

1 Timetable

Thursday, August 28 th , 2008			
08:30	Registration		
09:30	Coffee break		
10:00	Welcome Addresses and opening remarks by Thomas Lux, University of Kiel		
10:15	Parallel Session 1		
	<table border="1"> <tr> <td>Findlay Kryssanov Lin</td> <td>Yamamoto Riberio</td> </tr> </table>	Findlay Kryssanov Lin	Yamamoto Riberio
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11:45	Coffee break		
12:00	Keynote Lecture 1 Rosvall, M. Cartography in a complex world: from interactions to maps		
13:00	Lunch break		
14:00	Parallel Session 2		
	<table border="1"> <tr> <td>Sella Mimkes Ghonghadze</td> <td>Ruiz Trujillo Bossomaier</td> </tr> </table>	Sella Mimkes Ghonghadze	Ruiz Trujillo Bossomaier
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15:30	Coffee break		
15:45	Keynote Lecture 2 Chen, S.-H. Agent-based economic models and econometrics		
16:45	Coffee break		
17:00	Parallel Session 3		
	<table border="1"> <tr> <td>Stamataki Hott Hermsen</td> <td>Li Watanabe, K. Wagner</td> </tr> </table>	Stamataki Hott Hermsen	Li Watanabe, K. Wagner
Stamataki Hott Hermsen	Li Watanabe, K. Wagner		
18:30	Time for chill out		

Friday, August 29th, 2008

09:00	Keynote Lecture 3 Pietronero, L. Minimal agent based model for the origin and self-organization of financial markets	
10:00	Coffee break	
10:15	Parallel Session 4	
	Yamamoto Onozaki Tseng	Inoue Garlaschelli Raddant
11:45	Coffee break	
12:00	Keynote Lecture 4 Weidlich, W. Dynamics of political opinion formation including catastrophe theory	
13:00	Lunch break	
14:00	Parallel Session 5	
	Ormerod Sano Mizuno Ueno	Watanabe, H. Abreu Milaković
15:30	Coffee break	
15:45	Parallel Session 6	
	Kenett Kanevski Germano	Alfarano Lam Morales Kim
17:15	Conference Dinner. Meeting Point: Main entrance of the IFW	

Saturday, August 30th, 2008

09:00	Keynote Lecture 5 Bornholdt, S. Magnetic spin models of speculation	
10:00	Coffee break	
10:15	Parallel Session 7	
	Jain Bovina Ebadi/Karimi Oswiecimka	Oh Pozzi Manganote Aruka
11:45	Coffee break	
12:00	Keynote Lecture 6 Wilhite, A. Games on Networks	
13:00	End of the conference	

2 Abstracts

Abreu, Rute; Manuel Prado-Lorenzo, José; Martín-Jimenez, Doroteo

Could firm value be explained by thermal comfort? Evidence from Listed Companies in Portugal

This paper proposes a previously unexplored model to the valuation of a corporation using financial reporting and accounting numbers. In our view, this model promotes dissemination and exchange of ideas about the new perspectives of the value analysis and it claims that traditional valuation models does recognized the investors' behaviour in satisfactory approach at the same time of the corporate value. This research has been validating on a panel data of listed firms on the *Euronext Lisbon* as the Portuguese stock market. The population identifies 291 firms with officially quoted shares in the stock market, but after a process of depuration, the sample is 1.079 observations related with 114 firms, from December 31, 1991 until December 31, 2001. Further, by being able to identify corporate value, our model provides opportunities to gain a better understanding of the link between quality of the information produced and corporate strategies. Also, the quality of the economic decisions can also be inferred from publicly available data, our model generates new opportunities for empirical research.

The first answer to the question of this research argues that this paper contributes to the econophysics literature by examining the robustness of the relation between accounting (valuation) and physics (thermal comfort). In this perspective, the objective of valuation is to provide information about the firm and the objective of thermal comfort is to provide information about the person. The research promotes, more and more, that nature began to be governed by physical laws and we started to wonder whether such laws are able to apply to Human or firms sphere was well. Also prone to this problem, is valuation governed by accounting principles. The second answer to the question of this re-

search explains firm value as an application of the Fanger's model. In other words, by testing the firm value with different variables, we can move towards understanding not only of the emergent behavioural rules for firms and investors, but also to learn from these rules. This illustrates the innovation that it develops the widely-used International Organization for Standardization (ISO) standard 7730: 2005(E) and it permits to incorporate the company-specific valuation approach which use computing results obtained from large simulation. In addition, this standard is precisely, unequivocally defines and contributes to the literature by analyzing the standard implementation to which the valuation model is applied. The third answer to the question of this research shows the development of a theoretical model of the corporate value that links characteristics from the financial reporting such as operational, investment, financial, dividends, tax and market policy derived from corporate strategies adopted of the firm that provides a case study that it has been validated and understandable.

Alfarano, Simone; Milaković, Mishael; Wagner, Friedrich

A nonparametric approach to the unconditional distribution of volatility

The stochastic volatility decomposition (SV hereafter) of financial returns defines the returns as a product of two random variables, namely a noise term η and a positively correlated volatility σ . This decomposition reproduces the empirically identified positive correlation of simple return transformations (for instance absolute or squared returns) and the absence of correlation in raw returns. The latter is often interpreted as an imprint of market efficiency. Given the SV decomposition, the two stochastic variables η and σ are latent factors, since the only directly measurable quantity is their product. Therefore, it is the joint contribution of η and σ that determines the conditional and unconditional properties of financial returns under the SV decomposition. In our paper, we propose a non-

parametric method to determine the functional form of the unconditional distributions of the volatility factor σ , denoted as $p(\sigma)$. The non-parametric nature of the method consists in extracting information about the probability density of the variable σ , without making any parametric assumptions about the stochastic process for the noise term in the SV decomposition.

Aruka, Yuji; Akiyama, Eizo

Non-Self Averaging of a Two-Person Game only with Positive Spillover: A New Formulation of Avatamsaka Dilemma Process

We have the Avatamsaka game [Aruka 2001] as a two-person game only with positive spillovers. In this game, selfishness would not be determined even if the agent selfishly adopted the strategy of defection. Individual selfishness could only be realized if the other agent cooperated. Any same-sized gain can be generated by either defection or cooperation. The sanction by defection as a reaction of the rival agent cannot necessarily reduce the selfishness of the rival. This game can be classified into a dependent game ([Akiyama and Aruka 2006]).

Aruke ([Aruka 2002]) gave an idea to formulate an Avatamsaka game process in terms of Polya urn process. If we are regarded an evolution of gain-ratio of each agent as a nonlinear function, the dynamics of gain addition could be motivated by the behaviors of the other agents, and in the event, agents' behavior could be independent from the others.

Now we introduce different spillovers, i.e., different pay-off matrices. Each agent may be faced with a different pay-off matrix. A ball in the urn is interpreted with preference to the number of cooperation, while an urn a pay-off matrix. We apply Ewens' sampling formula to our urn process under this environment. In this case, we will have a similar result as in the classical case, because we have the *self averaging* on variances of the number of cooperation. We then apply Pit-

man's sampling formula to our urn process. Here the invariance of the random partition vectors under the properties of exchangeability and size-biased permutation does not hold in general. Incidentally, Pitman's sampling formula depends on the two parameters Poisson-Dirichlet distribution whose special case is just Ewens' formula.

More concretely, we will investigate the effects of differing pay-off sizes of playing a series of different games *coming out newly*. As [Aoki and Yoshikawa 2007] and [Aoki 2008] dealt with a product innovation and a process innovation, they criticized Lucas' presentative method that Microsoft and small grocery store on the street face micro shocks drawn from the same unchanged probability distribution. In the light of [Aoki and Yoshikawa 2007], we may show the same argument in our Avatamsaka game with different pay-offs. In this setting, *innovations* occurring on *urn* may be regarded as *increases* of the number of cooperation in *urns* whose pay-offs are different.

Bossomaier, Terry; Michael Harré

Equity Trees and Information Theory

Recently some sophisticated algorithms have been developed for the analysis of very complex sets of data that might naturally be thought of in terms of networks. Recently a popular theme has been the application of information theory based methods to the analysis of time series. Mutual information captures high order interactions which can be missed completely by correlation analysis. In this paper we apply these techniques to the dynamics of equity trees in financial markets. Previously these methods had only been applied to static trees or, alternatively, simpler correlation techniques had been applied to dynamic asset trees. We find that there are significant differences between the results achieved using previous approaches and the results we find using this alternative method.

Our approach was to take a set of 130 highly capitalised equities traded in the financial

markets for which the day close prices were available from Jan. 1st 1995 to April 1st 2008. The equities were chosen according to three simple criteria: they had to be traded on the market, have their data available for the time period and they had to be amongst the highest capitalised within their market sub-sector on the day their data were downloaded.

The significance of this result is in the underlying assumptions regarding the relationships being modelled by these asset trees. We have been able to show that using a measure of the relatedness between equities based on information theory provides two important results. The first is that a more accurate representation of the equity tree dynamics results from using this technique. The second is that there are qualitatively different outcomes which are overlooked by more conventional correlations which only capture the linear relationships between equities.

Bovina, Dario

Hurst exponent consistency for fat-tailed return distributions

The generalized Hurst exponent H is often used to establish multiscaling in financial time series. In computing $H(q)$ we are concerned with the q -order empirical moment of returns' distribution. Since power-law tails are among the most robust features observed financial data, our aim is to check if such analysis can be carried out when the returns' PDF has divergent moments. At an order q for which the theoretical moment doesn't exist, the behaviour of $H(q)$ seriously suffers from the finiteness of the sample.

We show how Pareto tails and a finite data set can result in a spurious multiscaling even for a strictly self-affine process. A process with independent increments distributed according to a Cauchy law should have a constant exponent H ; on the contrary we empirically observe bifractality. We find such behaviour is due to power-law tails only, suggesting that this spurious feature may

be common to every scaling process whose increments' PDF decays according to a power law.

Dealing with independent increments we neglect another robust 'stylized fact': the volatility clustering of returns; so we wonder if our above argument still holds when returns are correlated. We take into account some of the oldest and most important Stock Market indexes and, by reshuffling the whole series, we find that Pareto tails give rise to a strong empirical multiscaling, but volatility clustering can attenuate this spurious effect.

In computing $H(q)$ from a finite sample one should care about uncertainty. We propose a 'bootstrap' method to evaluate the reliability of $H(q)$, i.e. its sample dependence. Using this resampling method on real financial series we find such uncertainty suddenly start to increase as the order q reaches the value q_0 for which theoretical moments are expected to diverge. The Hurst analysis is no longer reliable in the range of divergent moments. Since the q -dependence of H has been observed for orders close to q_0 or even larger, in our opinion the robustness of this feature is quite doubtful.

Brida, Juan Gabriel; Punzo, Lionello; Riso, Wiston Adrián

Regime Convergence and Cluster Analysis

In this paper we study the existence of suitable redefined convergence clubs of countries. To detect such clubs we compare the dynamical evolution of different countries instead of their long run growth rate of per capita GDP. Two variables which appear in the standard convergence literature are representing countries: the level Y and the growth rate g_Y of per capita GDP. We introduce the concept of growth regime in this framework and evolution of countries is represented by their regime dynamics. Convergence is redefined as a tendency to exhibit a similar pattern in terms of regimes. We use nonparametric methods which combines the tools of Symbolic

Time Series Analysis with the nearest neighbor single linkage clustering algorithm in this two dimensional framework. More precisely, Minimal Spanning Tree and Hierarchical Tree are obtained from bidimensional time series to study the regime dynamics for 140 countries and to detect dynamic clusters exhibiting similar behaviours that can be interpreted as convergence clubs. We compare our results with well known empirical results on convergence in per capita income.

The methodology confirms the existence of two clubs of countries (poor and rich) that followed qualitative different patterns. The evolution of their relative distance shows a tendency to increase until the 90s and then to decrease. We also show that the group of rich countries tend to converge, while the club of the poors tend to diverge.

Chen, Shu-Heng; Chang, Chia-Ling; Du, Ye-Rong

Agent-based economic models and econometrics

This paper reviews the development of agent-based (computational) economics (ACE) from an econometrics viewpoint. The review comprises of three stages, characterizing the past, the present, and the future of this development. The first two stages can be interpreted as an attempt to build the econometric foundation of ACE, and, through that, enrich its empirical content. The second stage may then invoke an reverse reflection on the possible agent-based foundation of econometrics. While ACE modeling has been applied to different branches of economics, the one, and probably the only one, which is able to evidence this three-stage development is finance or financial economics. We, therefore, will focus our review only on the literature of agent-based computational finance, or more specifically, agent-based modeling of financial markets.

Ebadi, Haleh; Jafari, Gholamreza R.

Inverse statistics in Tehran price index

Inverse statistics borrowed from turbulence, is based on the algorithm of turning the variables around such that the fluctuating variable becomes fixed, while the fixed one becomes fluctuating. This concept developed by Simonsen et al. (Eur. Phys. J. 27 (2002) 583) and Jensen et al. (Physica A 324 (2003) 338), applied in economics by considering asset price returns as fixed variable and waiting times as fluctuating variable. This obtains the distribution of waiting times needed to reach a certain level of return. Such a distribution typically goes through a maximum at a time called the optimal investment horizon, since this defines the most likely waiting time for obtaining a given return. This article presents an investigation on return time series of TEPIX (Tehran Price Index) as a non-efficient market and S&P500 as an efficient one, using the inverse statistics analysis. In order to study the features of the PDF of the waiting times, the analysis is also performed for the shuffled and surrogated time series of return of these two kinds of stock markets. Since the application of shuffling data destroys the correlation and demonstrates whether there are actually correlations among time series, and the application of the phase randomized Fourier surrogate method, tests for gaussianity. Furthermore, to give a comparative discussion, all the above process is preformed for Brownian Motion.

Findlay, Eric

The effects of macro-level noise on unemployment, inflation and growth

We examine the macroeconomic theory of the physicist Henri Rathgeber (1908-1995), who in the early 1970s used information theory to introduce a stochastic element into the relationship between economic agreements and actual transactions. The negative feedback response of prices and quantities to excess supply and demand is at the core of economic theory. The problem is then to explain why the unemployment rate does not tend to ze-

ro. Economics is normally considered to be the study of the way sellers and buyers interact to reach a set of agreements about prices and quantities. It is assumed that this set of agreements results in the same set of actual transactions. This seems unrealistic due to the effects of entropy in daily life so, accepting that the price and quantity feedback process adequately explains the social process of reaching a set of agreements, Shannon's information theory is used to explain the subsequent relationship between agreements and actual transactions. The received error rate equates to the unemployment rate and this rate can only be reduced by increasing the rate of flow of currency. In this way the difficulty of reconciling price and quantity feedback with unemployment is resolved. The outstanding problem of money non-neutrality posed by David Hume about 256 years ago is also resolved. The relationship also explains the observed 'short-run' relationship between unemployment and inflation. A positive feedback process is identified where high inflation causes both higher inflation and unemployment, evident in post-1970 high inflation and unemployment and also the recent subsequent decreases in unemployment rates. Since this instability is dependent on the inflation component of the interest rate, instituting an indexed unit of account such as Chile's Unidad de Fomento breaks the positive feedback cycle and allows monetary authorities to control for stable full employment with stable high inflation.

Garlaschelli, Diego; diMatteo, Tiziana; Aste, Tomaso; Caldarelli, Guido; Loffredo, Maria I.

Interplay between topology and dynamics in the World Trade Web

We present an empirical analysis of the network formed by the trade relationships between all world countries, or *World Trade Web* (WTW). Each (directed) link is weighted by the amount of wealth flowing between two countries, and each country is characterized by the value of its Gross Domestic Product

(GDP). By analysing a set of year-by-year data covering the time interval 1950-2000, we show that the dynamics of all GDP values and the evolution of the WTW (trade flow and topology) are tightly coupled. The probability that two countries are connected depends on their GDP values, supporting recent theoretical models relating network topology to the presence of a 'hidden' variable (or *fitness*). On the other hand, the topology is shown to determine the GDP values due to the exchange between countries. This leads us to a new framework where the *fitness* value is a dynamical variable determining, and at the same time depending on, network topology in a continuous feedback.

Germano, Guido; Politi, Mauro; Fulger, Daniel; Scalas, Enrico

Synthetic high-frequency financial time series: Numerical study of free random Wishart-Lévy matrices

We review numerical methods for the Monte Carlo simulation of synthetic high-frequency financial time series, especially 1) uncoupled continuous-time random walks with a Lévy alpha-stable distribution of tick-by-tick log-returns and a stretched exponential distribution of intertrade durations and 2) autoregressive processes (GARCH-ACD). We discuss the analysis of correlation matrices of time series with fat-tailed log-returns, concentrating on the eigenvalue spectra of random Lévy and free random Lévy matrices (FRLM) in the Wishart ensemble. We show in detail how theoretical equations for the eigenvalue density can be obtained in the FRLM case, and compare the analytical results with numerical ones. Moreover, we mention how asynchronous time series can be sampled with the Fourier method as an alternative to a grid of regular observation times with previous tick interpolation.

Ghonghadze, Jaba; Lux, Thomas; Wang, Xiaokang

Modeling the dynamics of EU economic sentiment indicators: an interaction-based approach

This paper postulates and estimates a simple univariate model of expectation formation in continuous time. The framework is applied to a selected dataset on survey-based expectations from the rich EU business and consumer survey database for twelve European countries. The model parameters are estimated through maximum likelihood by numerically solving the relevant Fokker-Planck equation via finite difference approximations. The model's goodness-of-fit is checked with respect to its out-of-sample forecasting performance relative to univariate time series models of the ARMA(p, q) and ARFIMA(p, d, q) varieties. These tests speak for the slight superiority of the canonical continuous-time model over the alternatives in the majority of cases.

Hermesen, Oliver

Does Basel II destabilize financial markets? An agent-based financial market perspective

In this paper we use a financial market model with heterogeneous interacting agents to show that the regulations of Basel II may lead to a destabilization of financial markets. This is obviously the direct opposite of what the regulatory authority aims for. The Basel II framework was implemented to ascertain that financial institutions provide a sufficient level of regulatory capital to avoid a decrease in liquidity. So, among others, it shall be ascertained that banks withstand time periods with extraordinary losses in financial markets, for instance. The *International Convergence of Capital Measurement and Capital Standards* (Basel II) allows the calculation of the capital requirements for market risk by means of a Value-at-Risk (VaR) model when performing the Internal Models Approach. Here, the Basel Committee for Banking and Supervision (BCBS) does not prescribe banks a special type of model, but a special formula to determine the level of regulatory capital. At tra-

ding days with sharp price decreases, the loss might be higher than the VaR and a so called *backtesting exception* occurs. Then, the level of regulatory capital increases notably. Facing this situation, banks have two possibilities. On the one hand, they might raise their level of regulatory capital, although this option is quite expensive for banks. On the other hand, they might sell risky assets of their portfolio to lower the risk. In the paper, we explore the consequences, when banks choose the selling option. Here, we have to face at least two problems. First, we do not know the exact number of institutional traders in the market and, hence, we do not know the exact amount of market participants who are expected to sell assets. The second problem is that the Basel II framework is either for a short time or not at all put into national legislation by many countries. So, there is a lack of empirical data to explore this question. However, by means of a numerical analysis, we can shed light on this topic. It can be highlighted that the *selling option* may lead to a destabilization of financial markets. As the starting point of the numerical analysis, we choose the heterogeneous agent model of Lux and Marchesi (2000). This is a model which can mimic the stylized facts of financial markets quite well. Subsequently, we adjust this model by integrating regulation aspects of Basel II. That way, we can compare the behavior of financial markets with and without the regulations determined by the BCBS for varying ratios of institutional investors. First results show that the destabilization of financial markets - measured by the volatility, distortion, and hill tail index - might increase, when adopting the regulations of Basel II.

Hott, Christian

Banks and real estate prices

The willingness of banks to provide funding for real estate purchases depends on the creditworthiness of their borrowers. Beside other factors, the creditworthiness of the borrowers depends on the development of real estate prices. Real estate prices, in turn, depend on the

demand for houses which is influenced by the willingness of the banks to provide funding for real estate purchases. In this paper, I develop a theoretical model which shows how this circular relationship can lead to a cyclical behavior of real estate prices. Furthermore, I show that banks make above average profits in the upswing phase of the real estate cycle but suffer high losses when the market turns.

Inoue, Hiroyasu; Souma, Wataru; Tamada, Schumpeter

Verifications of growing models for cooperative R&D networks

We investigated a network based on joint patent applications and modeled it to reveal the dynamics of cooperative research and development among organizations. The network uses nodes to represent the offices of organizations and links to represent joint patent applications. We included about five million Japanese patents issued between 1993 and 2002. The results are summarized as follows. (1) The distributions of degree and node density follow power laws. (2) The distribution of link distance is inversely related to link distance. (3) We found models that could generate a network consistent with the above results. They are revised models of preferential attachment that takes into account the distances between nodes.

Ishikawa, Atushi

Quasistatically varying power-law and log-normal distributions in the large and the middle scale regions of Japanese land prices

Log-normal distributions are frequently observed not only in natural phenomena but also in social ones. For representative example, the probability density function $P(x)$ of personal income or firm size x is considered to obey the log-normal distribution in the middle scale region. A large number of persons or firms are included in the middle scale region.

The study of the distributions is significant. We have shown that the log-normal distribution can be derived [1] by using no model such as the pure multiplicative stochastic process. In the derivation, two laws are employed. One is the law of detailed balance which represents symmetry in a stable economy [2]. The other is a Non-Gibrat's law which describes a statistical dependence in the growth rate of the past value [1]. In Ref. [3], the Non-Gibrat's law and the static log-normal distribution in the middle scale region are uniquely derived from the detailed balance. The derivation has been confirmed in profits data of Japanese firms. In this study, we extend the derivation by replacing the detailed balance with the detailed quasi-balance proposed in Ref. [4] to derive a log-normal distribution in the quasistatic system. By this procedure, the log-normal distribution is described as quasistatic. In the derivation, the Non-Gibrat's law under the detailed quasi-balance is adopted together with two approximations. The resultant distribution is power-law with the varying exponent in the large scale region [4] and the quasistatic log-normal distribution with the varying standard deviation in the middle scale region. In the distribution, not only the change of the exponent but also the change of the standard deviation depends on the parameter of the detailed quasi-balance. These results are consistently confirmed employing data on the assessed value of land in 1974-2008 Japan.

Jain, Sudhir

Distribution of passage times and intermittency in financial markets

We study the intermittency observed in major financial markets around the world by using a definition based on a form normally used in fluid dynamics. We work with the time series data for the following major financial indices: London FTSE100, Nikkei 225, Dow Jones and the DAX. In each case we first calculate the daily log returns and then extract the appropriate intermittency exponents. The exponent values for the different markets are

compared and contrasted. We also calculate an intermittency exponent for the averaged daily log returns for the constituent companies of the <Nikkei 225 for 2002.

We further study the distribution of passage times in the Japanese market by extracting exponents from the historical share values quoted on the Nikkei Index. Our approach, which permits a direct analogy with the persistence problem studied in statistical physics, is an extension of recent work carried out on the persistence problem in financial markets.

Kanevski, Mikhail; Timonin, V.; Pozdnoukhov, A.; Maignan, M.

Analysis of interest rate curves clustering using self-organizing maps

Interest rate (IR) curves are fundamental objects for economics and finance. They are extremely important tools in banking and financial risk management. Interest rates depend on time and on maturity which defines term structure of the interest rate curves. IR curves are composed of interest rates at different maturities which move coherently in time: evolutions of different maturities in time can not be considered independently. The present study deals with the analysis of interest rate curves clustering. The main idea is to consider IR curves as objects evolving in time and to study the similarity and dissimilarity between these them. Detection of finite number of clusters will help to reveal typical patterns and their relationships with market conditions. In the present study Self-Organising Kohonen Maps - SOM, are used in order to analyse and to model clustering structure of IR curves. SOM belong to the well known unsupervised nonlinear machine learning algorithms used to detect clusters in high dimensional data. Real case study is based on the analysis and modelling of Swiss franc interest rates. Daily data during several consecutive years are studied. Curves are considered as objects embedded into 13th dimensional space, coordinates of which correspond to the number of maturities. Temporal

dimension (date) of IR data was not directly taken into account. Moreover, a priori it is not known how many clusters can be detected. Comprehensive analysis was carried out considering different number of potential clusters. Structures of clusters, their properties and relationships between them are examined in details. For the completeness of the research the SOM analysis was performed also on: 1) temporal increments of interest rates and 2) in a feature space characterized by a well known 3 factors (level, slope, and curvature) Nelson-Siegel model. Interesting findings deal with the observation of several typical behaviours (clusters) of IR curves and their clustering in time according to different market conditions: low rates, high rates, and periods of transition between the two. Such analysis is an important nonlinear exploratory tool and can help in prediction of interest rates curves.

Kenett, Dror; Shapira, Yoash; Jacob, Eshel Ben

The stock market as a complex adaptive system with self-reference - The functional role of the index

Investigation of the market dynamics within the framework of Complex Adaptive Systems (CAS) is a promising new approach that might lead to important practical implications in several areas (e.g. in earnings expectations game and risk management). The hall mark of CAS is that new system level features emerge from the interactions of constituents which in turn are regulated by top-down feedback mechanisms. According to this approach the processes and dynamics of the stock market can not be understood and predicted based on the analyses of individual stocks. Instead one has to devise methods to analyze the stock market as a whole and to decipher top-down feedback mechanisms (downward causations). Motivated by the above we devised a new system level analysis of the stock market in terms of the correlations between the changes in the daily adjusted closing prices of the individual stocks and between the stocks and the index. We analyzed over

a time period of about 7 years the New York Stock Exchange (NYSE) as a representative of mature (old), large market, and the Tel Aviv Stock Exchange (TASE) as a representative of a small young market. For the NYSE, we used two indices, the S&P500 (Standard & Poor) and the DJIA (Dow Jones). For the Tel Aviv market we used TA25 and the general index. Our analysis revealed hidden dynamical motifs of the stock market and special functional role of the index as a top-down feedback mechanism: 1. For both markets we observed the existence of bursting events - time windows marked by higher correlations. 2. Studying the correlation matrices by clustering algorithms, we found the existence of functional subgroups (clusters) of stocks (that are related but not identical to the sector partitioning) with high mutual correlations in the NYSE, but not in the TASE. 3. Analysis of the standard deviations (STD) of the correlations revealed that, for the NYSE, the correlations bursting events corresponded to maxima in the STD but not for the TASE. We propose that this phenomenon is related to the existence of stock clusters in the NYSE. 4. We found that the observed correlations between stocks are largely due the strong correlation of each individual stock with the index which is indicative of the functional role of the index as an external driving force and as an important feedback mechanism. 5. The index has a stronger effect on the ungrouped stocks (those that do not belong to functional clusters) relative to the clustered ones and on the TASE relative to the NYSE. It might imply that the clustered stocks have stronger functional relations which make them less sensitive to the index effect. Our findings suggest that: 1. the functional role of the index should be included in market analyses. 2. The functionally clustered stocks and the ungrouped ones are subject to somewhat different dynamical motifs, hence different analyses methods and investment strategies should be applied to each case. 3. For similar reasons, different methods and strategies should be applied to small and young markets.

Kim, Kyungsik

Dynamical analysis of two-phase phenomena in financial markets

We investigate the dynamical analysis of two-phase behavior in Korean exchange market. In order to discuss two-phase phenomena for the heavy tailed behavior of the distribution of returns, we examine the real data such as KTB futures with the shuffled and the Brownian processes. In addition, we show whether the volatility clustering plays a key role in the equilibrium and non-equilibrium states of financial markets. It is obtained that the two-phase behavior is basically resulted from the heavy-tailed behavior of the distribution of returns. The importance of inverse statistics from two-phase behavior can be also confirmed numerically via the simulation. Particularly, we find the probability distribution of the first passage time that follows either a powerlaw distribution or a distribution having an optimal value, and our result is compared to other calculated findings.

Kryssanov, Victor V.; Ogawa, H.; Buryakov, I.

How the diffusion of money may direct the distribution of income

In the presented study, an attempt was made to explain the mechanism of income distribution, using the metaphor of the physical diffusion process. The corresponding generating mechanism is defined in terms of the real GDP, the average price level, and uniformity characteristics of the economy. The standard exponential distribution is derived as the model of income distribution in the simplest case, and it is shown how this model can be extended to accommodate to the realities of income analysis. A pilot study of the application of the proposed modeling framework to the JTA tax return data for 1970-2001 is described, and its results are briefly discussed. Finally, some conclusions are drawn at the paper's end.

Lam, Kai P.

Characterizing jumps using MEM and titration for chaotic patterns

Recent research in financial econometrics (Barndorff-Nielsen & Shephard, 2005) has made significant stride in clarifying the intimate relationship between two important latent processes, namely, volatility and jump diffusion. While various issues concerning volatility have been extensively investigated, the characterization of jumps is still in its infancy and can be interpreted under different perspectives. This includes qualitative study of news impact as reported by Barndorff-Nielsen & Shephard, central bank intervention on exchange rate (Beine et al, 2006), and quantitative analysis of jump statistics (Huang, 2004), amongst others. We consider two new perspectives in characterizing jumps. The first perspective focuses on the idea of conditional jump QV (Quadratic Variation) prediction, based on the framework of MEM (Multiplicative Error Model) (Engle & Gallo, 2006) with a nonnegative input of realized jump QV (which is the difference between realized variance and multi-power variation). A comparison between conditional jump and realized jump is then made, by investigating the nonlinearities embedded in each process. Inspired by the work of titration for chaotic patterns (Poon and Barahona, 2001), our second perspective provides details on the nonlinearities associated with conditional and realized jumps using a litmus test on their respective strength against random noise process. Some empirical studies were performed using a high-frequency data set of S&P 500 from October 3, 2005 to September 29, 2006, covering a period of 247 days regularly-sampled at 10 minutes intervals during each trading day. In particular, the realized and conditional jumps obtained from realized variance, bi-power variation, and quad-power variation were evaluated with respect to the presence of chaotic patterns under the titration metric.

Li, Sai-Ping ; Tseng, Jie-Jun; Lin, Chih-

Hao; Lin, Chih-Ting; Wang, Sun-Chong

Statistical properties of agent-based models in markets with continuous double auction mechanism

Real world markets display power law features in variables such as price fluctuations in stocks. To further understand market behavior, we have set up a web-based prediction market platform (TAIPEX) which allows us to reconstruct transaction networks among traders. From these networks, we are able to record the degree of a trader (the number of links of a trader to other traders), the size of a community of traders (who have similar trading behavior), the transaction time interval among traders and other variables that are of interest. The distributions of all these variables show power law behavior. On the other hand, agent-based models have been proposed to study properties of real financial markets. We here study the statistical properties of these agent-based models and compare them with data from real world markets as well as from our recent web-based prediction market platform. Three agent-based models are studied, namely, zero-intelligence (ZI), zero-intelligence plus (ZIP) and Gjerstad-Dickhaut (GD). Computer simulations of variables based on these three agent-based models were carried out. By comparing with real market data, we found that although being the most naive agentbased model, ZI indeed best describes the above mentioned properties in real markets. A feature which distinguishes ZI from the two other agent-based models is that while the market values of the stocks in these models all tend to converge to an equilibrium value, large fluctuations are observed in ZI. Analysis of the power law behavior in these models was also carried out. Our study suggests that the basic ingredient to produce the observed properties from real world markets could in fact be the result of a continuously evolving dynamical system with basic features similar to the ZI model.

Lin, Lin

An agent-based general equilibrium model of employment, production and consumption

In this paper, an agent-based general equilibrium model of employment, production and consumption will be introduced, the model is an extended work based on Ian Wright's design in his paper "The Social Architecture of Capitalism" (*Physica A* 346 (2005) 589-620). The game rules have been simplified, modified and restructured, which result in qualitatively changes in simulation outcomes, and it also largely enhanced the model's capacity in explaining the empirical distributions. The model's code is written with MatLab and C++, an outstanding performance of the model is that once the simulation starts, it quickly converges to equilibrium with statistical properties that are in agreement with many empirical distributions of developed capitalistic countries, including the lognormal firm size distribution (instead of power law), the Gaussian GDP growth distribution (instead of Laplace), the Gaussian firm demise distribution (instead of lognormal), the exponential duration of recession distribution, the Gaussian wage-profit share distribution, the lognormal-pareto income distribution and etc. Normally these distributions are studied in an isolated manner, while the aim of this paper is to introduce an enhanced agent-based model, which not only unifies all these empirical distributions into a causal framework, but also exhibits more robust simulation results in accordance with empirical findings.

Manganote, Edmilson, J.T.; Ballini; Rosangela

Stock price collective behavior in an emerging market

Complex systems consist of a large number of interacting elements, giving rise to the emergence of organization without any external organizing principle being applied. Consequently, decomposing the system and studying its subparts in isolation does not con-

tribute to our understanding of how it works. Fortunately, complex systems can be described, analyzed, and modeled using complex networks. To understand the structure of interactions among the elements in a financial market, physicists primarily focus on the spectral properties of the correlation matrix of stock price movements. Financial markets can be considered as complex systems having many interacting elements and exhibiting large fluctuations in their associated observable properties, such as stock price or market index. The state of the market is governed by interactions among its components, which can be either traders or stocks. In addition, market activity is also influenced significantly by the arrival of external information. Statistical properties of stock price fluctuations and correlations between price movements of different stocks have been analyzed by physicists in order to understand and model financial market dynamics. To investigate the universality of the structure of interactions in different markets, we analyze the cross-correlation matrix of stock price fluctuations in the Stock Exchange of Sao Paulo (BOVESPA), Brazil. We find that this emerging market exhibits strong correlations in the movement of stock prices compared to developed markets, such as the New York Stock Exchange (NYSE). This is due to the dominant influence of a common market mode on the stock prices. By comparison, interactions between related stocks, e.g., those belonging to the same business sector, are much weaker. This lack of distinct sector identity in emerging markets is explicitly shown by reconstructing the network of mutually interacting stocks. Spectral analysis of cross-correlation matrix for BOVESPA reveals that, the few largest Eigen values deviate from the bulk of the spectrum predicted by random matrix theory, but they are far fewer in number compared to, e.g., NYSE. This behavior is due to the relative weakness of intrasector interactions between stocks, compared to the market mode, by modeling stock price dynamics with a two-factor model. These results suggest that the emergence of an internal structure comprising multiple groups of strongly

coupled components is a signature of market development.

Mimkes, Juergen

Differential forms: A new tool in economics from biological models to econophysics

Investors would like to calculate profits in advance, *ex ante*, like the path of a flying ball. But income can only be given *ex post*, after the money is earned. The properties *ex ante* and *ex post* have never been investigated in economic theory by a mathematical tool. According to this paper the tool is given by exact and not exact differential forms. Integrals of inexact forms depend on the path of integration and may only be given *ex post*, when the path of integration is known. The equivalence of monetary and production cycles leads to closed integrals of differential forms and a first and second law of economics, that deviates in many aspects from neo-classical theory. The most important result is entropy as the new production function, which enters production, trade, growth, optimization. Differential forms move economics close to thermodynamics and statistics. This new approach is called econophysics.

Milaković, Mishael; Alfarano, Simone

The empirical distribution of firm profit rates

The classical notion of competition rests on the idea that entrepreneurs will allocate their capital into the most profitable sector or business activity, utilizing the average rate of profit as a benchmark in their investment decision. We propose a statistical equilibrium model in the spirit of Foley (1994) that interprets the tendency for competition to equalize profit rates as a dispersion measure around an average profit rate. The model predicts an exponential power (a.k.a. Subbotin) distribution of firms' profit rates. We investigate the profit rate distribution among more than a

dozen diverse US business sectors, and find that profit rates have a clearly non-Gaussian distribution, mostly speaking in favor of the so-called Laplace distribution. The Laplace distribution is a particular case of the more general Subbotin distribution, having previously been observed in firm growth rates as well.

Mizuno, Takayuki ; Watanabe, Tsutomu

Analysis of high-resolution product prices in an online shopping mall

Recently, huge point-of-sale (POS) databases containing detailed records of all customer purchases in many stores have been attracted the attention of both physicists and economists. In this conference, we will show statistical laws of high-resolution product prices in an online shopping mall. "Kakaku.com" is the famous online shopping mall in Japan. There are about 1,500 electronics retail stores. About 12 million persons come to the shopping mall in one month. Kakaku.com always ranks the stores from the best price to the worst price for each product. As a result, many stores are engaged in a price war. We investigate a time series graph of average prices of a LCD television in all stores. We can observe a fractal property of the prices in the time axis. The Hurst exponent of the price is 0.5, and the auto-correlation function for the price change decays very quickly. Therefore, the statistics of product price changes is close to random walk. However, volatility of the product price has a long memory. These statistical laws can be also observed in financial markets. In this conference, we show statistical similarities between a product price in competitive online markets and a stock price in financial markets.

Morales, Leonardo; Lux, Thomas

Forecasting Volatility under Fractality, Regime-Switching, Long Memory and Student-t Innovations

In this paper we examine the performan-

ce of volatility models that incorporate features such as long (short) memory, regime-switching and multifractality along with two competing distributional assumptions of the error component, i.e. Normal vs. Student-t. Our precise contribution is twofold. First, we introduce a new model to the family of Markov-Switching Multifractal models of asset returns (MSM), namely, the Markov-Switching Multifractal model of asset returns with Student-t innovations (MSM-t). Second, we perform a comprehensive panel forecasting analysis of the MSM models as well as other competing volatility models (GARCH, GARCH-t, FIGARCH and FIGARCH-t). Our cross-sections consist of all-share equity portfolios, bond indices and portfolios of listed real estate at the country level. Furthermore we investigate whether there is an improvement upon singular forecasts when optimally combining forecasts obtained from the different models at hand. To preview our results we find that: (i) MLE and GMM estimation are both suitable for estimating the MSM-t models, (ii) introducing Student-t innovations to capture *fat tails* may not conclusively improve forecasting accuracy in a Monte Carlo set up, (iii) empirical panel forecasts of MSM-t models show an improvement over those of (FI)GARCH and MSM models at longer horizons and (iv) forecast combinations obtained from MSM and (FI)GARCH models appear to provide some improvement upon singular forecasts.

Oh, Gabjin ; Eom, Cheoljun; Kim, Seung-hwan

Grouping property of complex network in financial markets

We investigate the grouping coefficients of industry sectors in the complex network based on stock data for US and Korean stock markets. The complex networks are constructed by the minimal spanning tree (MST). We proposed a novel approach based on the shortest path length (SPL) between stocks to quantify the grouping property of industry sectors. We find that the grouping coefficient for the US have a higher value than those of the Korean stock market. We also find that the grouping

coefficients calculated based on the correlation matrix, which filtered the random and largest eigenvalue parts by the random matrix theory, have a higher value than those of the original network. In particular, for the Korean stock market the conglomerates, which have the companies belonging to diverse industry sectors, have a significant grouping coefficient.

Onozaki, Tamotsu ; Yanagita, Tatsuo

A model of market structure dynamics with boundedly rational agents

A market economy is a typical complex adaptive system which consists of a large number of adaptive agents involved in parallel local interactions. These microlevel local interactions give rise to a certain macrolevel spontaneous order, and then, the macro-order plays the role of binding conditions for micro-behavior. Complex dynamical behavior emerges as a consequence of recurrent causal chains among individual behavior and the macro-order. In the present paper, we formulate a goods market as a complex adaptive system consisting of locally interacting, boundedly rational agents, i.e., firms and consumers. We posit market share distribution as the macro-order of a market economy, and a special attention is paid on the market share dynamics. At each time period, consumer has a given amount of income and determines from which firm to purchase goods, and then spends all his income so as to purchase as much as he can do. We employ the statistical description of consumer's behavior: The Boltzmann distribution is used to represent firm's share distribution of consumer, which is characterized by 'temperature' in physical systems describing how greedily consumer pursues higher utility. Such consumer's greediness is one of the important parameters controlling consumer's behavior. On the other hand, firm does not know the shape of demand function it faces, so that it revises production and price so as to raise its profit with the aid of reinforcement learning algorithm, i.e., by learning through its experiences. We

mainly focus on the dynamical phases which emerge as consumer's greediness changes. Numerical simulations show that, depending on consumer's greediness, there appears three typical phases, i.e., stationary equi-share co-existence phase, marketshare battle oligopoly phase, and changing monopoly phase. It is also shown that, in an oligopolistic and monopolistic phases, the distribution of market share exhibits a long-tail and it follows Zipf's Law. It is also shown that the size of a firm and its growth rate are independent in the same situation (Gibrat's Law). Furthermore, it is shown that there is an optimal greediness at which each consumer maximizes his time-averaged utility.

Ormerod, Paul ; Bentley, Alex; Batty, Michael

Evolution and turnover in scaling systems

Scaling has been discovered in the long tails of size distributions characterizing a variety of diverse systems, many of which evolve in terms of the size of their components through competition. Such time-invariant macro distributions, however, often obscure the micro-dynamics of change, such as continual turnover in the rank order of the constituents. Here we show how a model drawn from evolutionary theory can explain this change, such that the time spent in the top ranked constituents is finite and also characterized by longtailed distributions. To show the broad applicability of this model, we compare typical model runs to real-world examples including US boys' names, UK Number One for pop albums, journal article keywords, and city sizes.

Oświęcimka, Paweł; Drożdż, Stanisław; Kwapien, Jarosław; Rak, Rafał

Empirics of financial multifractality

The financial dynamics is a multiscale phenomenon and therefore the question which of its properties are scale invariant and which

are scale characteristic refers to the essence of this phenomenon. There exists strong evidence that at least a large portion of the financial dynamics is governed by phenomena analogous to criticality in the statistical physics sense. Multifractality constitutes the most significant related financial stylized fact. Multifractal Detrended Fluctuation Analysis (MF-DFA) method provides the most practical and reliable framework to quantify such characteristics.

In the present contribution, based on a properly adopted variant of MF-DFA, using the time series representing the price changes and the inter-transaction time intervals on various financial markets as well as several types of artificially generated series, we provide arguments demonstrating that the financial multifractality originates exclusively from the long-range nonlinear temporal correlations. Contrary to the frequent claims the leptokurtic tails in the return distributions do not contribute to the width of the multifractal spectrum since in the real markets they are Levy unstable. This is an effect analogous to the Central Limit Theorem and can be seen only for sufficiently long time series.

We also show that not all of the financial series develop multifractal scaling. For instance, price changes of the smaller stock market companies are typically associated with fluctuations that do not respect a correspondingly consistent hierarchical organization. This however can be considered an encouraging observation because it provides further arguments in favor of the multifractal spectrum as a highly informative measure of correlations.

Pietronero, Luciano

Minimal agent based model for the origin and self-organization of financial markets

We introduce a minimal Agent Based Model which includes the following elements (first considered by Lux and Marchesi):

- Fundamentalists (F: stabilizing tendency)
- Chartists (C: destabilizing tendency)
- Herding effect (tendency to follow the others)
- Price behavior (analysis of the price time series according to F or C criteria)

The novelty of our model is a substantial simplification and corresponding reduction of the number of parameters. This leads to a detailed understanding of the origin of the Stylized Facts (SF) like the fat tails and volatility clustering. The SF are shown to correspond to finite size effects (with respect to time and to the number of agents N) which, however, can be active at different time scales. This implies that universality cannot be expected in describing these properties in terms of effective critical exponents.

A basic question is then the self-organization: why the system chooses to stay in this narrow range of parameters corresponding also to a finite value of N ?

We show that the introduction of a threshold in the agents' action (small price fluctuations lead to no action) triggers the self-organization towards the quasi-critical state and to a finite average value of N (which depends on the other parameters). Non stationarity in the number of active agents and in their action plays a fundamental role. The interpretation of N as the number of effective independent agents is non trivial and deserves further studies. The model can be easily generalized to more realistic variants in a systematic way.

Pozzi, Francesco ; Di Matteo, T.; Aste, T.

The use of dynamical networks to detect the hierarchical organization of financial market sectors

In this talk, we will show results concerning dynamical filtered correlated networks, in particular Minimum Spanning Trees (MSTs) and Planar Maximally Filte-

red Graphs (PMFGs) generated dynamically from correlations computed over a moving window of sizes between 1 and 12 months for daily time series of 300 most capitalized NY-SE stocks in the time period from 2001 to 2003. Both hierarchical and topological properties of these graphs are studied in relation to markets fluctuations. The dynamical PMFG preserves the same hierarchical structure as the dynamical MST, providing also a more significant and richer structure, a stronger robustness and dynamical stability in the long range. The computation and analysis of different quantities such as Degree, Betweenness, Eccentricity and Closeness give indication on the topological position of each stock in these graphs providing a clear differentiation of stocks in terms of centrality and peripherality. In particular we find stocks well connected and central; stocks well connected but at the same time peripheral; stocks poorly connected but central; stocks poorly connected and peripheral. The Financial Sector plays a central role in the entire system whereas the other sectors are sharing the peripheral regions. The robustness, stability and persistence of these results are also checked by changing the time window, by performing the computations on different time periods and confirmed by a principal component analysis. We will discuss these results and the economic meaning of this hierarchical positioning.

Raddant, Matthias; Alfarano, Simone; Milaković, Mishael

Hierarchical networks effects in a financial herding model

One reason for the popularity of herding models is that one can generate time-series that have statistical properties similar to those of financial market returns. This feature unfortunately vanishes once the number of agents in such a model is increased. This problem is known as N -dependence. The hierarchical network model we propose overcomes this effect. We divide the total population of agents into two groups of which the First group

forms a fully connected core which undergoes an opinion formation process, similar to the herding model of Kirman. The rest of the population, so-called followers, are each linked to only one of the core agents and have an indirect influence on the opinion formation of the core. This setup is supposed to mimic a hierarchical network in a financial market, where a relatively small number of core-agents are acting on behalf of a much greater number of followers. We assume that if a member of the core of this network changes his opinion about the state of the world, the contagious effects onto other core agents will depend on his weight, measured by the number of his followers. In this model we analyze the effects of differently distributed followers onto the volatility of the system-wide opinion formation process.

Ribeiro, Maria de Fatima Fabiao

Dynamical system of Solow model and the the Hamiltonian systems theory

The objective of the paper is to develop an Hamiltonian system for the Dynamical System of Solow Model, DSSM, that will exhibit some important properties in growth models. In fact, the system obtained can be considered of as an Hamiltonian system with a perturbation term. Contrary to Solow's original result, saving not only determines the accumulation but also plays a crucial role in the stability analysis of the model. The three economic elements α , s and δ are the key elements in the bifurcation analysis. These results depend on the assumption that the two growth rates (technological progress and labour) must reflect on the accumulation of some kind of knowledge.

Rosvall, Martin

Cartography in a complex world: from interactions to maps

Economic and social systems are differentiated, multipartite, integrated, and dynamic.

Data about these systems, now available on unprecedented scales, often are schematized as networks. Such abstractions are powerful, but even as abstractions they remain highly complex. It therefore is helpful to decompose the myriad nodes and links into modules that represent the network. A cogent representation will retain the important information about the network and reflect the fact that interactions between the elements in complex systems are weighted, directional, interdependent, and conductive. Good representations both simplify and highlight the underlying structures and the relationships that they depict; they are maps.

We present a new conceptual framework for turning large and sometimes messy networks into powerful, useful maps by tracing information or monetary flow on the network. By adopting an information-theoretic approach, we can measure how efficiently a map represents the underlying patterns of flow on a weighted and directed network. We can measure how well the map compresses the structure of the full network. And we can measure how much detail is lost in the process of simplification. As a result, we are able to formalize and quantify the millenium-old tradeoff that cartographers face between detail and simplicity.

Ruiz Trujillo, Jorge Enrique

Market Efficiency and entropy of foreign exchange markets and stock markets

In this work we apply two different methods to estimate the relative entropy of foreign exchange markets and stock markets. The first method estimates the Shannon entropy using the volatility probability distribution obtained from the solution of the Fokker-Planck equation of the Heston model corresponding to the financial information in each case [1]. The second method is the method of approximate entropy proposed by Pincus et al [2]. The results were compared with standard measures of weak efficiency such as the Geary test and the autocorrelation function. The re-

lative entropy is used as a measure of stability and maturity of financial markets from financial information of some emerging markets (Colombia, Argentina) and some more mature markets (Brazil, Germany and United States). This work gives new information based on more fundamental methods to compare financial markets [3] in contrast with the traditional random and independence criteria used to measure efficiency and stability. This work gives a comparative approach between traditional methods and methods from statistical physics and information theory to analyze financial time series that may give new valuable and useful information of the financial markets dynamics.

Samimi, Ahmad Jafari

Econophysics & developing countries

Econophysics is an interdisciplinary concept which have both pros and cons . The concept has been mostly debated since the last decade of the 20th century in developed countries and still there is disagreement among these economists .On the contrary, it is interesting to see that in developing world the concept is relatively new and therefore there is little discussion whatsoever in this regard.

The purpose of this paper is to find out more about the knowledge of economists in developing countries on Econophysics and then try to evaluate their views on this matter. I have used a sample of economists from both private and public universities in Iran as a case of recently tremendous progressed developing countries in scientific output. The preliminary results indicate very limited knowledge on Econophysics among economists in this country and those with knowledge in this regard can be divided in two distinct groups namely pros & cons. Almost all Quantitative economists are in favor of Econophysics and some including myself believe that without physics and mathematics economics could not have been achieved its today's credit. I am now sure that Keynes General theory is borrowed from Einstein's General Theory of Relativi-

ty and logical economists should accept it. However, those who oppose Econophysics are economists who are not familiar with the advantage of statistical mechanic and mathematical tools in economics and think economics as a purely descriptive science.

Sano, Yukie ; Yamada, Kenta ; Watanabe, Kota; Mizuno, Takayuki; Takayasu, Hideki; Takayasu, Misako

Statistical properties of number fluctuations observed in internet blog keywords

Human activity of word-of-mouth may be very important for our societies, however, it was impossible to observe its historical record quantitatively. The Internet has changed the situation drastically. Instead of vocal information exchange, people use textual information in blogs. By using the search-engine technology we can observe appearance of any given keyword in blogs automatically with detail time stamps. It is a new scientific activity to explore empirical laws in the number fluctuation of blog keywords and to clarify its impact to the society. In order to establish empirical statistical laws from time sequential data in general, it is required that the data is stationary. However, in the case of blog keywords there are a few inevitable non-stationary factors which make the analysis difficult. For example, the number of blog sites tends to increase nearly monotonically, so the average number of keywords may grow. Or some blog servers suddenly stop working due to maintenance or hardware replacement, which may cause sudden decrease of word frequency for a while. Moreover, there is always a calendar effect such that keyword numbers increase on holidays. It is important to introduce a procedure of normalization which can evaluate the keyword frequency independent of such non-stationary factors. To this end we calculate daily summation of frequencies for randomly chosen N sample adverbial words such as *more*. Then, by dividing the number of keyword frequency by this summation we get a time sequence of normalized word

frequency. It is confirmed that the normalized time sequence successfully removes the above non-stationary factors. Applying this method we find that any resulting normalized time sequence does not follow an independent Poisson process, instead the keyword frequency shows a long autocorrelation characterized by so-called the $1/f$ noise for those keywords which appear frequently everyday, such as *TOYOTA*. There are keywords which clearly show sharp boom such as *Christmas* which apparently tends to diverge on December 25th. For such a case we can approximate the functional form of increase before the critical day by a power law in terms of the difference of the observing day and the critical day. Also the decay form after the critical day can also be modeled nicely by a power law.

Sella, Lisa; Gianna, Vivaldo

Economic cycles: some empirical evidence from spectral and time-domain analysis of GDP time series

The present paper deals with one of the most controversial topics in macroeconomics: aggregate fluctuations. Since the first systematic time series analysis on France, England and U.S. datasets ((Juglar, 1862)), it has been hypothesized a recurrent behavior of the economic crises, with strong interdependence between boom and recession phases. From then on different schools of economic thought have taken part to the debate on the nature and causes of economic fluctuations, each one putting forward its own interpretations and models about the fundamental mechanisms and characteristics of such phenomena ((Arnold, 2002)). However, this issue has not been finally resolved yet, in particular concerning the exogenous or endogenous nature of economic fluctuations ((Slutsky, 1927); (Frisch, 1933);(Kaldor, 1940); (Hicks, 1950); (Goodwin, 1967); (Kydland & Prescott, 1982); (Long & Plosser, 1983); (King & Rebelo, 2000); (Chiarella, Flaschel, & Franke, 2005)). During the last twenty years the

debate has been enriched by the diffusion of complexity studies in economics: economic systems are increasingly thought of as complex adaptive dynamic systems ((Arthur, Durlauf, & Lane, 1997)), with the consequent spreading of new techniques and modeling tools. In this framework, (Hallegatte, Ghil, Dumas, & Hourcade, 2007) propose a non-equilibrium dynamic model (NEDyM) which introduces investment dynamics with adjustment delays and non-equilibrium effects into a neoclassical Solow growth model. Simulations on NEDyM show model dynamics exhibiting Keynesian features in response to exogenous shocks, thus producing endogenous business cycles with some recurrent periodicities. Our inquiry on some OECD countries is based on a double empirical analysis on both the time and frequency domain to recover the main cyclical characteristic of GDP time series in the last years. Our aim is to adopt spectral estimation and reconstruction techniques jointly with standard econometric tools in order to strengthen and enrich the results coming from the more customary time-domain analysis. More in details, recent spectral techniques such as Singular Spectrum Analysis (SSA), Maximum Entropy Method (MEM), Multi-Taper Method (MTM) allow to decompose noisy and short nonlinear time series, like the GDP profile, into their main spectral components (trend, periodic, and quasi-periodic cycles). This is remarkable, since from a statistical point of view such oscillations describe the most total variance of the series and can be significantly distinguished from the background noise ((Ghil, et al., 2002)). This methodological framework is not so widespread in mainstream economics, but its peculiarities are particularly attractive to shed light on some controversial issues such as trend-cycles separation, fundamental cycles extraction, lead-lags relations, seasonal variability, sectorial contribution to growth, denoising, and so on. Then, our aim is to adopt these empirical tools to find some econometric validation of the dynamics observed in NEDyM: this would be particularly relevant to strengthen the model results and clarify some fundamental mechanisms determining the

modern economic fluctuations.

Stamataki, Stella ; Smyrnakis, Titos

Physics and banking

The statistical physicists observed that the behavior of a macroscopic system, which is composed of a great number of microscopic particles, obeys certain laws which concern mostly random exchange energy phenomena and these laws established the field of Quantum Mechanics and Thermodynamics. Quantum atomic models and kinetic theory of gases prove suitable for studying dynamic structures such as a bank's balance-sheet. The bank is considered to be a complex economical system which is segmented by different units, whereas it interacts with the economic environment and thus, it can be studied according to the complex networks methodology. This means that the macroscopic balance sheet's behavior emerges from the microscopic units interactions. The return which derives from the changes of the bank's economic value is approached through the ideal gas model. The future business and interest rate scenarios comprise the possible states of the system and the return distribution corresponds to the energy distribution of the gas. The entropy increases until the immunization state where economic value tends to remain stable. However, due to duration drift of products, the economic value changes rapidly and the changes occurring in the structure of the balance sheet are offset with various business strategies in ALM, which correspond to the new structures of internal entropy production in the case of the gas. The application of Fair Value (FV) according to the IAS offers dynamism to the financial states of the bank which depicts its special characteristics, the market conditions and the customers' options. The FV may be compared to the dual nature of light as it provides a dual substance of a financial instrument's value (it includes the return and the undertaking risk in a single number). The FV is produced as the terms return and risk reproduce one another, just like the electromagnetic wa-

ve in Maxwell's theory. The fair value which is produced by the product's transition from one time bucket to another defines the possible position and quantizes the risk, just as a similar process occurs with the wave length λ of the emitted radiation due to Bohr's quantized energy. The electromagnetic spectrum which includes the analysis of radiation may be used for the scaling of each product's risk, in correspondence with the risk rating that is used by rating agents. The idea of risk quantization could be used for the achievement of balance-sheet immunization against the market's fluctuations.

Tseng, Jie-Jun ; Li, S.P.; Wang, S.C.

Experimental evidence for the interplay between individual wealth and transaction network

It has been widely observed that the distribution of wealth among individuals in an economy follows a remarkably simple pattern, namely, a 'Pareto'-tail (power-law tail) for large wealth and a lognormal or Gamma distribution for the bulk. Many attempts have been made to model the dynamics of wealth accumulation as an exchange process and some of the models succeed in explaining the exponent of the power-law tail. Nevertheless, there appears a major issue in these proposed exchange models where they introduce the concept of transaction networks for describing the interactions between each agent in a given economy without further knowledge regarding these networks. Therefore, we implement an experimental market with human agents in order to learn the structure of the transaction networks and to study the dynamics of wealth accumulation. The market experiment was conducted on the platform TAIPEX from Dec. 2007 to Mar. 2008, recording 16,936 entries of transaction from the 39,209 entries of order submitted by 2,095 effective traders during the experimental period. The resulting transaction network consists of 1,985 nodes and 9,092 links. In a previous work, we have demonstrated that the transaction networks exhibited a scale-free

and hierarchical structure though the relation between individual wealth and degrees in the transaction network was less clear due to limited statistics. With the latest results of higher statistics, the former conclusions regarding the structure of transaction networks are confirmed again. Furthermore, the networks reconstructed from arbitrary sections of the whole time horizon are observed to share similar topology. The most important finding is that the relation between individual wealth and degrees is revealed this time, allowing the exponent of the power-law tail in the wealth distribution to be related to that of the degree distribution of transaction network.

Ueno, Hiromichi ; Watanabe, Tsutomu; Takayasua, Misako

Statistical properties of relation between sales and prices in retail

We analyze a huge amount of retail sales data. It is consisted of about 1.2 million kinds of items sold in about 300 supermarkets in Japan for the period of 1988-2005. The time stamp is daily and the numbers of sold items in each supermarket are recorded with prices. In the field of marketing science Tellis analyzed about 350 kinds of items on the relation between sales numbers and prices. Here, we follow the similar analysis for the whole 1.2 million kinds of items. In order to evaluate the relation between sales and prices quantitatively, we observe the price elasticity. The price elasticity is defined as $e \equiv -\frac{ds/s}{dp/p}$, where s and p denote sales numbers and prices, respectively, and ds and dp represent the increase of sales numbers when the price is changed to $p+dp$. For most cases the value of e can be estimated independent of the value of p , that means, s and p satisfies an inverse power law. It is confirmed that the values of elasticity take similar values for those items in the same category such as instant noodles. There is a tendency for foods that the price elasticity of short life items is generally smaller than those of long life items. This is a natural consequence that long life foods can be stored, so that more sales are expected

than short life items which go bad easily. This is true for both store-side and customer-side. This is just one example of our analysis and more detail results will be presented in my talk.

Vahabi, Mahsa ; Jafari, G.R.

Investigation of privatization by level crossing approach

Recently, the political and economic policy of privatization, generally defined as the transfer of property or responsibility from public sector to private sector, is a matter of interest in many countries. Following a successful privatization program, profitability, efficiency, output, investment etc. increases. Progress in privatization is correlated with improvements in perceived political and investment risk. Many emerging countries have gradually reduced their political risks during the course of sustained privatization. Privatization is associated with improvements in the firm's financial and operating performance. Alternative benefits of privatization are improved risk sharing and increased liquidity and activity of the market. One of the main methods to develop privatization is entering a new stock to the markets for arising competition. However, capability of the markets to accept a new stock should be considered. Without paying attention to this statement, it can lead to reducing the market's efficiency. Based on complexity theory, we study the effects of stage of development, activity, risk and investment horizons on privatization.

Wagner, Friedrich; Alfarano, S.; Milaković, M.

Differences in the SV decomposition of noise factors for indices and individual stocks

The returns of stocks can be described by a volatility factor times an iid noise with zero mean in order to account for the absence of correlations in raw returns. Often the noise

is assumed to be Gaussian. To test for the distributional form of the noise factor, we assume a slow dynamic of the volatility factor, as suggested by the correlation of absolute returns, and derive a moment ratio which depends only on the noise but not on the volatility factor. While indices turn out to be compatible with Gaussian noise, individual stocks exhibit significant deviations. We assume that index and individual values differ by the dependence on profits of the latter, motivated by recent evidence on the Laplace distribution of firm profit rates. Under the assumption of Gaussian noise, index returns are well described by a Student t-distribution of the volatility factor, which is generally not the case for individual stocks. We achieve a good description of individual stock returns by adding a Laplacian part to the noise, which presumably accounts for the profit dependence. In one example, this addition increases the χ^2 probability from an unacceptable value of 10^{-23} to a reasonable value of 0.5.

Watanabe, Hayafumi ; Takayasu, Hideki; Takayasu, Misako

Renormalization of random multiplicative processes and statistics of business-firm growth

We introduce a simple mathematical model to explain the distribution of business-firm size and growth rates. We assume that the company consists of N independent sections whose time evolutions are given by the following set of equations:

$$\left\{ \begin{array}{l} x_1(t+1) = b_1(t)x_1(t) + f_1(t) \\ x_2(t+1) = b_2(t)x_2(t) + f_2(t) \\ \vdots \\ x_N(t+1) = b_N(t)x_N(t) + f_N(t) \end{array} \right.$$

where $x_i(t)$ and $x_i(t+1)$ are sales of the i -th section in the year and $t+1$, $b_i(t) \geq 0$ is the growth rate of this section, and $f_i(t)$ is an independent noise. Here, $b_i(t)$ and $f_i(t)$ are random variables characterized by given distributions. The whole sales of this firm, growth rate of the whole firm and the noise term

for the whole firm is defined as

$$\begin{aligned} X_n(t) &\equiv \sum_{k=1}^N x_k(t), \\ B_N(t) &\equiv \sum_{k=1}^N b_k(t)x_k(t)/X_N(t), \\ F_N &\equiv \sum_{k=1}^N f_k(t), \end{aligned}$$

which satisfy the following renormalized time evolution for the whole firm statistics:

$$X_N(t+1) = B_N(t)X_N(t) + F_N(t).$$

Our numerical and theoretical analyses derived many universal behaviors in the limit of very large N . The properties of firm growth statistics depend drastically on the conditions, $\langle b_i(t) \rangle \gg 1$, $\langle b_i(t) \rangle \geq 1$ or $\langle b_i(t) \rangle < 1$. In the case of $\langle b_i(t) \rangle \geq 1$ the growth rate distribution converges a Student's T-distribution having power law tails independent of initial conditions. We also introduce renormalization in the time scale.

All results are compared with the real firm data which exhaustively covers practically all firms in Japan, about 1 million firms. It is shown that our simple model captures most basic statistical properties.

Watanabe, Kota; Takayasu, Hideki; Takayasu, Misako

The Effect of Extended trading on emergence and collapse of the financial bubbles

Unlike the foreign exchange markets which are open 24 hours, we have restricted trading time in the stock markets. In the case of NASDAQ, the regular trading session opens at 9:30 AM and closes at 4:00 PM. In addition, traders can also trade in a few hours before and after this regular time. The trading from 8:00 AM to 9:30 AM is called *Pre-market trading* and the trading from 4:00 PM to 6:30 PM is called *After-Hours trading*.

Such transactions are called *Extended Trading*. It is pointed out that such extended trading has less activity, wider spread between bid and ask prices and greater price volatility than regular trading. Here, we show that the price changes in the extended trading is playing a critical role in emergence of the bubbles in the stock markets. Particularly we analyze the high-frequency NASDAQ data including so-called the Internet bubble period which appeared at the end of 20th century. Firstly, we clarify the differences of statistical properties of price changes, shared volumes and the transaction intervals between the regular trading and the extended trading. Secondly, we analyze the relationships among these market characterization quantities for each trading sessions. Then we subdivide the session into shorter time intervals and search more precisely about their contribution to bubbles and crashes. At last we introduce quantitative characterization method of market instability using the market potential force formulation and observe the dependence on the type of trading sessions.

Weidlich, Wolfgang

Dynamics of political opinion formation including catastrophe theory

After Nazism and Communism new forms of totalitarianism fostered by religious fundamentalism have arisen at the turn of the present century. In view of this fact the authors Wolfgang Weidlich and Heide Huebner present a parsimonious quantitative model designed to shed some light on the dynamics of the formation of totalitarian systems. The model is constructed according to the principles of Sociodynamics, that belongs to the broad field of nonlinear dynamic system theory (NDS). It comprises two order parameters and four trend parameters. All of them are socio-politically interpreted. Stationary, stagnant and revolutionary system-phases are exhibited in 6 scenarios. The relation to catastrophe theory is discussed.

Wilhite, Al

Games on Networks

Economic decisions seldom occur in a vacuum. Your decisions affect others, the decisions of others affect you, and the individuals with whom you interact are often the same people. This paper explores how economic decision making is affected by this structure of common acquaintances. We represent these structures, whether they are formal organizations or informal relationships, as networks, and we then study agents playing games on these networks. With repeated play we find that the choices people make are affected by the topology of their network of acquaintances; that is, the pattern by which agents are connected affects their decisions and some of these effects can be generalized

Yamamoto, Ryuichi ; LeBaron, Blake

The impact of order-splitting on long-memory in an order-driven market

We examine how traders' order splitting behavior is related to the long-memory properties in an order-driven market, i.e., long-memories in volume, volatility, and order signs (but yet, the market is informationally efficient in a sense that there is no persistence in returns). We conduct simulations on a simple automated order-splitting, and examine whether and under which conditions we can reproduce those properties with order-splitting. LeBaron and Yamamoto (2007, 2008) show that that investors' imitative behavior is so important for the phenomena. Our order-splitting model does not assume any herding among agents; however, we show that it generated long-memories of order signs and volatility. This implies that imitation would not be the only source for the long-memories. However, order-splitting would matter in our market when agents split orders into so many pieces like 50 without allowing others to enter the market where there are only 100 agents. We conclude that we need to impose such a strict assumption to generate the long-memories with order-

splitting, implying that order-splitting itself would not be the only source for these properties too. We analyze a simple automated system of order splitting with an iceberg type limit order with no imitation. We have 100 agents who are each given 50 units of orders to split. They first determine their forecast and execution prices. This determines whether they are buyers or sellers, and their bid or ask price. For a buyer, if the bid price is larger than the best ask, the agent will execute 1 trade, and drops the block of orders by 1. The agent will continue executing buy orders until the best ask price on the book exceeds the agent's bid price. At this point the agent will submit a limit order for the next unit. The remaining part of the order is entered as an iceberg order at this bid price. It does not show up on the book directly, but when that order is removed, a unit of the iceberg order is moved onto the book. If the buyer's initial bid price is less than the best ask, then 1 unit is entered on the book, and the remaining 49 are entered as iceberg orders. A similar mechanism takes place for sell orders. We assume that other agents cannot enter the market while one agent is executing orders. Once the iceberg order is in place the next agent enters the market. We found that signed order flows are persistent in our system mainly because agents are assumed to keep submitting their orders of the same sign without allowing others to enter the market. Volatility also shows long-memory. Our system implies that agents keep submitting the orders of the same sign unless the best prices cross the requested prices, persistently taking off liquidity. As a result, the book will become sparser, tending to have persistently larger price changes. However, once agents submit large size of iceberg orders without executing any of them, the book suddenly becomes thicker so that the price changes become smaller and such smaller changes will persist. We do not see volume persistence. In our system, we would see volume persistence only when the best price crosses their requested price after many agents execute similar sizes of market orders. However, it is not known when the best prices cross the requested prices and agents stop

submitting market orders. Since there is no persistence on the timing at which the best prices cross the pre-specified price, we would not see long-memory of volume.

Yamamoto, Ryuichi

Trading profitability of technical strategies in individual stocks

This paper examines the profitability and its statistical significance of intraday technical trading across 17 individual stocks listed in The New York Stock Exchange (NYSE). The NYSE Trades and Quotes (TAQ) dataset from April to June in 2002 is used with 5 minutes intervals, and 3807 technical trading rules from filter, moving average, trading range break, and channel breakout are examined. White's (2000) Reality Check bootstrap procedure is applied to the large sets of technical rules, in order to find the profitability and correct the data-snooping problem, which might occur when we find profitable rules due to pure luck. Some of the previous literature shows that the technical rules are not successful for predicting return dynamics in more recent periods. However, most of those papers have focused on daily data, so those results would indicate that the profitable opportunities from technical strategies tend to disappear when investors trade at daily trading horizons. Osler (2003) demonstrates that order clustering in the order book can explain two popular predictions from technical trading analyses (trends tend to be reversed around the round numbers while those tend to be intensified once the rate penetrates the round numbers). Her result implies the presence of predictable variations in return series in ultra high-frequency data. There have been quite few papers analyzing trading profits from technical indicators by using tick-by-tick data. Motivated by that, this paper utilizes high frequency data with 5 minutes intervals to test the profitability of technical strategies. Marshall et al (2008) also uses the 5 minutes intervals of the transactions data for the Standard and Poor's Depository Receipts (SPDRs).

However, they show that none of their 7846 rules are able to beat the market even after the data snooping problem is corrected, although some people may expect some profitability there because 5 minutes data gives rules more opportunities to transact. Rather than the SPDRs profitability, this paper analyzes the profitability for individual stocks to ask whether traders could be able to make profits if they focus on trading a few stocks so frequently. In addition to showing the profitability of individual stocks, this paper provides possible explanations on the results of Marshall et al (2008), i.e., why the SPDRs returns may not be profitable. I will show that some of the stocks would produce successful trading rules while some others would not over the 3 months. These results would imply that when we consider the profitability of the composite returns, the profitability for each stock is just averaged out.

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