Report about Kiel University contribution to the EU project on Complex Markets,

and about Kiel University organization and contribution in the workshop "Bubbles, Herding and Market Crashes" held in Kiel on 7 October, 2005

The research group at the University of Kiel has performed several activities within the EU STREP project "COMPLEX MARKETS" since its inception in May 1st, 2005. The structure of the group, the research topics and activities, and the present achievements are summarized below.

List of Members

- Prof. Dr. Thomas Lux, head of the group;
- Prof. Dr. Friedrich Wagner;
- Ass. Prof. Dr. Simone Alfarano
- PD Dr. Reiner Franke;
- Mishael Milaković, PhD;
- Markus Demary;
- Timur Yusupov.

Research Activities:

The research activities of the Kiel group cover the following topics:

- *Microfounded behavioural heterogeneity in macrodynamic systems* of interacting markets. While macroeconomic theory is essentially based on representative agents who either follow rules of thumb or (in mainstream theory) optimize over an infinite time horizon under rational expectations, concepts of heterogeneous interacting agents that have been developed elsewhere in the project can be fruitfully incorporated into (heterodox) feedback-guided systems. In particular, they can also be used to estimate the dynamics of survey expectations. This work, which is related to **WP 1.1**, is pursued by R. Franke.
- *Analysis of the impact of social networks* on the dynamical properties of financial markets. Traditionally, agent-based models of financial markets have not paid particular attention to the underlying network structure on which interaction among agents takes place. The project, which is conducted by S. Alfarano and M. Milaković, investigates the robustness of a generic herding model with respect to various specifications of network structure. The work is related to **WP 2.3**.
- *Analysis of experimental asset markets* with heterogeneously informed traders. The main idea is to study whether and how the heterogeneity of the information generates heterogeneity of behavior of traders, and how the traders' heterogeneity influences market efficiency. Several experimental treatments have been conducted at the experimental laboratory at the University of

Castellón (Spain), in collaboration with Dr. Eva Camacho and Dr. Ivan Barreda. The analysis of the data is an ongoing activity. The work is related to **WP 2.3** and **WP 2.4**.

- *Derivation and estimation of analytically tractable asset-pricing models* with heterogeneous investors. The derivation of closed-form solutions for various observables (distribution of returns, autocorrelation of volatility) allows the development of new techniques for the estimation of the behavioral parameters in agent-based models. It is planned to extend this work to more complex models for which closed-form solutions no longer exist and to estimate them via Markov chain Monte Carlo methods. This research is pursued by S. Alfarano, R. Franke, T. Lux and F. Wagner. The work is related to **WP 2.3**, **WP 2.5**, **WP 2.6** and **WP 2.7**.
- *Application of the multifractal framework to financial data*. Topics pursued in this area include comparison of different techniques for the estimation of the parameters of multifractal models and the analysis of the capability of the multifractal models in forecasting financial time series (volatility, volume and VaR). Research in this field has been conducted by Thomas Lux together with various collaborators. The work is related to **W 2.5**.
- *Analysis of policy implications of transaction taxes* on exchange rate behavior within the framework of agent-based models. The main work on this topic, which is related to **WP 2.6**. and **WP 3.2**, has been done by M. Demary.

Use of the EU Funds

- **Personal**: the position for a research scientist had been held by Simone Alfarano from 1st June 2005 to 30th November 2005. Effective 1st December, Simone Alfarano has moved to a position of Lecturer/Assistant Professor at the Department of Economics, University of Kiel. Effective 1st February 2006, Dr. Reiner Franke has been employed as a new research scientist within the project.
- **Other expenditures**: travel expenditures for conference presentations (London, Essex, Bielefeld, Cagliari, Bologna).

Completed Research Papers:

- Alfarano, S., *An Agent-Based Stochastic Volatility Model.* Dissertation, Kiel 2005. (**WP 2.6**)
- Alfarano S. and R. Franke, A Simple Asymmetric Herding Model to Distinguish Among Different Types of Financial Markets, August 2006. (**WP 2.7**)
- Alfarano S. and T. Lux, A Noise Trader Model as a Generator of Apparent Power Laws and Long Memory, May 2005; accepted by *Macroeconomic Dynamics*. (**WP 2.6**)
- Alfarano S. and T. Lux, Extreme Value Theory as a Theoretical Background for Power Law Behavior, in C.Cioffi (ed.), *Power Laws in the Social Sciences: Discovering Complexity and Non-Equilibrium in the Social Universe*; submitted to Cambridge University Press. (**WP 2.6**)
- Alfarano S., T. Lux and F. Wagner, Time-Variation of Higher Moments in a Financial Market with Heterogeneous Agents: An Analytical Approach, August 2005; submitted to *Journal of Economic Dynamics and Control*. (**WP 2.5**)
- Alfarano S., T. Lux and F. Wagner, Estimation of Agent-Based Models: the Case of an

Asymmetric Herding Model, *Computational Economics*, 26 (2005), 19–49. (**WP 2.7**)

- Alfarano S., T. Lux and F. Wagner, Estimation of a Simple Agent-Based Model of Financial Markets: An Application to Australian Stock and Foreign Exchange Data, December 2005; accepted by *Physica A*. (**WP 2.7**)
- Alfarano S., T. Lux and F. Wagner, Empirical Validation of Stochastic Models of Interacting Agents: A 'Maximally Skewed' Noise Trader Model, March 2006; submitted to *European Journal of Physics B.* (**WP 2.7**)
- Alfarano S. and M. Milaković, Agent Interaction on a Stylized Financial Market: Does Network Structure Matter?, July 2006. (**WP 2.3**)
- M. Demary, Transaction Taxes, Traders' Behavior, and Exchange Rate Risks. June 2006. (**WP 3.2**)
- M. Demary, Transaction Taxes and Exchange Rate Risks: Some Analytical Results. August 2006. (**WP 3.2**)
- Farmer D. and T. Lux (Guest Editors), Special issue of *Journal of Economic Dynamics and Control* on "Statistical Physics Approaches in Economics and Finance"; in preparation.
- Franke R., How to Model Animal Spirits in Macrodynamics, August 2006. (**WP 1.1**)
- Franke R., Microfounded Animal Spirits and Monetary Policy Over the Business Cycle, August 2006. (**WP 1.1**)
- Gallegatti M., S. Keen, T. Lux and P. Ormerod, Worrying Trends in Econophysics, December 2005; accepted by *Physica A*. (**WP 2.5**)
- Lux T., Applications of Statistical Physics in Finance and Economics", chapter for the *Handbook on Complexity Research*, August 2006. (**WP 2.5**)
- Lux T., Explaining Financial Power Laws: Models and Mechanisms, in: C.Cioffi (ed.), *Power Laws in the Social Sciences: Discovering Complexity and Non-Equilibrium in the Social Universe*; submitted to Cambridge University Press. (**WP 2.6**)
- Lux T., Parameter Estimation for Stochastic Models of Interacting Agents: An Approximate ML Approach via Numerical Solutions of Transitional Densities. August 2006. (**WP 2.7**)
- Lux T. and T. Kaizoji, Forecasting Volatility and Volume in the Tokyo Stock Market: Long Memory, Fractality and Regime Switching, January 2006; accepted by *Journal of Economic Dynamics and Control*. (**WP 2.6**)
- Wagner, F., Application of Zhangs Square Root Law and Herding in Financial Markets, October 2005; accepted by *Physica A*. (**WP 2.5**)
- Yusupov T. and E. Yusupova, What Makes Speculators Trade More Often: Empirical Analysis of the TSE Data, May 2006; submitted to Proceedings of 5th Annual International Conference, University of Lodz. (**WP 2.6**)

Conference Presentations

Prof. Dr. T. Lux

- Conference on "Socio-Dynamics, Networks and Markets", University of Warwick, 9–11 May 2005;
- 10th Workshop on Economics with Heterogeneous Interacting Agents, University of Essex, 13–

15 June 2005;
- Conference on "Agent-Based Models for Economics Policy Design", University of Bielefeld, 30 June-2 July 2005;
- Summer School "Econophysics and Complexity" funded by EU-COST Programme, Navodari, Romania, 2–9 September 2005 (Lecture series on Agent-Based Models in Finance);
- Workshop on Heterogeneous Agents, University of Technology, Sidney 8 November 2005;
- Econophysics Colloquium, Australia National University, Canberra, 14–18 November 2005;
- MODSIM 05, International Congress on Modeling and Simulations, Melbourne, 12–15 December 2005;
- Symposium on "Autonomous Agency and the Evolution of Diversity", University of Melbourne, 16 December 2005.
- Workshop on the Econophysics of Stock Markets and Minority Games, Saha Institute for Nuclear Physics, Kolkota, 14–17 February 2006.
- Annual Meeting of the German Physical Society, Dresden, 27–31 March 2006.
- 11th Workshop on Economics with Heterogeneous Interacting Agents, University of Bologna, 15–17 June 2006.
- Conference "Ecople: Economics from Tradition to Complexity", Capri, 2–3 July 2006.

Ass. Prof. Simone Alfarano
- 10th Workshop on Economic Interacting Heterogeneous Agents, University of Essex, 13–15 June 2005;
- Workshop on Informational Herding Behavior, University of Copenhagen, 16–18 September 2005.
- 11th Workshop on Economic Interacting Heterogeneous Agents, University of Bologna, 15–17 June 2006;

Timur Yusupov
- 5th Annual International Conference "Forecasting Financial Markets and Economic Decision-Making", University of Lodz, Poland, 11–13 May 2006.
- International Conference on High Frequency Finance "Microstructure of Financial Markets in Europe", University of Konstanz, Germany, 19–20 May 2006.

Meeting in Kiel

The Kiel unit has organized the *Workshop on Bubbles, Herding and Crashes* on October 7th in the Institute for World Economics in Kiel, Germany. The program of the meeting can be found in the Appendix of this report. The workshop schedule included presentations from four partner groups (Amsterdam, Cagliari, Kiel and Trieste) together with invited presentations by two guests whose research interests are closely related to the objectives of the project (Frank Westerhoff from University of Osnabrück, and David Goldbaum from Rutgers University, USA).

Appendix A

Workshop on Bubbles, Herding and Market Crashes

Institute for World Economics, Kiel 7.10.2005

Morning

9:00 - 9:45
Michele Marchesi *Modeling and Simulation of Transaction Taxes in Financial Markets*

9:45 - 10:30
Cars Hommes *Behavioral Heterogeneity in Stock Prices*

10:30 - 11:00
Coffee Break

11:00 - 11:45
Frank Westerhoff *Business Cycles, Heuristic Expectation Formation and Contracyclical Policies*

11:45 - 12:30
David Goldbaum *Coordinated Investment with Feedback and Learning*

12:30 - 14:00
Lunch

Afternoon

14:00 - 14:40
Simone Alfarano *An Agent-Based Stochastic Volatility Model*

14:40-15:20
Matteo Marsili *Risk Bubbles and Dynamic Instability in a Simple Model of Correlated Assets*

15.20 - 16:00
Silvano Cincotti *Artificial Stock Market: From Single- to Multi- Assets*

16:00 - 16:15
Coffee Break

16:15 - 17:00
Mikhail Anufriev *Price and Wealth Dynamics in a Speculative Market with an Arbitrary Number of Generic Technical Traders*

17:00 - 17:45
Friedrich Wagner *Application of Zhangs Square Root Law and Herding to Financial Markets*

Organizer: Prof. Dr. Thomas Lux, Institut für Volkswirtschaftslehre

Location: Institut für Weltwirtschaft, Düsternbrooker Weg 120

Financial Support: EU **S**pecific **T**argeted **R**esearch **P**roject on Complex Markets

Appendix B

Abstract of paper "A Simple Asymmetric Herding Model to Distinguish Among Different Types of Financial Markets" by S. Alfarano and R. Franke.

Drawing on previous work of one of the authors, the paper takes an asymmetric variant of Kirman's ant model and combines it with an elementary asset pricing mechanism. The closed-form solution of the equilibrium probability distribution of daily returns allows the specification of a tractable likelihood function, which is then employed to estimate the model's behavioural parameters for 982 Japanese stocks. By way of a bootstrap procedure it is found that nearly all of these markets belong to the same class, which is characterized by a dominance of the stylized noise traders. In contrast, the model assigns the main foreign exchange markets to a different class, where on average the majority of agents follows the fundamentalist trading rule. Implications for the tail index are also explored.

Abstract of paper "A Noise Traders Model as a Generator of Apparent Power Laws and Long Memory" by S. Alfarano and T. Lux.

In various agent-based models the stylized facts of financial markets (unit roots, fat tails and volatility clustering) have been shown to emerge from the interactions of agents. However, the complexity of these models often limits their analytical accessibility. In this paper we show that even a very simple mode lof a financial market with heterogeneous interacting agents is capable of reproducing these ubiquitous statistical properties. The simplicity of our approach permits to derive some analytical insights by using concepts from statistical mechanics. In our model, traders are divided into two groups: *fundamentalists* and *chartists*, and their interactions are based on a variant of the herding mechanism introduced by Kirman [1]. The statistical analysis of simulated data points toward long-term dependence in the auto-correlations of squared and absolute returns, and hyperbolic decay in the tail of the distribution of raw returns, both with estimated decay parameters in the same range like those of empirical data. Theoretical analysis, however, excludes the possibility of `true' scaling behavior because of the Markovian nature of the underlying process and the boundedness of returns. The model, therefore, only *mimics* power law behavior. Similarly to the phenomenological volatility models analyzed in LeBaron [2], the usual statistical tests are not able to distinguish between true or pseudo-scaling laws in the dynamics of our artificial market.

References

[1] A. Kirman, Ants, rationality, and recruitment. *Quarterly Journal of Economics*, 108:137– 156, 1993;

[2] B. LeBaron.,Agent based computational finance: Suggested readings and early research. *Journal of Economic Dynamics and Control*, 24:679–702, 2000.

Abstract of paper "Extreme Value Theory as a Theoretical Background for Power Law Behavior" by S. Alfarano and T. Lux.

Power law behavior has been recognized to be a pervasive feature of many phenomena in the natural and social sciences. While immense research efforts have been devoted to the analysis of behavioral mechanisms responsible for the ubiquity of power-law scaling, the strong theoretical foundation of power laws as a very general type of limiting behavior of large realizations of stochastic processes is less well known. In this chapter, we briefly present some of the key results of extreme value theory, which provide a statistical justification for the emergence of power laws as limiting behavior for

extreme fluctuations. The remarkable generality of the theory allows one to abstract from the details of the system under investigation, so that it can be applied in many diverse fields. Moreover, this theory offers new powerful techniques for the estimation of the Pareto index, which are detailed in the second part of this chapter.

Abstract of paper "Time-Variation of Higher Moments in a Financial Market with Heterogeneous Agents: An Analytical Approach" by S. Alfarano, T. Lux and F. Wagner.

A growing body of recent literature allows for heterogeneous trading strategies and limited rationality of agents in behavioral models of financial markets. More and more, this literature has been concerned with the explanation of some of the stylized facts of financial markets. It now seems that some previously mysterious time-series characteristics like fat tails of returns and temporal dependence of volatility can be observed in many of these models as macroscopic patterns resulting from the interaction among different groups of speculative traders. However, most of the available evidence stems from simulation studies of relatively complicated models, which do not allow for analytical solutions. In this paper, this line of research is supplemented by analytical solutions of a simple variant of the seminal herding model introduced by Kirman [1993]. Embedding the herding framework into a simple equilibrium asset pricing model, we are able to derive closed-form solutions for the time-variation of higher moments as well as related quantities of interest enabling us to spell out under what circumstances the model gives rise to realistic behavior of the resulting time series.

Reference

A. Kirman Ants, rationality, and recruitment. *Quarterly Journal of Economics*, 108:137– 156, 1993.

Abstract of paper "Estimation of Agent-Based Models: The Case of an Asymmetric Herding Model" by by S. Alfarano, T. Lux and F. Wagner.

The behavioral origins of the stylized facts of financial returns have been addressed in a growing body of agent-based models of financial markets. While the traditional efficient market viewpoint explains all statistical properties of returns by similar features of the news arrival process, the more recent behavioral finance models explain them as imprints of universal patterns of interaction in these markets. In this paper we contribute to this literature by introducing a very simple agent-based model in which the ubiquitous stylized facts (fat tails, volatility clustering) are emergent properties of the interaction among traders. The simplicity of the model allows us to estimate the underlying parameters, since it is possible to derive a closed form solution for the distribution of returns. We show that the tail shape characterizing the fatness of the unconditional distribution of returns can be directly derived from some structural variables that govern the traders' interactions, namely the herding propensity and the autonomous switching tendency.

Abstract of paper "Estimation of a Simple Agent-Based Model of Financial Markets: An Application to Australian Stock and Foreign Exchange Data" by S. Alfarano, T. Lux and F. Wagner.

Following Alfarano *et al.* [1], we consider a simple agent-based model of a highly stylised financial market. The model takes Kirman's ant process ([2]) of mimetic contagion as its starting point, but allows for asymmetry in the attractiveness of both groups. Embedding the contagion process into a standard asset-pricing framework, and identifying the abstract groups of the herding model as chartists and fundamentalist traders, a market with periodic bubbles and bursts is obtained. Taking stock of the availability of a closed-form solution for the stationary distribution of returns for this model [1], we can

estimate its parameters via maximum likelihood. Expanding our earlier work, this paper presents pertinent estimates for the Australian Dollar/U.S. Dollar exchange rate and the Australian stock market index. As it turns out, our model indicates dominance of fundamentalist behavior in both the stock and foreign exchange market.

References

[1] Alfarano, T. Lux, and F. Wagner, Estimation of agent-based models: the case of an asymmetric herding model. *Computational Economics*, 26:19–49, 2005.

[2] A. Kirman, Ants, rationality, and recruitment. *Quarterly Journal of Economics*, 108:137–156, 1993.

Abstract of paper "Empirical Validation of Stochastic Models of Interacting Agents: A 'Maximally Skewed' Noise Trader Model" by S. Alfarano, T. Lux and F. Wagner.

The present paper expands on recent attempts at estimating the parameters of simple interacting-agent models of financial markets. Here we provide additional evidence by (i) investigating a large sample of individual stocks from the Tokyo Stock Exchange, and (ii) comparing results from the baseline noise trader/fundamentalist model with those obtained from an even simpler version with a preponderance of noise trader behavior. As it turns out, this somewhat more parsimonious "maximally skewed" variant is often not rejected in favor of the more complex version. We also find that all stocks are dominated by noise trader behavior irrespective of whether the data prefer the skewed or the baseline version of our model.

Abstract of paper "Agent Interaction on a Stylized Financial Market: Does Network Structure Matter?" by S. Alfarano and M. Milaković.

We investigate whether and how the network structure among investors in an artificial stock market influences the stylized facts of financial time series. Investors communicate with each other according to various exogenously specified network structures, and possibly engage in some type of herding behavior, modelled in the spirit of Kirman's "ant model". The results suggest that the stylized facts of financial markets, that is, power law relationships in the distribution of returns and volatility autocorrelations, are preserved in those network structures where the average connectivity remains roughly constant as the system is enlarged. In our various herding models, regular network structures like lattices or the Strogatz-Watts "small world" networks are not able to reproduce the stylized facts as the system size increases.

Abstract of paper "Transaction Taxes, Traders' Behavior, and Exchange Rate Risks" by M. Demary.

If economic risks are caused by the irrational behavior of traders, policy makers may try to correct this mispricing by means of instruments like transaction taxes or profit taxes. This paper studies the effects of taxes on financial markets under the assumption of heterogeneous agents, where the two groups of chartists and fundamentalists are allowed to select endogenously between different forecasting models and different investment horizons. Stochastic interest rates in both countries and different behavioral assumptions for chartist and fundamentalist forecasts determine the agents' market orders, which drive the exchange rate. The model is able to replicate stylized facts of financial market data like volatility clustering and excess kurtosis of returns, which makes it a suitable tool for economic policy analysis.
Moreover, simulations show that transaction taxes are able to lower the variance of returns significantly, but increase the kurtosis of returns. Through the introduction of the transaction tax traders switch from short-term investment horizons to long-term investment horizons as it is argued by the

proponents of the Tobin tax. However, in contrast to their view, the tax favors trading rulesof chartists and not fundamental-oriented trading.

Abstract of paper "Transaction Taxes and Exchange Rate Risks: Some Analytical Results" by M. Demary.

The model proposed in this paper is a simplified version of Demary [1] in order make the model tractable and get analytical results in addition to the previous simulations. Again, the four groups of agents: short-term and long-term technical traders and short-term and long-term fundamentalist traders, use simple trading rules since they do not know the process which governs the exchange rate dynamics in all of its complexity. Their behavior can be seen as rational in that they change trading rules and investment horizons in the light of past profits earned by using these rules. We get the result that transaction taxes do not change the steady state of the model but increase the region in which the steady state is stable. Moreover, it is shown that transaction taxes are able to reduce the variance of exchange rate returns and the average number of agents practicing short-term speculation.

References

M. Demary, Transaction taxes, traders' behavior, and exchange rate risks, Working Paper, June 2006.

Abstract of paper "How to Model Animal Spirits in Macrodynamics" by R. Franke.

The paper considers the formation of an average opinion index, or business climate, in a microfounded framework where the agents switch between two kinds of sentiment with certain transition probabilities. Circumventing the elaborated tools of statistical mechanics which are usually here applied, a more elementary argument is put forward that allows one to derive a stochastic or deterministic law of motion for the aggregate outcome of the individual switches. While this concept will easily establish a positive feedback of optimism feeding optimism, a standard specification is also shown to give rise to a nonlinearity that can be very conveniently used to generate persistent cyclical behaviour in macrodynamic models.

Abstract of paper "Microfounded Animal Spirits and Monetary Policy Over the Business Cycle" by R. Franke.

The paper takes the Taylor rule and a Phillips curve from the "new consensus of macroeconomics" but views output as ultimately determined by the current business climate. The latter is explicitly microfounded as an average index of optimistic and pessimistic agents who individually switch between these attitudes with certain probabilities. For a large population the model becomes deterministic and can be reduced to two dimensions. The feature that the transition probabilities vary in response to, in particular, the interest rate gives rise to a stable limit cycle. The model is calibrated and it is shown how changes of the policy coefficients in the Taylor rule affect the amplitudes and the period of the cyclical motions.

Abstract of paper "Worrying Trends in Econophysics" by M. Gallegatti, S. Keen, T. Lux and P. Ormerod.

Econophysics has already made a number of important empirical contributions to our understanding of the social and economic world. These fall mainly into the areas of finance and industrial economics, where in each case there is a large amount of reasonably well-defined data. More recently, Econophysics has also begun to tackle other areas of economics where data is much more sparse and

much less reliable. In addition, econophysicists have attempted to apply the theoretical approach of statistical physics to try to understand empirical findings.
Our concerns are fourfold. First, a lack of awareness of work which has been done within economics itself. Second, resistance to more rigorous and robust statistical methodology. Third, the belief that universal empirical regularities can be found in many areas of economic activity. Fourth, the theoretical models which are being used to explain empirical phenomena. The latter point is of particular concern. Essentially, the models are based upon models of statistical physics in which energy is conserved in exchange processes. There are examples in economics where the principle of conservation may be a reasonable approximation to reality, such as primitive hunter-gatherer societies. But in the industrialised capitalist economies, income is most definitely not conserved. The process of production and not exchange is responsible for this. Models which focus purely on exchange and not on production cannot by definition offer a realistic description of the generation of income in the capitalist, industrialised economies.

Abstract of paper "Applications of Statistical Physics in Finance and Economics" by T. Lux.
This chapter reviews recent literature adopting methodology from statistical physics in finance and economics. From the early nineties, physicists have started to investigate large data sets like high-frequency price records from financial markets or cross-sectional records of company characteristics. The main motivation of most of this work was a search for power laws as the key signature of complex, self-organizing systems and their explanation via appropriate models. Besides more applied contributions to financial economics (such as the study of correlation matrices to portfolio theory or the fertilization of multi-fractal models for forecasting of volatility), this literature has brought about a well-established universal feature characterizing financial data and a plethora of microscopic models that provide potential explanations of some of these stylized facts. While these advances are emphasized, it is also remarked that some other reported regularities (such as log-periodic oscillations) have a weak statistical basis and should be taken with appropriate caution by economists. Outside the realm of financial economics, other important currents of the econophysics literature include (i) microscopic models of wealth and income distribution, and (ii) empirical and theoretical work on industrial dynamics, while macroeconomic applications of statistical physics methodology are still relatively scarce. The major methodological contribution of 'econophysic' literature is seen in an increasing awareness of the importance of interaction that characterize economic systems with many adaptive agents and the emergence of macroscopic features that cannot be explained by a reductionist approach.

Abstract of paper "Explaining Financial Power Laws: Models and Mechanisms" by T. Lux.
The ubiquitous finding of a robust, approximately cubic power law characterizing large returns together with similarly robust long-range dependence in volatility (i.e., hyperbolic decline of its autocorrelation function) has recently spurred attempts at theoretical explanations of the emergence of these key characteristics form the market process. In principle, different types of dynamic processes could be the source of power-law distributed fluctuations. Examples found in the economic literature include multiplicative stochastic processes as well as dynamic processes with multiple equilibria. Though both types of dynamics are characterised by intermittent behaviour which occasionally generates large bursts of activity, they can be based on fundamentally different perceptions of the trading process. The

present chapter reviews both the analytical background of the power laws emerging from the above data generating mechanism as well as pertinent models proposed in the economics literature.

Abstract of paper "Parameter Estimation for Stochastic Models of Interacting Agents: An Approximate ML Approach via Numerical Solutions of Transitional Densities" " by T. Lux.
Simple models of interacting agents can be formulated as jump Markov processes via suitably specified transition probabilities. Their aggregate dynamics might then be analyzed by the Master equation for the change of the probability distribution over time, or the Fokker-Planck equation that is obtained via a power series expansion and governs the probability distribution for fluctuations around an equilibrium. With such information on the transient density of the process, maximum likelihood estimation of its parameters becomes feasible. Even if the Fokker-Planck equation cannot be solved explicitly, one can resort to numerical approximations like the Crank-Nicolson method for approximate ML estimation. We explain this algorithm with a simple model of interacting agents and show that the approximate ML procedure works well and has desirable accuracy even in the case of bimodal limiting distributions. We illustrate possible applications by estimating the parameters of this model for a popular business climate index for the German economy.

Abstract of paper "Forecasting Volatility and Volume in the Tokyo Stock Market: The Advantage of Long Memory Models" by T. Lux and T. Kaisoji.
We investigate the predictability of both volatility and volume for a large sample of Japanese stocks. The particular emphasis of this paper is on assessing the performance of long memory time series models in comparison to their short-memory counterparts. Since long memory models should have a particular advantage over long forecasting horizons, we consider predictions of up to 100 days ahead. In most respects, the long memory models (ARFIMA, FIGARCH and the recently introduced multifractal models) dominate over GARCH and ARMA models. However, while FIGARCH and ARFIMA also have a number of cases with dramatic failures of their forecasts, the multifractal model does not suffer from this shortcoming and its performance practically always improves upon the naïve forecast provided by historical volatility. As a somewhat surprising result, we also find that, for FIGARCH and ARFIMA models, pooled estimates (i.e. averages of parameter estimates from a sample of time series) give much better results than individually estimated models.

Abstract of paper "Application of Zhangs Square Root Law and Herding to Financial Markets" by F. Wagner.
We apply an asymmetric version of Kirman's herding model to volatile financial markets. In the relation between returns and agent concentration we use the square root law proposed by Zhang. Extending the idea of a critical mean field theory suggested by Plerou et al can derive this. We show that this model is equivalent to the so-called 3/2-model of stochastic volatility. The description of the unconditional distribution for the absolute returns is in good agreement with the DAX independent whether one uses the square root or a conventional linear relation. Only the statistic of extreme events prefers the former. The description of the autocorrelations is in much better agreement for the square root law. A scaling law for the distribution of returns conditional to the value at the previous day describes the volatility clusters in good agreement with the data.

Reference

A. Kirman Ants, rationality, and recruitment. *Quarterly Journal of Economics*, 108:137– 156, 1993.

Abstract of paper "What Makes Speculators Trade More Often: Empirical Analysis of the TSE Data" by T. Yusupov and E. Yusupova,

In this paper we investigate how the value of transaction costs and the frequency of investment decision-making can influence the perception of market efficiency. Using the high frequency stock market data from the Tokyo Stock Exchange, we compare the ability of four types of investors to achieve positive returns adjusted for the defined schedule of transaction costs. Hypothetical results for several time series of stock prices indicate that the violation of the weak form of market efficiency, reflected in positive market returns, increases with a reduction of transaction costs and an increase of trading frequency. In-sample aggregate returns are tremendous even after adjusting for transaction costs especially for investors with a "perfect prediction mechanism". With declining transaction costs the hypothetical possibility of those returns can explain why so many investors are increasing their frequency of trades, even though their financial performance is getting worse.