, T. Aste, (2017), Phys.Rev.E, in press.

POSTERS & COFFEE

Econo- and Sociophysics
Wednesday morning, 5 July, 11:00
Main hall

ORAL TALKS

Sociophysics
Wednesday morning, 5 July, 11:30
Room C
Chair: Krzysztof Kułakowski

11:30 Oral

The probability distributions and the fluctuation scalings of the time series of key-word counts in nation-wide blog data.

Hayafumi Watanabe[1], Yukie Sano[6], Hideki Takayasu[2,3,4], Misako Takayasu[5]

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In analyses of social media data, one of the most important basic objects is the time series representing the appearance of considered keywords. We aim to describe this fluctuation precisely, whereas the majority of previous research has focused on “trends” in the time series (i.e., nonrandom parts of the time series) for practical reasons.

To elucidate the nontrivial empirical statistical properties of fluctuations of a typical nonsteady time series representing the appearance of words in blogs, we investigated approximately 3 billion Japanese blog articles over a period of six years and analyse some corresponding mathematical models.

First, we introduce a solvable nonsteady extension of the random diffusion model, which can be deduced by modeling the behavior of heterogeneous random bloggers. Next, we deduce theoretical expressions for both the temporal and ensemble fluctuation scalings of this model, and demonstrate that these expressions can reproduce all empirical scalings over eight orders of magnitude. Furthermore, we show that the model can reproduce other statistical properties of time series representing the appearance of words in blogs, such as functional forms of the probability density and correlations in the total number of blogs. As an application, we quantify the abnormality of special nationwide events by measuring the fluctuation scalings of 1771 basic adjectives.

[1] Phys. Rev. E 94, 052317 (2016)

11:52 Oral

On Personal Strategies in Conflict Socium

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We construct a simplest model of complex dynamical system describing the behavior of individuals (persons) in a conflict socium. The main problem is to find the personal strategy for providing of the best priority or at least survival. We show that wild law of conflict interaction, "each against all" , leads to the single winner, which possesses the maximal starting priority, all other individuals died. However, a choice of visible strategy may supply the reliable survival and even high priority for individual with a small starting power. We consider a conflict socium consisting of a big number of similar individuals (agents) living on a common resource space and mutually fighting for priority or survival. In the simplest case each agent is characterized by a single power value. The law of a conflict interaction "each against all" in the mathematical form is written by the explicit difference equation. We expose various spectrum of personal evolution of depending on choice of different strategies and propose the making decision problem interpretation of our model.

12:15 Oral

Metaphysics of Econophysics

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Leaving apart the general discussions about identity and validity of econophysics as a science, it is necessary to reflect upon a deeper sense of research in that area. In particular a rank of hidden assumptions made in econophysical discussions can be taken into account. I call them purposively “metaphysics of econophysics”. Two of them will be given more attention in the paper. Bearing in mind several simplifying assumptions applied in econophysics the study aims at investigating in depth the following characteristics of econophysics/ sociophysics:

1. Operationalization and measurement of value and operationalization and measurement of the value of money.
2. Application of scale-free networks in studying the processes of social organization.

The above aims are associated with the following hypotheses, which can be also treated as conjectures:

1. In developing econophysical models of financial phenomena insufficient attention is paid to the following issues:

1. intersubjective character of value and money as social constructs (money as social construction, problems with operatonalization and measurement,
2. measurement and operationalization of value,
3. measurement and operationalization of value of money,
4. multiple and multi-level randomization of the value of money contributes to the loss of informative usefulness of measurement of money; in other words the hypothesis will be tested with the use of formal models that in such case the GI-GO (Garbage In – Garbage Out) situation is emerging.

1. The social networks are created in the process of intersubjective discourse and operationalization and measurement of their characteristics are of a limited usefulness.

In the case of network models applied to social phenomena, the methods of identification of networks will be scrutinized. Basically,

two methods of networks identification/creation exist. In the first one, the network is identified on the basis of real interactions, not only physical but also symbolic, e.g. semantic networks. In the second approach, a network is created by an observer identifying ties between actors sharing the same interests, reading the same texts, etc. In both types of networks the challenges of measurement, operationalization, objectivity, subjectivity and intersubjectivity always occur.

12:37 Oral

A Case Study of Diffusion of Innovation Under Competition

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In this work, the aim is to discuss the relative importance of the driving parameters of the diffusion of innovation under competition. As a case study the competitive existence of Android and iOS operating systems is modelled in the context of an extended Bass model. The chosen model consist of two coupled differential equations. Each differential equation has the same form of the well known Bass equation with an extra term which represents the effect of the existence of the competitor. Since the smart phones sales and usage are globally well documented, publicly available global smart phone market share and sales data are used to determine the model parameter values. The smart phone global market share data spans a period of 28 quarters starting from the fist quarter of 2009. The distribution of the market share at the first quarter has been used as the initial values of the competing operating systems. The free parameters (six in total) of the differential equations are obtained by an minimisation process. The values of the parameters are fixed by minimising the difference between the solution of Bass equation and the smart phone global market share data. The parameter values of iOS and Android operating systems indicate that, in the global scale, the adaptation of new ideas/products the dominantly led by the personal interactions. In fact, through social networks, information flow is immense and individuals relay on the information obtained directly from a trusted individual. Publicity parameter values indicate that very rarely decision of an individual is formed by only the mass media or publicity. On the contrary to the publicity parameter it is observed that the existence of a competitor has considerable effect on the sales of both parties.

LUNCH

Wednesday afternoon, 5 July, 13:00
Main hall

INVITED TALKS

Failures, LRM, and economic cycles
Wednesday afternoon, 5 July, 14:00
Room C
Chair: Thomas Lux

14:00 Invited oral

Cascading Failures and Recovery in Interacting Networks: Application to Finance

Shlomo Havlin

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A framework for studying the failure and the recovery of networks of interdependent networks will be presented. In interdependent networks, when nodes in one network fail, they cause dependent nodes in other networks to also fail. This may happen recursively and can lead to a cascade of failures and to a sudden fragmentation of the system. I will present analytical solutions for the critical thresholds and the giant component of a network of n interdependent networks. I will demonstrate examples of applying our model to rea financial interacting networks and show that all model parameters are experimentally accessible I will also show, that the general theory has many novel features that are not present in the classical network theory. When recovery of components is possible, spontaneous recovery of the system of interacting networks and hysteresis phenomena occur and the theory suggests an optimal repairing strategy for the system of systems. I will also show that interdependent networks embedded in space are significantly more vulnerable compared to non embedded networks. In particular, small localized attacks of zero fraction may lead to cascading failures and catastrophic consequences. Thus, analyzing real data and realistic models of network of networks is highly required to understand coupled financial systems vulnerability.

References:

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[5] J. Zhao, Daqing Li, H. Sanhedai, S. Havlin, Nature Comm. 7, 10094 (2016).

14:30 Invited oral

The first passage time statistics as empirical test of observed long-range memory in the financial markets

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We aim to explain the phenomenon of long□range memory in social systems by nonlinear interactions of agents resulting in the macroscopic description by nonlinear stochastic differential equations. Thus we deal with models of social systems, empirical analysis of

data and theoretical consideration of the problem. The statistics of return and trading activity in the financial markets is the first task of our research. The scope of this research is of the highest importance as slowly decaying auto□correlation and 1/f noise occurs in Markov processes defined as memoryless. This means that in many real systems observed property of long□range memory may be spurious and might origin not from the correlations in stochastic noise. Thus the modeling of many real systems by fractional Brownian motion might be inappropriate. The specific statistical tests and criterions are needed to identify alternative methods for the modeling of long□range memory in real social systems. The identification of such criterions is the most significant task of our research.

It is well known that for the fBm first passage time PDF is of the power□law form with exponent dependent on Hurst exponent, as 2□H, while for the one□dimensional Markov processes power□law exponent is always 3/2. Consequently a detailed empirical analysis of the first passage times in return volatility and trading activity time series could be used to identify the true nature of the observed long□range memory effect. In this contribution we will present results of empirical study for high frequency time series in FOREX exhibiting exponent of first passage time PDF close to 3/2, with all deviations explained by the extraneous noises: order flow dynamics, daily seasonality and high□frequency speculative trading.

15:00	Invited oral

Measuring and Predicting Human Behaviour using Online Data

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Mammoth amounts of data are now being generated through society's extensive interactions with technological systems, automatically documenting collective human behaviour in a previously unimaginable fashion. In this talk, I will outline recent results of our research programme at the Data Science Lab in which we investigate whether data from sources such as Google, Wikipedia, Twitter, Flickr, Instagram can be used to: (1) reduce delays in measurement of human behaviour (2) measure behaviour which previously could not be measured (3) improve predictions of future behaviour.

POSTERS & COFFEE

Econo- and Sociophysics
Wednesday afternoon, 5 July, 15:30
Main hall

ORAL TALKS

Physics of Markets
Wednesday afternoon, 5 July, 16:15
Room C
Chair: Stanisław Drożdż

16:15	Oral

Modelling agents' asset price expectations: a quantum theoretical paradigm.

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Modelling agents' asset price expectations: a quantum theoretical paradigm.

Nowadays, human decision making in economic and finance decisions is facing increasing complexity due to a) non- classical assessment of probabilities associated with states of the world and outcomes (cf. seminal works by Kahneman and Tversky (1979) and Prelec (1998)), b) non Bayesian updating of information and finally, the most difficult, albeit existent situation – the inability to assess the state space of all the outcomes and hence their probabilities .

Situations, where no well-founded subjective probabilities can be devised, known as *ambiguity* could be well captured through probabilistic models of quantum mechanics (also known as ' Quantum-Like' models) by usage of complex- probability amplitudes that correspond to ambiguity in respect to the exact probabilistic distribution on the values of a random variable (e.g. the distribution of price states of a financial asset).

In the context of finance market, as presented in Khrennikova (2016), agents' ambiguity on the future distribution of assets' prices and the corresponding returns can be manifest in the impossibility to form a classical probabilistic distribution (normal distribution of returns is the foundation of Markowitz Modern Portfolio Theory) for the returns of financial assets. E.g., as highlighted in Shiller (2003), agents expectations on future asset price are often based on erogenous expectations and yield excess volatility on the stock market.

We propose a model based on quantum probabilistic framework, where the price dynamics of some financial assets is created by the informational bath that consists of the agents expectation about future asset prices (Khrennikova, 2016).

One of the basic behavioural factors leading to quantum-like dynamics of forecasted prices is the irrationality of expectations of the agents on the financial market. It leads to a deeper type of uncertainty than given by classical probability theory, e.g., in the framework of the classical financial mathematics, based on theory of stochastic processes.

The quantum dimension of the uncertainty in price dynamics is expressed in the form of the *price-state superposition* and *entanglement* of different financial assets.

The long-term equilibrium state in asset price dynamics can be well captured with the aid of a quantum master equation that has been successfully applied to decision making problems under uncertainty, e.g. Asano et al (2010), Khrennikova et al (2014).

16:41 Oral

A Quantum-Like Analysis of a Real Life Financial Scenario: The Dutch's Bank Loan Application

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Quantum-Like Bayesian Networks (QLBN) are used in quantum cognition to explain human decision problems. In this work, we apply a QLBN to human decision tasks in the financial domain with the aim to model a real life financial log of a loan application belonging to a bank in the Netherlands. The log is robust in terms of data, containing a total of 262 200 event logs, belonging to 13 087 credit applications. A customer selects a certain amount of money and submits his request to the bank's web platform. Some automatic tasks are triggered and it is verified if an application is eligible for credit. The dataset is heterogeneous and consists of a mixture of computer generated automatic processes and manual human tasks.

We investigate the capabilities of QLBN in this real life financial scenario in order to not only assess potential areas of improvement of the institution's internal operations, but also to use the information acquired during the analysis of the business process to make predictions about the outcome of certain events related to the loan application. However, this poses some challenging and interesting problems. First, there is the need to process the large amounts of log events and extract the necessary information. Second, a visualization tool is necessary in order to understand and determine the structure, order and dependencies of each operational task. Third, given a structure, an automatic machine learning algorithm is required in order to learn the conditional probabilities associated to each task given its parents' tasks. Only after these steps are completed, it is possible to analyze and perform quantum-like probabilistic inferences and predictions for the data. In this work, we give primary focus to human tasks, since they are more susceptible to errors.

We will also introduce uncertainty by disturbing the learning dataset (making some events unknown) and verify how the Quantum-Like and Classical Bayesian networks predict the data.

17:07 Oral

Diffusion in Autoregressive Based Models for Financial Data

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We study autoregressive process (AR) based models for financial time series, focusing on their diffusion behavior. First, we solve the basic AR process, deriving the analytical diffusion expression for arbitrary order and obtaining the conditions on the AR coefficients for the process to exhibit ordinary diffusion (mean square displacement linear in time) for large time scale but abnormal diffusion for short time scale. Then, we analyze the Potential of Unbalanced Complex Kinetics (PUCK) model, which describes the position of a random walker (or prices) subjected to a potential centered in its own past moving average. For a quadratic potential, this model reduces to a particular case of the AR process and the previously obtained results apply. Next, we develop the AR process with time-dependent coefficients and identify a special case of random correlated coefficients with a PUCK model in which the quadratic potential fluctuates; by adding random fluctuations to the original fixed potential of the PUCK model, we have a power-law distribution for price differences but keeping the same diffusion behavior. At last, we characterize real data from the foreign exchange market using the fluctuating potential PUCK model.

17:33 Oral

A thermo-comparative analysis of co-movements in economical indexes

Hênio Henrique Aragão Rêgo[1], Mario Bertella[2], Jonathas Silva[2], He Stanley, Yuko Yamada, Sasuke Miyazima

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The challenge to analyze the synchronization between stock market returns has calling the atention of economists, physics and mathematical researchers due to the complex nature of its dynamical colletive behavior. While some pair relations among the stock markets can be explained by basic, relatively simple rules, the global features that spans from the whole financial system may be hard to describe, very often presenting long-correlations, cascading effects, non-stationarity, and many others. In this work we used, what we called "thermos-comparative analysis", based on thermodynamical and statistical concepts, to quantify the relative performance between different stock market indexes. We study a number of stock indexes and examined the typical co-movements of the markets in different time scales and examine some common features across the markets that may distinguish their previous and/or upcoming dynamics.

Thursday, 6 July

COFFEE

Thursday morning, 6 July, 9:00
Main hall

INVITED TALKS

Stylised models, coaction, and rivaling leaders
Thursday morning, 6 July, 9:30
Room C
Chair: Peter Richmond

9:30 Invited oral

Stylised models for the distribution of wealth

Enrico Scalas

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In the last twenty years, physicists and mathematicians developed and studied models for the wealth distribution using the classical tools of statistical physics: discrete and continuous stochastic processes (in particular, random exchange models) as well as related Boltzmann-type kinetic equations. In these works, the usual concept of equilibrium in Economics is either complemented or fully replaced by statistical equilibrium.
Here, I present a general framework to deal with distributional problems in Economics using random exchange models and a series of models based on this general framework. The framework makes use of random partitions of stocks and fragmentation-coagulation processes acting on these partitions. I start from finitary versions of these models and show how they naturally lead to continuous versions.
Reference paper:
Bertram Düring, Nicos Georgiou, Enrico Scalas
A stylized model for wealth distribution

???
(2016).
Reference book:
U. Garibaldi, E. Scalas
Finitary probabilistic models in Econophysics
Cambridge University Press, 2010.

10:00 Invited oral

Is it rational for Homo Economicus to be "nice" to others ? The co-action solution resolves social dilemmas

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Understanding how cooperation can emerge in a population whose individual members are only interested in maximizing their personal well-being is one of the fundamental problems in economics, social sciences and evolutionary biology. The ever present temptation to not cooperate (thereby avoiding the associated cost) while enjoying the benefits of the cooperative acts of others appears to make it unlikely that cooperation will persist - even if it somehow arises occasionally by chance. Yet cooperation is seen to occur widely in society and forms the basis for complex economic organizations of the present era. The conventional theoretical approach to the problem, based on analysis of games such as the Prisoners Dilemma (PD), suggests that rational individuals will not cooperate even in situations where mutual cooperation may result in a better outcome for all. This incompatibility between individual rationality and collective benefit lies at the heart of the puzzle of evolution and robustness of cooperation, as illustrated by PD and similar games. We have recently shown that this apparent incompatibility is due to an inconsistency in the standard Nash framework for analyzing non-cooperative games and have proposed a new paradigm - that of the co-action equilibrium. As in the Nash solution, agents know that others are just as rational as them and taking this into account leads them to realize that others will independently adopt the same strategy, in contrast to the idea of unilateral deviation central to Nash equilibrium thinking. The co-action equilibrium results in radically different collective outcomes (compared to Nash) for games representing social dilemmas, with relatively “nicer” strategies being chosen by rational selfish individuals. In particular, the dilemma of PD gets resolved within this framework, suggesting that cooperation can evolve in nature as the rational outcome even for selfish agents, without having to take recourse to additional mechanisms (such as reciprocity or reputation) for promoting it. When extended to an iterative situation, we show that even in the absence of initial symmetry among agents, their behavior can converge to cooperation as a result of repeated interactions. In particular, the co-action solution for the iterative PD between 2 players corresponds to a win-stay, lose-shift behavioral rule, thereby providing a rational basis for this Pavlovian strategy.

References:

Sasidevan, V., and Sitabhra Sinha. "Symmetry warrants rational cooperation by co-action in Social Dilemmas." Scientific reports 5 (2015): 13071.

Sasidevan, V., and Sitabhra Sinha. "Co-action provides rational basis for the evolutionary success of Pavlovian strategies." Scientific Reports 6 (2016): 30831.

Sasidevan, V., and Sitabhra Sinha. "A Dynamical View of Different Solution Paradigms in Two-Person Symmetric Games: Nash Versus Co-action Equilibria." in F Abergel et al (Eds) Econophysics and Data Driven Modelling of Market Dynamics. Springer International Publishing, 2015: 213-223.

10:30 Invited oral

Hierarchical Partitions of Social Networks Between Rivaling Leaders

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A model algorithm is proposed to study subsequent hierarchical partitions of complex networks describing social structures. The partitions are supposed to appear as actions of rivaling leaders [1] corresponding to nodes with large degrees. The condition of a partition is that the distance between two leaders is at least three links. This ensures that the layer of nearest neighbours of each leader remains

attached to him. The process of cutting links starts from a selection of the shortest path between the leaders. If there is more than one path, we concentrate on one of them. If the length of the path is exactly three, there is only one link in the middle to be cut. If the shortest path consists of more than three links, the cutting can be performed in two ways; either we select the link with the lowest number (variant A) or the ink with the highest number (variant B). As a rule, numerically calculated size distribution of fragments of scale-free Albert-Barabasi networks reveals one large fragment which contains the original leader (hub of the network), and a number of small fragments with opponents that are described by two Weibull distributions [2].

Numerical simulations and mean-field theory reveal that size of the larger fragment scales as the square root of the initial network size. The algorithm is applied to the data on political blogs in U.S. (L. Adamic and N. Glance [3]). The obtained fragments are clearly polarized; either they belong to Democrats, or to the GOP.

[1] K. Kacperski and J.A. Holyst, *Phase transitions as a persisten feature of groups with leadersin models of opinion formation*, Physica A: Statistical Mechanics and its Applications. 2000; 287(34):631–643.

[2] Malgorzata J. Krawczyk, Krzysztof Kulakowski and Janusz A. Holyst, *Consequtive partitions of social networks between revealing leaders,* arXiv:1611.05604.

[3] L.A. Adamic and N. Glance, *The Political Blogosphere and the 2004 U.S. Election: Divided They Blog.* In: Proceedings of the 3rd InternationalWorkshop on Link Discovery. LinkKDD ’05. New York, NY, USA: ACM; 2005. p. 36–43.

POSTERS & COFFEE

Econo- and Sociophysics
Thursday morning, 6 July, 11:00
Main hall

ORAL TALKS

Macroeconomy and Economic Networks
Thursday morning, 6 July, 11:30
Room C
Chair: Rafał Weron

11:30 Oral

Agent based thought experiments: From powerful companies to catastrophic consumer synchronization

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The global network of corporate control is marked by a central, tightly-connected "core" made of a relatively small number of large companies which control a significant part of the global economy. This organization could arise due to an explicit collusion among the central companies, or it could emerge from "rich-get-richer" effects. Here we show how a simple, adaptive rich-get-richer dynamics can account for this characteristic. The process we propose incorporates the indirect control that companies have on other companies they own, which in turn increases their buying power. The higher buying power can then be used to buy portions of more important companies. The system spontaneously organizes into a steady-state network comprised of a well-defined core-periphery structure, which reproduces well many qualitative observations in the real network of corporate control. Our model shows that this kind of centralized structure can emerge without it being an explicit goal of the companies involved.

As a second question, we deal with a hypothetic market situation: Electricity markets with time-dependent consumer prices. Electricity markets including fluctuating energy sources as, e.g. windmills, face the challenge to satisfy the continuous demand for electricity. One possible reaction is to use time-varying pricing schemes that shift power consumption for activities as for example washing and heating to times with excess supply. An artificial market, where many consumers perform time-flexible consumption due to individual stochastic decisions, shows extreme synchronization of demand at low prices. We find that synchronization occurs robustly and is therefore hard to control.

11:52 Oral

Trade flow network of world commodity market

Jae Woo Lee[1], Ahadun Nobi[2], Le Anh Quang[1]

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We consider the structural change of the world trade flow network for different commodities from 1995 to 2013. The minimum spanning tree is generated by the trade flow and investigates the hierarchical organization of the tree by using the hierarchical path. We find that the network for man-made products such as machinery and transport equipment and manufactured goods is more hierarchical than the natural products such as mineral fuels. We also find out that the hierarchy F over time is changed notably due to globalization and crises. We observe the big role of China on world trade network in recent years.

12:15 Oral

Impacts of Regional Trade Agreements on bilateral economic interconnectedness

Julian Maluck, Nicole Glanemann, Reik V. Donner

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Free trade agreements have received rising attention in the last decades, with trade deals having been negotiated at an increasing pace. Multi-regional input-output (MRIO) tables allow for a concise ana-

lysis of trade relations between industries both at the national and international level. By evaluating an industry's dependency on its consuming and supplying industries from MRIO data, we construct two networks depicting the output and input flow of intermediate goods, respectively. We present how complex network theory allows for the design of a dependency measure between two countries that takes higher order dependencies in supply chains into account. In the constructed flow networks, the dependency measure is based on path probabilities that track the flow of goods and money in the network and model the relative importance of hypothetical supply chains. By analyzing its time evolution for each pair of trade agreement partners, we present a reliable method to quantify short-term impacts on the economies of the countries involved in various Regional Trade Agreements. We show that different countries show distinctive negotiation profiles that either have resulted from different objectives and interests during the trade negotiation process or might indicate that some parties could not achieve their objectives at the negotiation of the agreement. To further investigate an agreement's impact for a country's economic structure, we compare the impact on both the export and import dependency on the economy of the agreement partner. An analysis of the resulting import/export asymmetry profiles can reveal a country's strategy in adjusting the trade balance through trade agreement negotiations. Next to a comprehensive overview on the impacts of Regional Trade Agreements, our results provide the basis for further detailed studies on the implications of specific design patterns and strategies within trade agreements.

12:37	Oral

A method to estimate company performance using global inter-firm relationships

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In economics and finance, asset price bubbles are defined as the deviation of the price of an asset from its fundamental value. The main factor of company's fundamentals is financial variables. However, it is not easy to always obtain information about financial variables. The financial variables are discretely published quarterly as settled-account reports, whereas, stock prices change at speeds of one hundredth of a second in the stock market. In order to measure gap between asset price and fundamentals, we must always nowcast company performance in the time between one settlement report and the next. In this paper, we establish an estimation method of financial variables with high estimation accuracy by using global inter-firm relationships.

There are many companies with similar business, sales area and sizes in the world. The companies have business connections. Because the settlement dates are different for many companies, we may estimate unreported financial variable of each company from already reported financial variable of similar companies. We investigate whether it can be estimated using a unique dataset that covers list of business connections and a highly structured companies' revenues by geographic and business segments. Through the analysis of random forests, we found that common shocks affected by each company can be measured from revenues of companies that operate in the same area. This result means that the main component of common shocks is foreign exchange fluctuations. We also can estimate individual shocks of each company from the revenue fluctuations of suppliers and customers because there is shock propagation through business connections [1]. Fig. 1 shows Toyota's sales estimated by this method. The estimation accuracy is sufficiently high.

In this conference, we will report these results and discuss the estimation accuracy compared to I/B/E/S data that includes empirical estimates by many economists and analysts. Furthermore, by also estimating I/B/E/S data with this method, we clarify what kind of information changes their estimates. Such analysis is important from the viewpoint of agent-based modeling of financial markets.

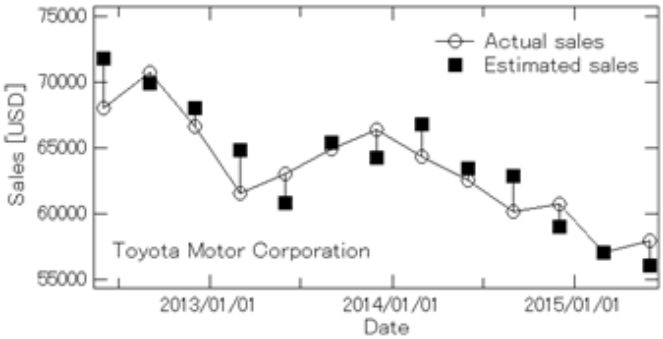

Fig. 1 Estimated Toyota's sales.

[1] T. Mizuno, et al. (2014) The Structure and Evolution of Buyer-Supplier Networks, PLOS ONE 9, e100712.

LUNCH

Thursday afternoon, 6 July, 13:00
Main hall

INVITED TALKS

Energy market, democracy, fractional cointegration
Thursday afternoon, 6 July, 14:00
Room C
Chair: Dariusz Grech

14:00	Invited oral

Probabilistic forecasting in energy markets: Why? When? How?

Rafał Weron

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Since the inception of competitive power markets two decades ago, electricity price forecasting (EPF) has gradually become a fundamental process for energy companies' decision making mechanisms. Over the years, the bulk of research has concerned point predictions. However, the recent introduction of smart grids and renewable integration requirements has had the effect of increasing the uncertainty of future supply, demand and prices. Academics and practitioners alike have come to understand that probabilistic electricity price (and load) forecasting is now more important for energy sys-

tems planning and operations than ever before. With this paper we offer a tutorial review of probabilistic forecasting (and EPF in particular) and present much needed guidelines for the rigorous use of methods, measures and tests.

14:30	Invited oral

On the relationship between income, fertility rates and the state of democracy in society

Peter Richmond, Stefan Hutzler, Christine Sommer, Vladislav Sirenko

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We examine the relationship between gross national income (GNI) and 'democracy' where the latter is quantified using an index proposed by the 'Economist'. Countries considered to be authoritarian or undemocratic have significantly lower GNI than more democratic countries. Of especial interest for the physicist is that the relationship shows a sharp increase in gradient for GNI v democracy at a particular point and seems to be characteristic of a phase transition observed in many body gaseous systems. Introducing the notion of a social temperature and taking account of the inequality in income within societies allows the transition to be revealed more clearly.

Again by analogy with binding energy of molecules and cohesion we explore the relationship between democracy and fertility rates in societies. Hierachic or authoratarian societies have high fertilitiy rates whereas democratic socities have low fertility rates. The relationship is hyperbolic and not dissimilar to that between pressure and volume in a gas. The results raise questions raised for further attention: Is it meaningful to identify fertility rate and indeed other variables as "state variable" in the manner of physics. How will the these data change over time, for example, what will happen over time with some countries we identify as "superheated"? Should economic information feed-back into the definition of democracy index?

15:00	Invited oral

Fractal methods for fractional cointegration

Ladislav Kristoufek

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Detrended fluctuation analysis (DFA) and detrending moving average (DMA) methods are standardly used for fractional differencing parameter d estimation. Recently, the DFA and DMA based estimators of standard regression parameters have been proposed. The estimators possess some desirable properties with regards to long-range dependence, trends, seasonalities and heavy tails. We study properties of both estimators beyond the general fractional cointegration framework, i.e. we examine a simple model $y_t = \alpha + \beta x_t + u_t$, where $x_t \sim I(d)$ and $u_t \sim I(d\text{-}b)$, which implies $y_t \sim I(\max[d,d\text{-}b])$. The fractional cointegration requires $b>0$, while the standard cointegration $CI(1,1)$ assumes $x_t, y_t \sim I(1)$ and $u_t \sim I(0)$. We are interested in various combinations of d and b parameters ($0 \leq d,b \leq 1$, i.e. we cover not only the fractional cointegration framework). We provide a broad Monte Carlo simulation study focusing on different time series lengths, combination of d and b parameters, and on possible spurious relationships. Specifically, we compare the estimators based on DFA and DMA with the standard OLS procedure under true and spurious relationships $\beta=0$ and $\beta \neq 0$). Based on the bias, standard error and mean squared error of the estimators, the new procedures outperform OLS for various settings (e.g. with $d=1$ and $b<0.5$).

POSTERS & COFFEE

Econo- and Sociophysics
Thursday afternoon, 6 July, 15:30
Main hall

ORAL TALKS

Financial Time Series
Thursday afternoon, 6 July, 16:15
Room C
Chair: Arkadiusz Orłowski

16:15	Oral

Evidence of chaotic structure in the S&P 500 price-index: a horizontal visibility graph approach

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In this paper, we study the behavior of the S&P 500 price-index series via the Horizontal Visibility Graph (HVG) method and we provide strong evidence that the behavior of the S&P 500 stock index is similar to a noisy low dimensional chaotic process for the time span between January, 2nd, 1996 and March, 13th, 2016. Further, we study the local behavior of the index series being particularly interested on how financial crises that happened worldwide affected the properties of the index series. Results shows that financial crises that originated outside of US affected considerably the behavior of the index while financial crises that originated in US do not alter the behavior of the index in a significant manner.

Horizontal Visibility Graph is a method that maps a time series into a network that inherits some properties of the original time series introduced in [1]. This method is based on simple geometric criterion based on which, two arbitrary data observation (y_a, t_a) and (y_b, t_b) in a time series become nodes in the associated graph and are connected to each other only if the following condition is fulfilled:

$y_a, y_b > y_c$ for all other (y_c, t_c) such that $t_a < t_c < t_b$.

It has been shown [2] that uncorrelated (or correlated) stochastic and chaotic series are mapped into scale-free network with a power law

degree distribution in the form of $P(k)=\exp(-\gamma\kappa)$.

If the value of the exponent $\gamma=\ln(3/2)$ then, the time series under study is an uncorrelated stochastic series. Values of the $\gamma<\ln(3/2)$, indicate that the series has the same properties with a chaotic series while the value of the exponent γ gives us an insight regarding the dimensionality of the chaotic attractor since as γ approaches asymptotically $\ln(3/2)$ the dimensionality of chaos increases. In case that $\gamma>\ln(3/2)$, the series is a correlated stochastic series with higher values of the γ exponent indicating higher degree of autocorrelation within series observations.

In addition, HVG method is a tool for discriminating between reversible and irreversible series and further, for irreversible series we can quantify the degree of irreversibility by calculating the Hellinger distance between the in- and out- degree distributions of the associated directed HVG, where the higher the value of the Hellinger distance, the higher the degree of asymmetry underlying a series. Theoritically speaking, for reversible series of infinite length the Hellinger distance between the two distributions is zero.

The purpose of this study if twofold. First, we study the properties of the S&P 500 index for the whole interval under study i.e. we calculate the γ exponent of the degree distribution of the associated HVG and the Hellinger distance between the in- and out- degree distribution of the assotiated directed HVG. Then, using the rolling window methos, we study the local properties of the index series and we pay attention on how financial crises affect the properties of the index series. For the purpose of this research we have used 5-min data for the S&P 500 from January 1996 to March 2016.In particular, we found that the exponent of the index series over the whole period under study is which implies that the series has the same properties with a chaotic process. In addition, the Hellinger distance between the in- and out- degree distribution was found to be , which is much higher than the corresponding values for reversible series but at the same time it is too low in comparison with other chaotic processes. So, in short, the series under study can be characterized as noisy dissipative chaotic process. The fact that the index series is found to be irreversible reveals that the index can be described as an out-of-equilibrium dynamic system.

In particular, we found that the γ exponent of the index series over the whole period under study is $\gamma=0.206$ which implies that the series has the same properties with a chaotic process. In addition, the Hellinger distance between the in- and out- degree distribution was found to be $H=0.0136$, which is much higher than the corresponding values for reversible series but at the same time it is too low in comparison with other chaotic processes. So, in short, the series under study can be characterized as noisy dissipative chaotic process. The fact that the index series is found to be irreversible reveals that the index can be described as an out-of-equilibrium dynamic system.

In Fig. 1 and 2, we plot the values of γ exponent and Hellinger distance for all sub-periods. Shadowed regions denote periods of financial crises. Grey shadowed regions represent financial crises that took place abroad while red shadowed regions represent market crashes following a stock market bubble happened in US.

We observe that γ exponent lies in the chaotic band mainly when a crisis is ongoing abroad. In particular, it is obvious that within the grey shadowed regions the exponent have values $\gamma<\ln(3/2)$, while irreversibility peaks during the corresponding periods. On contrary, red shadowed regions do not contain that high percentage of windows exhibiting chaotic behavior while irreversibility fluctuates at lower levels in comparison with the grey shadowed regions.

Based on these graphs the conclusion one can draw is that external shocks trigger a chaotic behaviour in the index series while internal shocks do not seem to affect the properties of the index series considerably.

Figure 1: Values of exponent γ for all windows for the S&P 500 price-index. In the vertical axis it is plotted values of γ exponent and on the horizontal line we plot the last date of each window. The red line represents the value $\gamma=\ln(3/2)$ which correspond to an uncorrelated random process. Red shadowed regions represent periods of market crashes following a market bubble in US and grey shadowed regions represents periods of financial crisis that took place abroad.

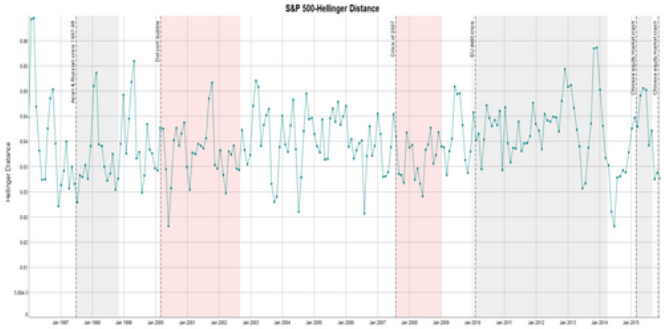

Figure 2: Values of the Hellinger distance (H) between the in- and out- degree distribution for all windows for the S&P 500 price-index. In the vertical axis it is plotted values of H and on the horizontal line we plot the last date of each window. Red shadowed regions represent periods of market crashes following a market bubble in US and grey shadowed regions represents periods of financial crisis that took place abroad.

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[2] Lacasa, L. and Toral, R., 2010. Description of stochastic and chaotic series using visibility graphs. Physical Review E, 82(3), p.036120.

16:41 Oral

Inter-transaction times and long memory of financial time series

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There are many well known and universal properties of the financial time series called stylized fact. One of them states that autocorrelation of increments of the financial time series decays very quickly while the one of their absolute values decays very slowly. The latter property is strongly related to the phenomena of volatility clustering. By using high frequency empirical data we state that The foundation of this type of behavior is indeed the long-term autocorrelation of inter-event times. Such dependence can be described in terms of the stochastic model based on Continuous-Time Random Walk [1], the model introduced by physicists Montroll and Weiss nearly 50 years ago [2]. The model with dependent inter-event times can significantly contribute to successful description of high-frequency financial data by CTRW [3,4].

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17:07 Oral

Forecasting the daily stock index using various singular value decomposition entropy

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Forecasting daily stock price is an important task in financial time series area. And it is known that the singular value decomposition Entropy has a predictive power for stock market. This study attempts to develop various models and compare their performances in predicting the daily KOSPI200 index. The models are based on a singular value decomposition process which has various correlation and entropy methods: Pearson correlation, Kendall correlation, Shannon entropy, Renyi entropy, Max-entropy, Min-entropy. Input variables include moving time window singular value decomposition entropy series which are the combination of two correlations and four entropies. Support Vector Regression is used to predict daily KOSPI200 index and the model performance is evaluated using accuracy measures such as MAE, MAPE, and RMSE of the forecasting values. As a result of its application, investors may have a guidance of their trading strategy.

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17:33 Oral

Granger causality, transfer entropy and GARCH models for financial time series

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There exist several tools for the assessment of possible causality in the Granger sense between two or more variables. Causality tests based on entropy transfer have been proposed e.g. by Schreiber (2000), Hlavackova et al. (2007) and by Barnett and Seth (2014) (see Syczewska and Struzik (2014)). In our earlier research causal relationship between financial variables has been shown for returns of bilateral exchange rates and stock indices. Prefiltering of the series with ARMA-GARCH type models is recommended in financial literature (Kliber (2011), Fiszeder and Orzeszko (2012), among others). This approach will be applied for the same variables, to updated time series data. The results of the Granger causality test and the nonlinear Diks-Panchenko test are compared with the results of the transfer-entropy method of causality assessment for the same variables.

Friday, 7 July

COFFEE

Friday morning, 7 July, 9:00
Main hall

INVITED TALKS

Life understanding, firms' bancrupcy
Friday morning, 7 July, 9:30
Room C
Chair: Vygintas Gontis

9:30 Invited oral

Should we (try to) understand life?

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Contrary to non-living matter, to date life as a phenomenon has evaded attempts at satisfactory explanations of its very origin, development and future fate.

However, it seems that the advance of the exact sciences in the past century could break their conceptual monopoly of focus and open the debate on life within the tractable and verifiable domains of exact sciences previously restricted to non-living matter.

Indeed, since the turn of the millennium, the science of living systems has steadily been becoming dominant, with several disciplines raising questions considered to be intractable - as were the fundamental building blocks of matter, two hundred years ago, or the evolution of the universe, a hundred years ago.

Recent advances in bioinformatics, in particular neuroscience and information science as applied to the genetic make-up of life, the science of modelling and explaining adaptation, evolution and emergence, have advanced our conceptual understanding of life's mechanisms, possibly revealing an opportunity to interpret life's very meaning.

Physics is essential to these developments, I will argue. In particular applications of physics to exotic domains, such as the physics of human interactions - sociophysics, or the monetary aspect of such interactions - econophysics, have been flourishing in recent times. This is not surprising - arguably, the most complex ingredient of the complex system of life at present is the most 'universal automaton' life has produced to date: Homo sapiens.

In addition to its superior adaptation skills, it is capable of reflecting upon its very existence, through conscious cognition – a phenomenon that - possibly through sociocultural interactions - apparently emerged as a result of Homo sapiens' universal adaptability, yet which to date lacks adequate explanation, both theoretical and experimental.

Likely inherent to the adaptive success of Homo sapiens is its ability both to solve problems by reductionist approaches and to abstract, posing theories - including those concerning its own existence. The extraordinary span of the levels of abstraction utilised by Homo sapiens is possibly congruent with the span of conscious awareness this species has developed.

The borders between the disciplines involved in the 'physics of life' have become less clear-cut than we were used to in the science of the 20th century. With recent advances in the exchange of scientific information, a Renaissance polymath type of science is not only possible, but required. Indeed, the early 21st century has already been dubbed the century of 'the renaissance of science'.

But, given this, will it be possible in our lifetime to ask the profound question - the title of this talk - in the context of science? Or should we leave it to intelligent machines, which in a couple of decades will likely overtake Homo sapiens in our ability to reason and to abstract, to build and verify models, and possibly to run off copies of themselves, superior to the originals?

Or - in a nutshell - after the period of neo-romanticism in science, still dominant since the turn of the millennium, are we to expect the advent of neo-positivism to follow, with its sceptical 'nay' in answer to the question posed by this talk's title?

10:00 Invited oral

Construction of mathematical models of bankruptcy of firms from the big data

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Construction of mathematical models of bankruptcy of business firms from the big data is a very important problem both practically and academically. About 50 years ago Altman started data analysis of bankruptcy and established the basic 3 steps [1]: Preparation of variables, Selection of variables, and Modeling. We follow this basic steps using a huge database of business firms provided by a Japanese credit research company, Teikoku Databank. There are about 10,000 bankruptcy events among 1 million firms in Japan every year for these 20 years, and we also analyze business firms transaction network data including about 4 million business relations.
For preparation of variables we pick up about 100 variables in the financial reports, and also we add new variables describing network information such as link numbers. For selection of variables, we firstly make a one-body ranking list in view of strength of correlation with the bankruptcy events, and we check spurious correlations by introducing conditional probability for two-body and reduce the number of variables. Then, we combine the chosen variables for modeling, in which we select the best functional forms of selected variables to maximize the resulting predictability of the model. This methodology is applicable not only for bankruptcy but also to various complex phenomena in which cause-and-result relations are not known but needed to be estimated from the data.

References

[1] E. Altman, Journal of Finance, 23 (1968) 589.
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Proceedings of the Asia-Pacific Econophysics Conference 2016-Big Data Analysis and Modeling toward Super Smart Society (APEC-SSS2016), Japan Physical Society Conference Proceedings, to appear.

ORAL TALKS

Socioeconomics
Friday morning, 7 July, 10:30
Room C
Chair: Sitabhra Sinha

10:30 Oral

The Great Gatsby curve revisited - networks, mobility and inequality

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Economic and social mobilities are cornerstones of modern democratic societies and known to be linked to prosperity and welfare. Cross-country empirical findings from the past several decades indicate that high levels of mobility are associated with low levels of income inequality. While deep understanding of these findings may lead to important policies for the benefit of the economy and society, standard neoclassical economic models offer them contradicting theoretical explanations without a clear consensus. In this talk we show how stochastic and network-based approaches can provide an original explanation to the empirical findings. We describe a mechanism for the effect the network structure - and in particular clustering - has on mobility and inequality. We find that increasing mobility can be achieved without reducing inequality, by declustering of the social structure and support our findings with additional empirical evidence. We also provide an explanation for the statistical association between inequality and immobility and show it is mechanically driven by the definition of mobility. This may hint that reducing income inequality will lead to higher mobility and vice versa. However, it questions the underlying economic significance of the empirical findings depicted in the Great Gatsby curve.

10:50 Oral

Models of families' incomes based on the convolutions of personal incomes distributions

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The analysis of the families' incomes in the USA is presented. The starting point of the analysis is the exponential distribution of the personal incomes. Income distributions of the families with 2, 3, 4, 5, and more adult persons are constructed based on the personal income distribution. The convolution of distributions technique has been used. We assumed the incomes distributions of 2-nd, 3-rd, etc. person in the family have rescaled exponential shape. Values of the scaling parameters are evaluated based on the empirical data. We present and discus the results obtained based on the income data for various years.

11:10 Oral

Self-organization of extreme inequalities

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We investigate the self-organization of inequality in a model society which consists of warlike-challenging (WC) individuals who always try to fight and fight with the strongest neighbor, and pacific-timid (PT) individuals who always try not to fight and when necessary fight with the weakest neighbor. The population density is controlled by changing the lattice size on which each individual makes a random walk. When two individuals meet on a lattice site, they fight and the winner deprives a unit wealth from the loser keeping its position, where the winning odd is determined by a sigmoid function of the difference in their wealths. The wealth of individuals relaxes to zero when they do not participate in fighting. Using Monte Carlo simulation, we analyze the structure of social inequality in the entire parameter space spanned by the population density and the fraction of pacific-timid individuals in the population. We determine the phases in the entire parameter space on the basis of an order parameter defined by the fluctuation in winning probabilities and the profile of the wealth distribution. We find an egalitarian phase, and one normal inequal and three different extreme inequal phases which are the plutonomy, the gap inequality and the terrace inequality. It is concluded that the extreme inequalities are the consequence of the coexistence of different fighting strategies.

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POSTERS & COFFEE

Econo- and Sociophysics
Friday morning, 7 July, 11:30
Main hall

ORAL TALKS

Interbank market and Systemic Ris
Friday afternoon, 7 July, 12:00
Room C
Chair: Mateusz Pipień

12:00 Oral

Reverse stress testing interbank networks

Daniel Grigat[1], Fabio Caccioli[1,2]

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We reverse engineer dynamics of financial contagion to find the scenario of smallest exogenous shock that, should it occur, would lead to a given final systemic loss. This reverse stress test can be used to identify the potential triggers of systemic events, and it removes the arbitrariness in the selection of shock scenarios in stress testing. We consider in particular the case of distress propagation in an interbank market, and we study a network of 44 European banks, which we reconstruct using data collected from Bloomberg. By looking at the distribution across banks of the size of smallest exogenous shocks we rank banks in terms of their systemic importance, and we show the effectiveness of a policy with capital requirements based on this ranking. We also study the properties of smallest exo-

genous shocks as a function of the largest eigenvalue of the matrix of interbank leverages, which determines the endogenous amplification of shocks. We find that the size of smallest exogenous shocks reduces and that the distribution across banks becomes more localized as the largest eigenvalue increases.

12:30 Oral

Stress test of dynamic interbank networks under various financial market scenarios

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During the financial crisis, the collapse of financial institution raise the attention of studying interbank network to manage financial risk. However, analyzing the interbank network is limited due to the unavailability of bank-by–bank bilateral exposures. In this research, we build on agent based model of interbank market which lending contracts are dynamically adjusted through simulations. We perform stress test to analyze the topology of the interbank network with various scenarios. Types of scenarios we use are focused on the shock to a single agent, to specific sector, and to whole market. First, we find that the shape of interbank topology on each scenario is significantly different. Second, we compare the result of each scenario to find stylized facts. Using these results, we build an efficient strategy to manage financial risk in interbank markets.

Abstracts

in author alphabetical order

Oral

Interbank Credit and the Money Manufacturing Process. A Systemic Perspective on Financial Stability

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Interbank lending and borrowing occur when financial institutions seek to settle and refinance their mutual positions over time and circumstances. This interactive process involves money creation at the aggregate level. Coordination mismatch on interbank credit may trigger systemic crises. This happened when, since summer 2007, interbank credit coordination did not longer work smoothly across financial institutions, eventually requiring exceptional monetary policies by central banks, and guarantee and bailout interventions by governments. Our article develops an interacting heterogeneous agents-based model of interbank credit coordination under minimal institutions. First, we explore the link between interbank credit coordination and the money generation process. Contrary to received understanding, interbank credit has the capacity to make the monetary system unbound. Second, we develop simulation analysis on imperfect interbank credit coordination, studying impact of interbank dynamics on financial stability and resilience at individual and aggregate levels. Systemically destabilizing forces prove to be related to the working of the banking system over time, especially interbank coordination conditions and circumstances.

Oral

Influence of opinions on vaccines on the evolution of a disease

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Some doubts about the effects, beneficial or not, of vaccines arose in recent years. As a consequence some people decide to not vaccinate themselves and/or their relatives. This attitude in face of vaccines has clear consequences in the spread of diseases. In this paper we study, in a simultaneous way, the changes of opinions on vaccination together with the evolution of a disease that can become epidemic. To do so we consider a bi-layered complex network. One of the layers corresponds to a social network where people confront their opinions and influence the opinions of the others. This network may be of real or virtual contacts. The second layer corresponds to a network of physical contacts that can cause contagion of a disease. The dynamics of opinions makes use of a model where intermediate opinions are possible, and the evolution is such that with a given probability p opinions evolve towards extremes (In favor or against vaccination), while with probability 1-p opinions evolve to a middle term position[1]. The dynamics of contagion proceeds through the well-known SIR model. The results are sensitive to the ratio r=p/(1-p), to the infectivity of the disease and to the efficacy of the vaccine that we call W. Even though the results depend of the infectivity and on the ratio r, one observes that if the efficacy is lower than 80% opinion generally evolves against the vaccine, while for higher efficacy most of the populations decide to vaccinate.

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Oral

Portfolio Theory in Terms of Partial Covariance

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It is found that partial correlations between 12 major US equity sector ETFs conditioned on the state of economy (mimicked here by the S&P 500 index) are significantly lower than the Pearson's correla-

tions. The Markowitz mean-variance portfolio theory is modified in terms of partial covariance. The maximum Sharpe portfolios formed by 12 equity sector ETFs in 2007 – 2015 are examined. With the exclusion of the bear market of 2008, the partial correlation based portfolios (PaCP) are much more diversified than the Pearson's correlation based portfolios (PeCP). Out-of-sample performance of the maximum Sharpe PeCP and PaCP, and the equal-weight portfolio (EWP) are compared. The results are very sensitive to the model parameters (portfolio calibration window and frequency of portfolio rebalancing). While the PeCP weights change significantly from month to month, the PaCP weights outside the bear market effects are almost constant. PaCP outperforms both EWP and PeCP when the 36-month calibration window and one-month rebalancing frequency are used. We conclude that partial covariance is a promising concept for constructing optimal portfolios.

Posters

Wednesday, 5 July

POSTERS & COFFEE

Econo- and Sociophysics
Wednesday morning, 5 July, 11:00
Main hall

POSTERS & COFFEE

Econo- and Sociophysics
Wednesday afternoon, 5 July, 15:30
Main hall

15:30	Poster	22

Modeling correlations in operational risk

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Operational risk models are used to examine losses that arise as a result of operational events that can be treated as stochastic variables. One of the problems encountered in modeling is the need of taking into account correlations between events. Estimation of copulas and their application in risk models is complicated because random vectors here cannot be represented as matched pairs for which one could build correlation based models. Fortunately, copulas used in operational risk (the Archimedean copulas) are based on existence of common factors. Thanks to that it is possible to build models for correlated events.

In the article the authors present models of copulas and their application to calculating operational risk. The calculations were done both real data and on simulated data that allows for estimation of correlation influence on risk measurement.

15:30	Poster	23

An Interacting Model of Market Risk

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The standard models of risk in the mathematical finance community typically connect to the well known Geometric Brownian motion (GBM). However, they are faced with the usual shortcomings that they do not reproduce the so called 'stylised facts' of financial markets. Several other alternatives have since been proposed where most of these non-trivial features are forced in by hand - leading to ever more complicated approaches. In the contrary however, those in the Econophysics community have recognised that such universal features are in fact a signature of collective behaviour and instead propose a 'bottom-up' agent based approach. In most of such examples, one typically considers the actions of individual agents and their subsequent interactions making little attempt to connect with more descriptive approach described above. Therefore, whilst substantial and insightful, the modelling capabilities in market risk setting are already naturally limited.

In this work we present an alternative approach which can be thought of as a middle ground between the two. We propose a model in which an interacting non-linear feedback mechanism is added to the standard GBM. The rationale behind this starts with a hypothetical complete knowledge of all degrees of freedom in a market setting. If one were to integrate all of such except the price we would be left with resulting effective interactions between prices and memory. Here, we take the minimalist Markovian approach with pairwise interactions only. Interestingly, the resulting dynamics is equivalent to that of a graded response neural network which have been well studied and are known to exhibit glassy dynamics being largely dominated by a landscape with many meta-stable states. Using such methods, analytical tractability can be made and we find closed form expressions for return distributions as well as other quantities of interest. Another promising feature is that a natural study of the market state detection arises since the dynamics exhibits significantly different behaviour when transitioning across meta-stable states as opposed to fluctuations within one. It is of surprise and great interest that even in this first approximation approach, essentially all non-trivial effects one hopes to observe are recovered in full detail - suggesting that interactions must be acknowledged if accurate models of risk and portfolio management are to be constructed.

15:30	Poster	24

Continuous-time random walk with memory in study of autocorrelations present in financial time series

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Continuous-time random walk (CTRW) is a stochastic process with continuous and fluctuating waiting (interevent) time. It was firstly introduced to physics by Montroll and Weiss [1]. Since then it has been used to model anomalous transport and diffusion, hydrogen diffusion in nanostructure compounds, electron transfer, aging of glasses, transport in porous media, diffusion of epicenters of earthquakes aftershocks, cardiological rhythms, human travel and many more [2]. CTRW is also successfully applied in econophysics [3], for example its version with the one-step memory was used to describe stock price dynamics [4], especially autocorrelation function (ACF) of price changes.

However, empirical ACF of absolute values of price changes decays much slower than ACF of price changes. Is the one-step jump memory able to describe this phenomena? In order to answer this question, we introduce a directed CTRW with one-step jump memory, which turned out to be analytically solvable.

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15:30	Poster	25

Technological stock market revolution from multifractal perspective

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For today's investors electronic trading platforms together with algorithmic trading constitute "natural environment" for carrying out efficient and transparent transactions. Advanced technology has displaced traditional trading floor makes the trading available not only for professional traders but also for retail investors. Moreover, especially in the case of high-frequency trading, many transactions are executed not by human but automated trading systems using complicated algorithms of trading. These technology innovations are also core driving force of coupling between markets from distant geographical locations and developing globalization of financial markets. However, the algorithmic trading can also carry some serious risk for investors. The best example of the danger related to the automated electronic trading is the stock market crash in 1987 where electronic technology is considered to be one of the main factors responsible for the index value plunge. This, in turn, forced the introduction of some financial regulatory instruments protecting investors against possible dramatic losses.

Natural question which arises in this context is the impact of the technology revolution and related trading regulations on the stock market dynamics. In this contribution we used multifractal formalism to rolling-window multiscale analysis of the indices values coming from the major world stock exchanges. We showed that the stock market dynamics changed significantly in the second half of the 80s which coincides with the period of growing popularity of the electronic trading. Distortion of the hierarchical organization of the data is clearly visible on the level of multifractal spectra which are characterized by strongly asymmetric shape for the period after 87 in contrast to almost symmetric shape for the earlier one. Heterogeneity of multiscaling properties related to the asymmetry of the multifractal spectrum indicates imbalance in fractal complexity between the price fluctuations of different amplitude. It has been demonstrated that in the era of electronic trading large price fluctuations reveal much more pronounced hierarchy then the small ones which can be considered as a kind of noise. Moreover, temporal variability of the multifractal properties of the financial data offers the possibility of its practical application. In particular, our findings suggest that this approach can be potentially useful in predicting stock market crashes.

15:30	Poster	26

Multiples of ten in the survey data on the number of friends

Maria Nawojczyk[2], Maria Stojkow[2], Dorota Żuchowska-Skiba[2], Małgorzata Krawczyk[1], Krzysztof Kułakowski[1]

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The number of acquaintances has been highlighted by Robin Dunbar as a relevant measure of social functions of brain [1,2]. This number is also relevant for modeling social networks [3]. The distribution of the number of social links, as measured in social media, has been reported as a scale-free function [4,5]. On the other hand, the order of magnitude of the mean degree in social networks is often so large that the binning procedure hides details of the distribution [5]. Here we consider the data on the declared number of friends, as collected from [6] for respondents above 50 years. We demonstrate, that the answers on the number of friends show sharp maxima at 10, 15, 20 and sometimes 30, which accompany a broader peak between 0 and 8 [7]. These results do not change qualitatively with sex and age of the respondents. The results are interpreted as a demonstration of the

size effect, which applies to the reported values as well as to their uncertainty [8]. Analogy with the Benford's law [9] is explored. Our analysis could be placed in NSN (new science of network) paradigm [10].

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15:30	Poster	27

Paradox of integration – mean field approach

Krzysztof Kułakowski[1], Piotr Gronek[1], Alfio Borzi[2]

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Theory of integration has been described by Peter Blau more than 50 years ago [1], but it is only recently when a computational model has been proposed [2]. In this model, agents praise or critique each other, what influences their social status and raise positive or negative emotions. Here we develop a mean field version of the approach. Namely, the active and passive roles (praising and being praised, etc.) are decoupled in the model. As in [2], we observe a phase transition from friendly to hostile emotions in the space of parameters. For both phases, we investigate the time dependence of the distribution of social status. We observe a diffusive spread, supplemented by a phase-dependent drift [3]. The role of self-deprecating strategy is discussed.

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15:30	Poster	28

Measuring and explaining income inequalities in Poland: an estimation of Lorenz curves using hazard function approach

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The goal of our paper is to examine differences between the income distributions for men and women in Poland. We use a flexible hazard-function based estimator in the presence of covariates to construct conditional density and cumulative distribution functions. Then we estimate the Lorenz curves for wages. This method allows us to investigate the differences in income inequality for two groups of people. Incorporating the effects of covariates into Lorenz curve ordinate estimates makes it possible to infer the effects of various person's characteristics on the shape of this curve.

15:30	Poster	29

Asymmetry of trends: a simple, 2-phase market index simulator

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Financial time series exhibit a set of characteristics, known in the economic community as stylized facts, without a clearly confirmed explanation [1, 2]. Among these are:

- heavy tails of returns,

- volatility clustering,

- gain/loss asymmetry,

- absence of autocorrelations in returns,

- slow decay of the autocorrelation function (ACF) of absolute returns.

There have been a multitude of models attempting to reproduce or explain some or all of the above observed phenomena, ranging from the GARCH family of models [3] to agent-based simulation techniques [4].

We present a much simpler approach. We start with an observation of different properties of "uptrend" and "downtrend" market regimes in terms of volatility and heaviness of tails (different stability parameter of the Lévy-stable distribution). We build upon this observation to construct a bootstrap-style, stochastic stock market index. We arrive at a market index with 2 distinct market regimes and all the listed above stylized facts. An ACF profile of absolute returns similar to that of the S&P500 index is obtained.

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15:30	Poster	30

Influence of a range of interaction among agents on efficiency of knowledge transfer within an organization

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Recently we have proposed a simple model of knowledge transfer within an organization [1] based on cellular automata technique [2]. The main goal of this paper was to check which factors influence the efficiency of knowledge transfer. In model organization agents send and receive chunks of knowledge only when numbers of knowledge chunks possessed by sender and receiver are very similar. Namely, we assume that such transfer is possible only when sender has exactly one more chunk of knowledge than recipient. This strong restriction on knowledge transfer influences negatively the efficiency of knowledge transfer what results in decreasing the average number of knowledge chunks possessed by the whole organization for relatively high values of initial concentration of chunks of knowledge within the organization. The latter effect is rather counterintuitive but vanishes when agents may receive chunks of knowledge from senders having the same or greater number of chunks of knowledge than receivers [3].

Now, we would like to check how the range of interaction influence the efficiency of knowledge transfer. Namely, we extend the neighbourhood considered in Refs. [1, 3] from von Neumann neighbourhood to the Moore's one. On square lattice—when von Neumann neighbourhood is assumed—the site at coordinate (x, y) has exactly four neighbours at $(x–1, y)$, $(x+1, y)$, $(x, y–1)$ and $(x, y+1)$. For Moore's neighbourhoods also sites at $(x–1, y–1)$, $(x+1, y–1)$, $(x–1, y+1)$ and $(x+1, y+1)$ belong to the neighbourhood. Our preliminary results indicate that increasing range of interaction make the knowledge transfer more effective.

The Java applet allowing for system evolution observation is available at http://www.zis.agh.edu.pl/knowledge_transfer/.

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15:30	Poster	31

Shortening review time in peer review with Cartesian Genetic Programming

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Peer review is one of the cornerstones of scientific publishing. It is a process whose goal is to ensure (and often improve) the quality of scientific work published in journals. However, despite its importance, peer review remains an understudied subject and only in recent years has it attracted the attention of scientists interested in the dynamical aspect of the process.

On of the problems in peer review is that the number of manuscripts submitted for publication is increasing every year. This puts strain on reviewers and leads to longer review time.

In our work, we use Cartesian Genetic Programming [1] to improve the effectiveness (that is to reduce review time) of peer review. Cartesian Genetic Programming is a technique which employs (much like genetic algorithms) certain concept known from the theory of evolution in order to artificially evolve optimised solutions to user-defined problems. We use CGP to evolve editorial strategies – sets of rules that help editors decide when (and how many) invitations should be sent to potential reviewers.

Our approach is entirely data-driven: we use the analysis presented in [2] as the basis for simulations of the peer review process. These simulations allow the CGP algorithm to assess and optimise editorial strategies. The strategies we managed to evolve result in review time shorter even by 30% when compared to typical strategies used by

actual editors. We also show that by employing groups of mixed reviewers – that is reviewers know personally by the editor and reviewers found through scientific databases – review time can be shortened even further.

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15:30 Poster 32

Extreme portfolio loss correlations in credit risk

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The global financial crisis 2007-2009 has shown that the common belief that credit risk can be diversified is deeply flawed. This is due to the ever present correlations in financial markets. We consider the problem of two credit portfolios on a nonstationary and correlated market within the framework of the Merton model. This structural model allows us to take fluctuating asset correlations into account. We use an ensemble approach which preserves analytical tractability and yields results that coincide with empirical data. This allows us to derive the multivariate distribution of credit portfolio losses. We show that for two disjoint credit portfolios diversification does not work in a correlated market. Additionally we find large concurrent portfolio losses to be rather likely. Studying the portfolio loss correlations we show that significant correlations emerge not only for large portfolios containing thousands of credit contracts but also for small portfolios containing only a few credit contracts. We extend the model to the effect that we consider two credit portfolios on two markets which are on average uncorrelated. Furthermore we include subordination levels. At maturity time the senior creditor is paid out first and the junior subordinated creditor is only paid out if the senior creditor regained the full promised payment. This is related to CDO tranches and gives further insight to multivariate credit risk.

15:30 Poster 33

Numerical analysis of a mathematical model of a tumor growth and possible economic analogies

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The main aim of this research is to elaborate a model of tumor growth containing therapy impact. Proposed model is based on stochastic differential equations. The model is able to reproduce the most important pathological properties. Analytical results are illustrated by numerical examples of the model dynamics. Possible analogies with some simple extensive and out of equilibrium economies are indicated.

15:30 Poster 34

Fast rumour source detection in large social networks

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The localization of a source of a malicious rumour became an urgent issue in last years. Most of the known methods works under very restricted conditions and their computational complexity is rather high. We examined carefully the method invented by Pinto et al. and we proposed improved version. The improvements include filtering the low quality information and smart selection of nodes suspected of being the source. As a results of improvements, our Gradient Pinto Algorithm (GPA) has the time complexity $O(N^2 \log(N))$, while the complexity of Basic Pinto Algorithm (BPA) is $O(N^a)$, where a \in (3,4) depending on the number of the observers in the network. The numerical tests performed using three different measures confirmed that GPA outperforms BPA also in terms of efficiency.

15:30 Poster 35

Coevolving complex networks in the model of social interaction

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In the 90s Robert Axelrod have proposed the canonical model of social interactions [1] explaining one of possible important mechanisms of dissemination of culture. He have found that depending on initial conditions the system can end up in one of two states: ordered with global culture or disordered with many small subcultures. The dynamics of this model capturescomplexities of real interactions between people, but the square lattice which was considered is far from satisfying reflection of real-world social networks. Others have studied Axelrod's model deeper on complex networks and it turned out that thestructure can have fundamental influence on the behaviorof the system. Maxi San Miguel et. al. [2] made the next step by exploring the model of social interactions on coevolving random networks and finding two phase transitions with interesting properties. Unfortunately social networks are as far from randomness as from regularity. In our work we introduce four extensions with different mechanisms of edge rewiring. The models are intended to catch two kinds of interactions - preferential attachment, which can be observed in scientists or actors collaborations, and local rewiring, which can be observed in friendship formation in everyday relations.

Numerical simulations show that proposed dynamics can lead to the power-law distribution of nodes' degree and high value of the clustering coefficient, while still retaining the small-world effect in three models. All models are characterized by two phase transitions of a different nature. In case of local rewiring we obtain order-disorder discontinuous phase transition even in the thermodynamic limit, while in case of long-distance switching discontinuity disappears in the thermodynamic limit, leaving one continuous phase transition. In addition, we discover a new and universal characteristic of the second transition point - an abrupt increase of the clustering coefficient, due to formation of many small complete subgraphs inside the network.

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15:30 Poster 36

The impact of heavy tailed asymmetric and symmetric probability distributions on spurious multifractallity

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In this paper we analyze numerically the effect of spurious multifractality caused entirely by the presence of fat-tailed symmetric and asymmetric probability distributions of fluctuations in time series. In the presented approach different kinds of symmetric, asymmetric, thin- and fat-tailed probability distributions of synthetic data are examined starting from Levy regime up to those with finite variance, lying outside Levy regime.
We use nonextensive Tsallis statistics to construct all considered data. The semi-analytical compact formula are then provided to express the level of spurious multifractality generated by fat tails in terms of Tsallis parameter q. The results are presented in Hurst and Holder languages - more often used in study of multifractal phenomena. It turns out that fat tails and, in particular, the level of symmetry (asymmetry) of probalility distributions have a non-trivial influence on the measured multifractal properties of the time series. According to semianalitycal relations we provide we argue that it is possible to make a clear quantitative distinction between true multifractality caused by the presence of nonlinear correlations in data and spurious multifractality generated by effects not connected with nonlinear correlations like fat-tailed shape of distributions, their asymmetry, linear autocorrelations or finite length of analysed time series.

15:30 Poster 37

Analysis of the Warsaw's rail transport's network

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Thouseds of people travel by public transport everyday. Good connections between strategic areas of the city seem to be very important issue. Well designed communication network has huge influence on environment (fresh air without smog) and our expenses (faster and cheaper travelling). Have you ever wondered how the transport system really works? What is the impact of a single tram stop on the entire network? What would happen if the longest tram line in a huge city is cancelled? To deal with these and other questions I analyse Warsaw's rail transport;s network.

15:30 Poster 38

Agricultural prices in Italy

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In this poster the structure of Italian agricultural commodity markets is outlined. Price fluctuations for wheat, corn and soybean products traded in Milan are studied. A simple model is introduced for price fluctuations and compared with real data.

This research has been funded by the Italian CNR Project VOPA.

15:30 Poster 39

Financial network maintain a scale-free organization during the different market states

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Connectedness between subjects in economic system is an essential feature of systemic risk. Although the risk management of financial system during the normal circumstances have been identified in the single object level, there has been relatively small study of interconnection domain. The several financial market crisis were considered to check the usefulness of proposed method. Here, we considered the temporal organization of financial network using the duration of interconnections. The duration of network connections in the financial market was analyzed by individual firms listed the given stock market and the minimum spanning tree method. The global temporal configuration of financial network was investigated by constructing the distribution function of connection time in different economic states, such as normal (1999 2003), pre-crisis (2004 2007), crisis (2008 2009), and post crisis (2010 2015) periods. Financial crisis was associated with a significant increase in the number of network connections and significant alternations of temporal organization in

terms of the cumulative distribution function of duration time. These changes were most important in the financial crisis and were also associated with a significant reduction in the pattern of duration. Despite of different economic states, the cumulative distribution function follows a power-law distribution. Our findings suggest a fundamental principle of temporal organization of network connection in financial market that is maintained during different market status, despite local changes. Further research will be considered in the systemic risk management based on the outcome of this finding.

15:30	Poster	40

New constant of motion for coevolving voter model

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In the voter model, there are two kinds of nodes states and three kinds of bonds. In the coevolving voter model topology of the network changes in response to the voter dynamics on the network. In detail, nodes can change their state and links can rewire in order to connect nodes of the same state. Our work is focused on conservation laws for coevolving voter model. We treat mean degree of nodes in different states as separate variables, which do not have to be equal. This allows to discuss the magnetization of nodes and the magnetization of links as potentially independent variables. Mean field calculation indicate that these two values are coupled - their linear combination is constant of motion. Obtained results were confirmed by numerical simulations.

15:30	Poster	41

Modeling Endogenous Contagion on O/N Interbank Market

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The interbank market activity in many countries has been severely impaired during the recent global financial crisis. The events of 2007 were the hard way to find out how a single shock can lead to disastrous effects on the whole international financial system. The network of complicated relations and dependencies between financial institutions across the globe was the main reason for which a single crash spread through the world like a disease. From this moment on, the term contagion became an important topic in financial stability research. As a result, many complex networks researchers decided to follow the emerging subject of Systemic Risk. We propose a new model of the liquidity driven banking system focusing on overnight interbank loans. This significant branch of the interbank market is commonly neglected in the banking system modeling and systemic risk analysis. We construct a model where banks are allowed to use both the interbank and the securities markets to manage their liquidity demand and supply as driven by prudential requirements in a volatile environment. The network of interbank loans is dynamic and simulated every day. We show how only the intrasystem cash fluctuations, without any external shocks, may lead to systemic defaults, what may be a symptom of the self-organized criticality of the system. We also analyze the impact of different prudential regulations and market conditions on the interbank market resilience. Starting with leverage ratio, we also explore more complicated regulations and show which of them are actually effective and which may even amplify losses in a time of distress. Therefore, the model can be used to analyze the interbank market impact of macroprudential tools. Finally, we confirm that central bank's asset purchase programs, limiting the declines in government bond prices, can successfully stabilize bank's liquidity demand.

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