



Latsis Symposium 2012 11. - 14. Sep. | ETH Zurich, Switzerland
Economics on the Move

Trends and Challenges from the Natural Sciences

Latsis Symposium

12. - 14. September 2012
ETH Zurich, Switzerland



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ETH Zurich

Latsis Symposium 2012

Economics is on the move. This is true for the world economy with its strongly growing “emerging states”, China’s GDP being already the second largest in the world. But it is also true for the national economies of the industrial states coping with the aftermath of the financial crisis of 2009.

How are these recent changes reflected in economics as a scientific discipline? Are there economic theories and concepts to explain, if not to predict, these transitions? Or did economics fail to deal with these challenges? The essay “How did economists get it so wrong?” by Paul Krugman, winner of the 2008 Nobel Memorial Prize in Economic Science, lists as possible causes: the blindness of the discipline, the shortfall of established idealized theories, and the absence of new scientific concepts able to meet the challenges of the real economic world. Hence the question arises of how to cope with this conceptual crisis.

Different from many other events, the Latsis Symposium 2012 will not focus on analyzing the failure of previous economic (and political) decisions, or the shortfall of mainstream economic theories. Rather, it poses a provocative question:

Can economics as a scientific discipline that must extricate itself from its current conceptual crises, benefit from concepts, methods and insights developed in other disciplines, notably the natural sciences?

Instead of tackling this question in the broadest way, the Latsis Symposium will concentrate on the three aspects *Behavioral Economics*, *Systemic Risk* and *Economic Networks*, where the relation between economics and other scientific disciplines already became obvious. Each of these topics will be discussed on a separate day, featuring various high-profile speakers.

The symposium aims to provide a forum for interdisciplinary knowledge-transfer and will leave ample room for stimulating discussions. We wish all participants a stimulating and successful Symposium.

Frank Schweitzer, Ernst Fehr and Didier Sornette
Zurich, 12. September 2012

Aims and Scope

Day 1: Behavioral Economics

The crisis of the “homo economicus” as a rational, informed, independent decision maker is already widely acknowledged. But what concepts are suitable to support a new theory of economic decision making? The recent insights from the behavioral sciences, ranging from psychology to biology and anthropology, as well as from neuroscience and experimental economics, provide evidence that human behavior largely differs from what economic theory assumes as the foundation of microbehavior. Can the recent findings be integrated in established economic theories? Or, do we need a fundamentally new view on economic decisions, to be in line with the findings from outside economics?

Day 2: Systemic Risk

Different from political wisdom, systemic risk does not only occur in finance, but is also a predominant feature in technical and social systems. The breakdown of a fiber bundle or of an infrastructural network, e.g. a power grid, is to some extent much better understood than the breakdown of a financial transaction network due to the propagation of financial distress. These dynamics have much in common with percolation phenomena in physics, but also with epidemic spreading in human societies. What is the common denominator in these systemic properties? Can economics benefit from formal concepts derived in such disciplines? Are there design principles to prevent systemic failure?

Day 3: Economic Networks

Research on economic networks, as published by economists, is mostly concerned with the strategic interaction of agents representing different economic entities, which could be regarded as a micro approach. The macro perspective is missing, i.e. the relation to economic networks at large. Such networks, on the other hand, were empirically studied outside mainstream economics, e.g. in physics (examples are the world trade network, global ownership networks, financial networks). The next step thus is to find ways to merge these two approaches, and provide a better empirical basis through the analysis of massive data.

Program

Wednesday: Behavioral Economics

Lecture Hall **CAB G 11**.

08.30 - 09.00 Opening by Frank Schweitzer
Welcome Address by the President of ETH Zurich, Prof. Ralph Eichler

09.00 - 09.45 *Daniel Houser, George Mason University, USA*
Self-Control and Altruism at Work

09.45 - 10.30 *Roberto Weber, University of Zurich, Switzerland*
Multiple Equilibria and Economic Theory

Coffee Break

11.00 - 11.30 *Arno Riedl, Maastricht University, Netherlands*
On the Interaction of Economic Theory and Experimental Economics:
Studies on Incomplete Preferences and Partner Choice

11.30 - 12.00 *Matthias Sutter, University of Innsbruck, Austria*
Experimental Choices and Field Behavior: On Impatience, Saving and
Smoking

12.00 - 12.30 *Dirk Helbing, ETH Zurich, Switzerland*
Rethinking Macroeconomics Based on Complexity Theory

Lunch Break

14.00 - 14.30 *Ryan Murphy, ETH Zurich, Switzerland*
Simple Stochastic Games: Risk Taking in Strategic Contexts

14.30 - 15.00 *Christian Zehnder, University of Lausanne, Switzerland*
On the Psychology of Contracts

15.00 - 15.30 *Massimo Molinari, University of Trento, Italy*
Competition Policy as a Tool for the Macroprudential Regulation of the
Banking Sector

Coffee Break

16.00 - 16.45 *Jean-Robert Tyran, University of Vienna, Austria*
The Economics of Money Illusion

16.45 - 17.30 *Lorenz Goette, University of Lausanne, Switzerland*
The Weave of Social Life: How Community Participation Shapes the
Individual

Thursday: Systemic Risk

Lecture Halls **CAB G 11** (*) and **CAB G 51** (‡).

09.00 - 09.45* *Carsten Detken, European Central Bank, Germany*
Is Early Warning Against Systemic Risk Feasible? The ECB's Newly
Developed Analytical Support to the European Systemic Risk Board

09.45 - 10.30* *Joseph E. Stiglitz, Columbia University, USA*
Crisis, Contagion, and the Need for a New Paradigm

Coffee Break

11.00 - 12.00* **Systemic Risk: Are There Lessons To Be Learned?**
Panel Discussion, Chair: Frank Schweitzer (ETH Zurich)
Jürg Blum (Swiss National Bank)
Rama Cont (Imperial College London)
Carsten Detken (European Central Bank)
Peter Fischer (Neue Zürcher Zeitung)
Jean Charles Rochet (University of Zurich)
Didier Sornette (ETH Zurich)
Joseph E. Stiglitz (Columbia University, New York)

Lunch Aperó

14.00 - 14.45* *Jean Charles Rochet, University of Zurich, Switzerland*
Taming Systemically Important Financial Institutions

14.45 - 15.30* *Rama Cont, Imperial College London, UK*
Channels of Contagion: Identifying and Monitoring Systemic Risk in the
Financial System

Coffee Break

16.00 - 16.30* *Matteo Luciani, ECARES - Université Libre de Bruxelles, Belgium*
Ranking Systemically Important Institutions

16.00 - 16.30‡ *Kimmo Soramäki, Financial Network Analytics, Spain*
Identifying Systemically Important Banks in Payment Systems

16.30 - 17.00* *Giovanni di Iasio, Bank of Italy, Italy*
Contagion in Financial Networks

16.30 - 17.00‡ *Co-Pierre Georg, UC3M & Oxford University, United Kingdom*
Financial Linkages, Macroprudential Policy, and Systemic Risk

17.00 - 17.30* *Vladimir Filimonov, ETH Zurich, D-MTEC, Switzerland*
Quantifying Reflexivity in Financial Markets: Towards a Prediction of
Flash Crashes

17.00 - 17.30‡ *Andreas Krause, University of Bath, Great Britain*
The Role of Interbank Lending in the Prediction of Individual Bank
Failures during a Banking Crisis

Friday: Economic Networks

Lecture Halls **CAB G 11** (*) and **CAB G 51** (‡).

09.00 - 09.45* *Giorgio Fagiolo, Scuola Superiore Sant'Anna Pisa, Italy*
The International Trade Network: Statistical Properties and Modeling

09.45 - 10.30* *Sanjeev Goyal, Cambridge University, UK*
Network Resilience

Coffee Break

11.00 - 11.30* *Benjamin Tabak, Banco Central do Brasil and UCB, Brazil*
Directed Clustering Coefficient as a Measure of Systemic Risk in
Complex Banking Networks

11.00 - 11.30‡ *Andrea Tacchella, La Sapienza - University of Rome, Italy*
A New Metric for the Economic Complexity of Countries and Products

11.30 - 12.00* *Xiaobing Feng, Shanghai Jiaotong University, SHIFT, China*
Measurement and Internalization of Systemic Risk in a Global Bank
Trading & Clearing Network

11.30 - 12.00‡ *Stefano Battiston, ETH Zurich, Switzerland*
The Network of Global Corporate Control

12.00 - 12.30* *Antonio Scala, CNR-ISC "La Sapienza", IMT Lucca and LIMS London*
Mitigating Distress Cascades in Financial Networks

12.00 - 12.30‡ *Martinez Jaramillo Serafin, Banco de Mexico*
An Empirical Study of the Mexican Banking System's Network and its
Implications for Systemic Risk

Lunch Break

14.00 - 14.30* *Hamed Amini, EPFL (Swiss Finance Institute), Switzerland*
Contagious Defaults in Financial Networks

14.30 - 15.00* *Frank Page, Indiana University, USA*
Rollover Risk and Endogenous Network Dynamics

15.00 - 15.30* *Sam Langfield, European Systemic Risk Board, Germany and UK*
Mapping the UK interbank market

Coffee Break

16.00 - 16.45* *Fernando Vega-Redondo, European University Institute Florence, Italy*
Globalization and Social Networks

16.45 - 17.30* *Pier-Paolo Saviotti, Universität Hohenheim, Germany*
Networks of Knowledge

17.30 - 18.00* Closing remarks by the organizers

Abstracts

Wednesday: Behavioral Economics

- **9.00-9.45: Self-control and Altruism at Work**

Daniel Houser, George Mason University, USA

Self-control resolves conflict between altruistic and selfish impulses. Self-control requires energy, and in work environments controlling one's short-run desires can have a detrimental impact on subsequent productivity. Further, controlling selfish impulses is more difficult when costs of altruistic effort for others are monetized. Brain imaging data suggest altruism is mediated by social reward systems. These systems may be difficult to activate (that is, self-control more difficult) in the presence of pecuniary costs, as money is perceived as an individual resource.

- **9.45-10.30: Multiple Equilibria and Economic Theory**

Roberto Weber, University of Zurich, Switzerland

Many economic contexts possess multiple equilibria. These situations are important for many reasons, including because they are often where traditional theoretical approaches fail to generate precise or accurate predictions. I discuss recent experimental studies that demonstrate how, in situations with multiple equilibria, behavior can change dramatically in ways unaccounted for by current theoretical models. This evidence highlights the need for improved behavioral theories of equilibrium selection, comparable to advances in other areas of behavioral economic research.

- **11.00-11.30: On the Interaction of Economic Theory and Experimental Economics: Studies on Incomplete Preferences and Partner Choice**

Arno Riedl, Maastricht University, Netherlands

Experiments in economics and psychology have critically contributed to the development of new theoretical (behavioral) models of individual and social behavior. Experiments may not only be used to falsify existing models but can also suggest the right way of modeling. This will be exemplified by a novel study on the incompleteness of preferences in decisions under uncertainty where the major (behavioral) models fail to account for observed behavior. Moreover, in a strategic setting it will be shown that economics experiments that ignore the power of partner choice in social interaction are likely doomed to produce misleading predictions for field behavior and to give wrong guidance for theory development.

- **11.30-12.00: Experimental Choices and Field Behavior: On Impatience, Saving and Smoking**

Matthias Sutter, University of Innsbruck, Austria

Experimental economics applies controlled conditions to investigate the causal factors that drive economic behavior. Recent work has been focusing on how experimental choices relate to field behavior. We link teenagers' decisions in an intertemporal choice experiment to their savings decisions and health related behavior (such as smoking). We do not only find important correlations, but also a predictive power of experimental choices for field behavior a few years later.

- **12.00-12.30: Rethinking Macroeconomics Based on Complexity Theory**

Dirk Helbing, ETH Zurich, Switzerland

We argue that, if we are to find a more satisfactory approach to tackling the major socio-economic problems with which we are faced, we may need to thoroughly rethink the basic assumptions of macroeconomic and financial theory. Making minor modifications to the standard models to remove "imperfections" may not be enough, the whole framework may need to be reconstructed. Let us first enumerate some of the standard assumptions and postulates of economic theory: The first of these is the idea that an economy is an equilibrium system. In other words it is a system in which all markets systematically clear at each point of time but where the equilibrium may be perturbed, from time to time by exogenous shocks. The second is that the selfish or greedy behaviour of individuals yields a result which is beneficial to society, a modern and inadequate restatement of Adam Smith's description of "the invisible hand". Thirdly, Individuals and companies decide rationally. By this is meant that individuals optimize under the constraints with which they are faced and that their choices satisfy some standard axioms of consistency. Fourthly, the behaviour of the all agents together can be treated as corresponding to that of the average or representative individual. Fifthly when the financial sector is analysed it is assumed that financial markets are efficient. Efficiency here meaning that all the relevant information about the price of an asset is reflected by the price of that asset. Thus no individual has any incentive to seek information for himself. Sixthly in financial markets it is assumed that the more liquid they are the better they function. Lastly in financial markets the more connected the network of links between individuals and institutions the more risk is spread and the more stable and robust the system. We will show computer simulations or analyses of other social systems that question assumptions such as the above, but also give a perspective of how a new theoretical approach may be developed that is in better agreement with real-world evidence.

- **14.00-14.30: Simple Stochastic Games: Risk Taking in Strategic Contexts**

Ryan Murphy, ETH Zurich, Switzerland

Stochastic game theory unifies both strategic interactions and random processes into a single analytic framework. Along these lines, we develop a simple risky choice problem, and then extend that decision theoretic problem into a strategic context. We derive the equilibrium for this simple 2-player zero sum game and show that its mixed strategy equilibrium is both complicated and highly sensitive to the stochastic process. Further we show a non-zero sum version of this game, and then outline several experiments along these lines.

- **14.30-15.00: On the Psychology of Contracts**

Christian Zehnder, University of Lausanne, Switzerland

Recent theoretical work on incomplete contracts suggests that contracts may not only define trading parties' rights and obligations but may also have important psychological effects. In particular, it has been hypothesized that competitively negotiated ex ante contracts may provide salient reference points which shape perceived entitlements in ex post trade. A series of papers demonstrates that the existence of such contractual reference points has a number of important implications for the theory of the firm. We have conducted a series of controlled laboratory experiments testing the empirical relevance of the underlying behavioral assumptions of this new strand of literature. Our evidence is highly supportive for the hypothesis that contracts serve as reference points. Specifically, we find that there is an important trade-off between contractual rigidity and flexibility. While the existence of this trade-off is in line with the theory of contractual reference points, it is in strong contrast to both standard economic theory and established behavioral models of social preferences. Further experimental conditions also reveal that the central behavioral mechanism underlying the concept of contractual reference points is robust to the presence of informal agreements and ex post renegotiation.

- **15.00-15.30: Competition Policy as a Tool for the Macroprudential Regulation of the Banking Sector**

Massimo Molinari, University of Trento, Italy

Coauthors: Edoardo Gaffeo

In this paper we employ network analysis to re-assess competition policy within a macroprudential framework. Such an exercise seems to be relevant as it explicitly addresses a question posed forcefully by Haldane (2009), that is whether policy interventions can alter the topological network structure with the declared aim of improving network robustness. Here we concentrate on the idea that central banks and antitrust authorities have the opportunity to design the structure of the industry by choosing how banks are allowed to merge. Merges change the topology of the system for three reasons: 1) larger banks are formed as the summation of smaller ones; 2) the total number of active banks decrease; 3) large banks generally possess more connections than small banks. One can imagine that different competition policies (e.g., let just one very big bank to form by allowing it to acquire a large number of smaller banks; limit the size of each merger to just two small units, etc.) lead to different network topologies, which could in principle be characterized by different degrees of resilience to shocks. If this is the case, competition policy can be interpreted as an additional tool for macroprudential regulation aimed at preventing systemic crises. We build an agent-based computational laboratory of an interbank network and employ three different types of M&A strategies as network-changing devices, in order to evaluate their effect on the resilience of the system. Our results suggest that topologies are not all alike: more specifically, it appears that a concentrated and yet asymmetric system is better geared to cope with an external shock. By contrast, concentrated and symmetric markets turns out to be in fact more fragile than a competitive one. The extent of the damage to the system depends on the exposure to interbank claims, the degree of connectivity, the structure of the network and capital requirements. In addition, we put forward the idea that capital requirements should be network-varying. Different shock-amplifying dynamics are observed because flat capital requirements force an inefficient allocation of net worth within the system. For example, it turns out that large banks are forced to hold too much capital whereas small institutions have

less than what it is necessary and this misallocation renders the system less resilient. Once we introduce network-varying capital requirements, the robustness of the system improves and this aligns the performance of different topologies. The clear policy implication is that the regulator shall closely monitor the structure of the network and its evolution over time because policy on capital requirements is sensitive to it and one size does not fit all. We need to improve our effort towards the production of reliable and up-to-date data that allows us to map banking networks as precisely as possible.

- **16.00-16.45: The Economics of Money Illusion**

Jean-Robert Tyran, University of Vienna, Austria

Money illusion refers to a tendency to think about economic transactions in terms of nominal rather than real values. While standard economics assumes that all economic agents are free from money illusion, increasing evidence suggests that thinking in nominal terms is common, that purely nominal changes can affect individual choices, and that money illusion can shape outcomes in labor, housing and asset markets. The lecture argues that experiments can be used to understand when money illusion matters for economic outcomes – and when it does not.

- **16.45-17.30: The Weave of Social Life: How Community Participation Shapes the Individual**

Lorenz Goette, University of Lausanne, Switzerland

Coauthors: Rene Algesheimer and Ernst Fehr

Does society shape individuals? Examining this question is difficult, as individuals influence the collective just as the collective may influence the individual. We use a large-scale field experiment to solve this causality problem and show that groups with stronger community participation render their members generally more altruistic and trusting towards anonymous strangers. Moreover, stronger community participation also causes a boost in trust towards those who reciprocate favours, thus generating stronger implicit punishment for untrustworthy individuals. Increased community participation enhances the strategic sophistication of individuals and raises the prevalence of Machiavellian strategies.

Thursday: Systemic Risk

- **9.00-9.45: Is Early Warning Against Systemic Risk Feasible? The ECB's Newly Developed Analytical Support to the European Systemic Risk Board**

Carsten Detken, European Central Bank, Germany

The lecture will address the question whether the construction of early warning systems against systemic risks might not be a futile attempt to safeguard financial stability, as the orthodox academic scepticism towards the early warning literature might suggest. The position taken here is that a careful optimism is defensible, due to lessons learned, methodological advances, improvements in data availability, as well as policy makers changed attitude towards type I versus type II errors. The newly developed risk identification approach as well as some examples of models and tools employed by the ECB to provide analytical support to the European Systemic Risk Board will be presented. Experience with different models, with hindsight, reveals the usefulness of some structural indicators, like global credit gaps, and the uselessness of market price based indicators for early warning purposes.

- **9.45-10.30: Crisis, Contagion, and the Need for a New Paradigm**

Joseph E. Stiglitz, Columbia University, USA

Joseph E. Stiglitz is Professor of Economics at Columbia University New York and recipient of the 2001 Nobel Memorial Prize in Economic Sciences. He is not only one of the most influential academic economists of the last decades, but also has been the Chairman of the Council of Economic Advisers during the Clinton administration, Chief Economist of the World Bank and member of the Intergovernmental Panel on Climate Change.

- **11.00-12.00: Panel Discussion Systemic Risk: Are There Lessons To Be Learned?**

Chaired by Frank Schweitzer

Jürg Blum (Swiss National Bank), Rama Cont (Imperial College London), Carsten Detken (European Central Bank), Peter Fischer (Neue Zürcher Zeitung), Jean Charles Rochet (University of Zurich), Didier Sornette (ETH Zurich), Joseph E. Stiglitz (Columbia University, New York) and Frank Schweitzer (ETH Zurich) will discuss about the role of Systemic Risks in a modern, highly interconnected world. Especially the question *Are There Lessons To Be Learned?* will be addressed - triggered, but not limited to - the recent economic crisis.

- **14.00-14.45: Channels of Contagion: Identifying and Monitoring Systemic Risk in the Financial System**

Rama Cont, Imperial College London, UK

The recent financial crisis has simultaneously underlined the importance of systemic risk and the absence of an appropriate framework for assessing, monitoring and regulating it. Modeling systemic risk requires to change the traditional focus of risk modeling and examine the structure and stability of the financial system as a whole, with special attention given to contagion mechanisms which may lead to large scale instabilities in the financial system.

We present some recent work on the quantitative modeling of systemic risk, focusing on three key channels for financial contagion: balance sheet contagion [1,2,3,4], illiquidity cascades [3]

and endogenous risk [7,8] generated by feedback effects. Finally, we discuss the implications of these results for monitoring of systemic risk. [1] H Amini, R Cont, A Minca (2011) Resilience to contagion in financial networks. [2] H Amini, R Cont, A Minca (2012) Stress testing the resilience of financial networks, *International Journal of Theoretical and applied finance*, Vol 15. [3] R Cont (2009) Measuring systemic risk, Working Paper. [4] R Cont, A Moussa, E B Santos (2010) Network structure and systemic risk in banking systems in: J.P. Fouque & J. Langsam (Eds.) *Handbook of Systemic Risk*, Cambridge University Press. [5] R Cont, L Wagalath (2011) Running for the exit: short selling and endogenous correlation in financial markets. To appear in *Mathematical Finance*, Volume 22. [6] R Cont, L Wagalath (2012) Fire sale forensics: measuring endogenous risk.

- **14.45-15.30: Taming Systemically Important Financial Institutions**

Jean Charles Rochet, Swiss Finance Institute and University of Zurich, Switzerland
Coauthors: Xavier Freixas (UPF Barcelona)

We model a Systemically Important Financial Institution (SIFI) that is too big (or too interconnected) to fail. Without credible regulation and strong supervision, the shareholders of this institution might deliberately let its managers take excessive risk. We propose a solution to this problem, showing how insurance against systemic shocks can be provided without generating moral hazard. The solution involves levying a systemic tax needed to cover the costs of future crises and more importantly establishing a Systemic Risk Authority endowed with special resolution powers, including the control of bankers' compensation packages during crisis periods.

- **16.00-16.30: Ranking Systemically Important Institutions**

Matteo Luciani, ECARES - Universite libre de Bruxelles, Belgium

Coauthors: Mardi Dungey (Cambridge and Tasmania Univ.) and David Veredas (ECARES - Univ. libre de Bruxelles)

Based on the definition of systemic risk given by Jean-Claude Trichet at Clare College in Cambridge (Dec. 2009), we propose a simple methodology for ranking systemically important institutions. We incorporate both the cross sectional aspects of risks through firms interrelations and the time series aspects of the evolution of this interconnectedness over time. We view firm's risks as a network with vertices equal to the volatility shocks and edges equal to their correlations. Dynamic centrality measures allow us to rank the firms in terms of risk connectedness and firm characteristics. The resulting global systemic risk (GS) measure from applying this approach to all firms in the S&P500 for 2003-2011 reveals that the systemic risk in the financial sector stocks peaked in September 2008, but was greatly reduced by the introduction of TARP. Anxiety about European debt markets saw the systemic risk begin to rise again from April 2010. We further decompose these results to find that the systemic risk of insurance and deposit taking institutions differs importantly, the latter experienced generally declining systemic risk from late 2007, in line with burst of the housing price bubble, while risk for insurance companies continued to climb up to the rescue of AIG. Our systemic risk index emphasises interconnectedness: a comparison of this with the capital shortfall approach of Brownlees and Engle (2011) shows that while risk due to interconnectedness declined post September 2008, capital shortfall risk remained at sustained levels. The two approaches offer complementary information. Further, we show the importance of including the interconnectedness of the financial sector with firms in the real economy, in producing measures of systemic risk.

- **16.00-16.30: Identifying Systemically Important Banks in Payment Systems**

Kimmo Soramäki, Financial Network Analytics, Spain

Coauthors: Samantha Cook, PhD

The ability to accurately estimate the extent to which the failure of a bank disrupts the financial system is very valuable for regulators of the financial system. One important part of the financial system is the interbank payment system. The paper develops a robust measure, SinkRank, that not only accurately predicts the magnitude of disruption by a given bank in a payment system, but also informs about which banks are most affected by the failure. In interbank payment networks banks (nodes) transfer payments related to customer requests or their own trading along directed links of the network. When a payment is made the money is no longer available to the sender, and the receiver of the funds can make a payment to any other bank in the system. The transfer process takes place along walks in the network as any bank can pay other multiple times without constraints. Traditional measures of centrality that have been developed in network theory with other types of processes in mind (e.g. processes transmitted along geodesic paths or trails or processes based on duplications instead of transfer) are not able to accurately identify central nodes in systems based on transfers along walks and with feedback loops present in payment systems. SinkRank is based on absorbing Markov chains which are well suited to model transfers processes along walks in a network. An absorbing state is a state from which there is a zero probability of exiting. The theory reflects accurately the process of bank failure in a payment system – any funds sent to the failing bank stay in its account until the bank resumes operations. Because actual bank failures are rare and the data is not generally publicly available, the metric is tested by simulating payment networks and inducing failures in them. In the simulations each bank is set in turn to be unable to send any payments during the day. The failing bank continues, however, to receive payments and traps some of the total liquidity on its account - becoming a sink. As a consequence other banks run short of liquidity and queues will build, first causing existing liquidity buffers to be used more and eventually causing payments to be delayed. We use two metrics to evaluate the magnitude of the disturbance. First, duration of delays in the system ('Congestion') aggregated over all banks and the average reduction in available funds of the other banks due to the failing bank (Liquidity Dislocation) as measures of the extent of this disruption. We test the measure on Barabasi-Albert types of scale-free networks, random networks and lattice networks. We find that the SinkRank of a node correlates very strongly and stronger than other topological measures considered with both Congestion and Liquidity Dislocation caused by its simulated failure.

- **16.30-17.00: Contagion in Financial Networks**

Giovanni di Iasio, Bank of Italy, Italy

Coauthors: Stefano Battiston, Luigi Infante, Federico Pierobon

A default of a bank has cascade-effects in a financial network in which entities are tightly intertwined. The cascade may propagate sequentially with additional defaults, from close neighbors to distant banks. Many contributions show that banking systems seem to be fairly stable to contagion via credit risk, as very large shocks are needed to simulate cascades of a meaningful size. We use a novel method - DebtRank – from previous contributions of one of the authors, to assess the centrality of a bank in a network, accounting for the propagation of distress even in the absence of defaults in the cascade. Indeed, an event that weakens the balance-sheet of a bank j , has a negative spillover on the balance sheet of claim-holders of j (contagion through

distress). In this respect, the centrality of a bank is (i) proportional to its relative exposure toward the source of distress and (ii) depends on its financial soundness. DebtRank solves the infinite reverberation problem typical of contagion in networks with loops. We estimate the total potential loss to the financial system caused either by an initial default of a single institution or by a common shock to several institutions. The method also allows to find candidate subsets of institutions that, together, may constitute systemically important groups. We use a unique dataset of supervisory reports to the Bank of Italy that includes (i) bilateral exposures (secured and unsecured, short and long term) between all Italian banks, (ii) the links with major foreign financial institutions and (iii) balance sheet data (capital, total and encumbered assets,...).

- **16.30-17.00: Financial Linkages, Macroprudential Policy, and Systemic Risk**

Co-Pierre Georg, UC3M & Oxford University, United Kingdom

Coauthors: Silvia Gabrieli, Banque de France

With the financial crisis of 2007/2008 systemic risk took center stage and challenged our understanding of a financial system that has become highly interconnected and increasingly complex. Policy makers and academics alike are faced with the key task to develop new models of systemic risk that account for agent heterogeneity, interconnectedness, and complexity. In recent years, financial networks and Agent-Based-Models have gained increasing attention as tools to model and understand systemic risk. In this paper we analyse the interplay of different forms of systemic risk and assess the effectiveness of macroprudential measures to facilitate financial stability. We develop a multi-agent simulation of the banking system that features all relevant forms of systemic risk: interbank contagion caused by counterparty risk; endogenously generated fire-sales caused by common asset holdings; and information contagion triggered by either an initial bank default or an ongoing fire-sale. The novelty of our contribution is the simultaneous occurrence of various sources of financial fragility, which allows us to take feedback effects between the different forms of systemic risk into account. In addition, we allow for varying macroeconomic conditions during the course of a simulation, analysing the effect of financial fragility building in good times and manifesting during a recession. Hence, our model helps to bridge the gap between the time-dimension of systemic risk (i.e. how it builds over time) and the cross-sectional dimension (i.e. how it spreads when a shock hit the system). We use our framework to assess the effectiveness of various macroprudential measures, including countercyclical capital requirements, different liquidity ratios, a leverage ratio, and surcharges for systemically financial institutions. We model agents as optimising a portfolio of risky real assets (i.e. loans to the real economy), risky financial assets (i.e. interbank loans and repurchase agreements) and riskless assets (i.e. cash or US treasury bonds). Agent heterogeneity is introduced through varying risk, return, and liquidity preferences. When a shock hits the system, (myopic) agents optimally rebalance their portfolios. This endogenously changes the interbank network structure and correlations of banks' portfolios originating from common asset holdings. Information contagion emerges whenever a shock hits the system. This gives rise to feedback effects aggravating interbank market freezes, credit crunches (i.e. substantially reduced investment in real assets), fire sales, and interbank contagion.

- **17.00-17.30: Quantifying Reflexivity in Financial Markets: Towards a Prediction of Flash Crashes**

Vladimir Filimonov, ETH Zurich, D-MTEC, Switzerland

Coauthors: Didier Sornette

We introduce a new measure of activity of financial markets that provides a direct access to their level of endogeneity. This measure quantifies how much of price changes are due to endogenous feedback processes, as opposed to exogenous news. For this, we calibrate the self-excited conditional Poisson Hawkes model, which combines in a natural and parsimonious way exogenous influences with self-excited dynamics, to the E-mini S&P 500 futures contracts traded in the Chicago Mercantile Exchange from 1998 to 2010. We find that the level of endogeneity has increased significantly from 1998 to 2010, with only 70% in 1998 to less than 30% since 2007 of the price changes resulting from some revealed exogenous information. Analogous to nuclear plant safety concerned with avoiding "criticality", our measure provides a direct quantification of the distance of the financial market to a critical state defined precisely as the limit of diverging trading activity in absence of any external driving. This talk represents work with D. Sornette (PRE 85 (5), 2012: 056108)

- **17.00-17.30: The Role of Interbank Lending in the Prediction of Individual Bank Failures during a Banking Crisis**

Andreas Krause, University of Bath, Great Britain

Coauthors: Simone Giansante

We analyze the determinants of individual bank failures arising from solvency and liquidity shortages in a stylized banking system following Krause/Giansante (2012, forthcoming JEBO) where banks are characterized by the amount of capital, cash reserves and their exposure to the interbank loan market as borrowers as well as lenders. A network of interbank lending is established that is used as a transmission mechanism for the failure of banks through the system. We trigger a potential banking crisis by exogenously failing a bank and then investigate the likelihood of an individual bank failing. Most notably we find that the probability of a bank failing depends on the characteristics of the network of interbank loans and the market structure, while balance sheet relationships are of limited influence. We also establish different determinants for failures arising from solvency and liquidity shortages.

Friday: Economic Networks

- **9.00-9.45: The International Trade Network: Statistical Properties and Modeling**

Giorgio Fagiolo, Scuola Superiore Sant'Anna Pisa, Italy

In the last years, complex-network analysis has been applied to several fields in economics, giving rise to a wide literature, both empirical and theoretical. In this talk, I will overview some recent work exploring the properties of the international-trade network (ITN), defined as the graph where nodes are world countries and links represent bilateral trade flows (imports or exports). I address five main questions: (1) Why characterizing trade flows using a network representation may be relevant for trade economists? (2) Can the knowledge of the ITN topological properties shed new light on issues like growth, globalization and trade integration? (3) Can we separate ITN topological properties that are the sheer outcome of randomness from those that are instead statistically significant? (4) Is the gravity model of trade able to replicate the observed ITN structure? (5) Can we explain the properties of the ITN in terms of standard economic forces such as country specialization and comparative advantage?

- **9.45-10.30: Network Resilience**

Sanjeev Goyal, Cambridge University, UK

Connections between individuals facilitate the exchange of goods, resources and information and create benefits. However, the connections are costly to create and also serve as conduits for the spread of attacks and viruses. What are the implications of this trade-off for the network design and the nature of contagion in networks. The talk will present an overview of theoretical models and empirical studies of network resilience.

- **11.00-11.30: Directed Clustering Coefficient as a Measure of Systemic Risk in Complex Banking Networks**

Benjamin Tabak, Banco Central do Brasil and UCB, Brazil

Coauthors: Daniel O Cajueiro; Marcelo Takami; Jadson Rocha

Recent literature has focused on the study of systemic risk in complex networks. It is clear now, after the crisis of 2008, that the aggregate behavior of the interaction among the agents is not straightforward and it is very difficult to predict. Contributing to this debate, this paper shows that the directed clustering coefficient may be used as a measure of systemic risk in complex networks. Furthermore, using data from the Brazilian bank interbank network, we show that the directed clustering coefficient is negatively correlated with domestic interest rates

- **11.00-11.30: A New Metric for the Economic Complexity of Countries and Products**

Andrea Tacchella, La Sapienza - University of Rome, Italy

Coauthors: Andrea Tacchella, Matthieu Cristelli, Luciano Pietronero

We discuss a new approach to the complexity of countries and products in the spirit of the recent work by Hidalgo and Hausmann (PNAS 2009). The basic information is represented by the matrix of countries and exported products. The standard economic analysis is essentially based on the GDP but the diversification of this into a series of different products provides an additional

element of fitness in the spirit of biodiversification in a fluctuating environment. According to the standard analysis, the specialization of countries towards certain specific products should be optimal, but this is valid only in a static condition. The strongly dynamical situation of the world market suggests that flexibility and adaptability are even more important. We propose a novel metric, defined as the fixed point of two nonlinear coupled maps, which is able to quantify these qualitative observations. Our new metric has the following fundamental properties: 1. It defines a Fitness for countries and a Complexity for products which are improved by iteration but always keep their original meaning. 2. The iteration adds complexity to the distributions which become broad and Pareto like. 3. Test cases show that the fixed point of the iteration is weakly perturbed by noise. This is crucial as real export data is unavoidably noisy. 4. Test cases and real applications are strongly improved with respect to previous approaches. The information provided by this new metric can be used in various ways. The direct comparison of the Fitness with the country GDP gives an assessment of the non expressed potential of the country. Also for each country it is possible to define the Complexity of the products exported and how competitive is this country with respect to the other countries which produce the same product. The behavior of the countries in this new space is rather heterogeneous for different groups of countries. This heterogeneity is crucial to identify a predictive power for the GDP or for the Stock indices. The method permits also a scientific test of the rating and the new variables are shown to be far superior to the standard rating in identifying risky situations long before the collapse.

- **11.30-12.00: Measurement and Internalization of Systemic Risk in a Global Bank Trading & Clearing Network**

Xiaobing Feng, Shanghai Jiaotong University, SHIFT, China

Coauthors: Haibo Hu, Matt Pritsker, Beomjun Kim

The negative externalities from an individual bank failure to the whole system can be huge. One of the key purposes of bank regulation is to internalize the social costs of potential bank failures via capital charges. This study proposes a method to evaluate and allocate the systemic risk to different countries using a SIR type of epidemic spreading model and the Shapley value in game theory. The paper also explores features of a constructed bank network using real globe-wide banking data. The major findings are that the magnitude of the systemic risk at the national level is related to the degree distribution of a bank in a nonlinear fashion. To be more specific, it depends on whether the network is more heterogeneous such as a scale free network, or more homogeneous such as an exponential or even a regular network. The constructed global banking network includes over 30,000 public and private overseas banks all over the world. The systemic important institutions are identified. The detected modularity of the global network indicates that the geographical location still plays roles in formulating the communities. The systemic risk is internalized by capital charges required from each country. The capital charge is evaluated based on the country level systemic risk. A type-two-holling function is used to convert systemic risk to capital charge. Finally we suggest that individual risk control policy should be combined to the systemic risk control policy to maintain the stability of the system, neither of which can be ignored. This is an advice that is different from the current policy stance that emphasizes only the safety of individual bank.

- **11.30-12.00: An Empirical Study of the Mexican Banking System's Network and its Implications for Systemic Risk**

Martinez Jaramillo Serafin, Banco de Mexico

With the purpose of measuring and monitoring systemic risk, some topological properties of the interbank exposures and the payments system networks are studied. We propose non-topological measures which are useful to describe the individual behavior of banks in both networks. The evolution of such networks is also studied and some important conclusions from the systemic risks perspective are drawn. A unified measure of interconnectedness is also created. The main findings of this study are: the payments system network is strongly connected in contrast to the interbank exposures network; the type of exposures and payment size reveal different roles played by banks; behavior of banks in the exposures network changed considerably after Lehman's failure; interconnectedness of a bank, estimated by the unified measure, is not necessarily related with its assets size.

- **12.00-12.30: Mitigating Distress Cascades in Financial Networks**

Antonio Scala, CNR-ISC La Sapienza, IMT Lucca and LIMS London, Italy

Coauthors: Guido Caldarelli

We use a simple model of distress propagation (the sandpile model) to show how financial systems are naturally subject to the risk of systemic failures. Taking into account possible network structures among financial institutions, we investigate if simple policies can limit financial distress propagation to avoid system-wide crises, i.e. to dampen systemic risk. We therefore compare different immunization policies (targeted helps to financial institutions) and find that the information coming from the network topology allows to mitigate systemic cascades by targeting just few institutions. Furthermore, our analysis points that "Rich Clubs" can significantly enhance the effects of targeted policies for securing the financial network. This result represents a highly controversial point from the perspective of policy makers trying to enforce a free market and to avoid oligopolies.

- **12.00-12.30: The Network of Global Corporate Control**

Stefano Battiston, ETH Zurich, Switzerland

Coauthors: Stefania Vitali and James B. Glattfelder

The structure of the control network of transnational corporations affects global market competition and financial stability. So far, only small national samples were studied and there was no appropriate methodology to assess control globally. We present the first investigation of the architecture of the international ownership network, along with the computation of the control held by each global player. We find that transnational corporations form a giant bow-tie structure and that a large portion of control flows to a small tightly-knit core of financial institutions. This core can be seen as an economic "super-entity" that raises new important issues both for researchers and policy makers.

- **14.00-14.30: Contagious Defaults in Financial Networks**

Hamed Amini, EPFL (Swiss Finance Institute), Switzerland

Coauthors: Rama Cont and Andreea Minca

Propagation of balance-sheet or cash-flow insolvency across financial institutions may be modeled as a cascade process on a network representing their mutual exposures. In the first part, we derive rigorous asymptotic results for the magnitude of contagion in a large financial network and give an analytical expression for the asymptotic fraction of defaults, in terms of network characteristics. Our results extend previous studies on contagion in random graphs to inhomogeneous directed graphs with a given degree sequence and arbitrary distribution of weights. We introduce a criterion for the resilience of a large financial network to the insolvency of a small group of financial institutions and quantify how contagion amplifies small shocks to the network. Our results emphasize the role played by "contagious links" and show that institutions which contribute most to network instability in case of default have both large connectivity and a large fraction of contagious links. The asymptotic results show good agreement with simulations for networks with realistic sizes. This part of talk is based on joint work with Rama Cont and Andreea Minca. In the second part, we consider the problem of a lender of last resort who seeks to minimize the magnitude of contagion under budget constraints. In case the lender observes the interbank exposures progressively, as banks report their exposures to banks in default, we can model distress propagation under intervention as a Markov Decision Process. We find the optimal intervention policy as a result of Hamilton Jacobi Bellman equations. Our results show that, in the case of non-anticipative information, the optimal strategy depends in a non-linear way on the fraction of banks that use short-term funding. This part is based on a joint work with Jean-Philippe Chancelier, Andreea Minca and Agnes Sulem.

- **14.30-15.00: Rollover Risk and Endogenous Network Dynamics**

Frank Page, Indiana University, USA

Coauthors: Jose Pedro Figue

One of the most striking phenomena of the 2007-2009 financial crises was the rapidity with which liquidity in the interbank markets dried up, especially in long term maturities. In network literature terminology, the once dense interbank network that allowed highly liquid banks to channel liquidity to those banks with investment opportunities, transitioned to a sparse architecture. The sudden failure of the once well-functioning interbank loan network during the recent financial crisis has given momentum to the movement toward major, worldwide regulatory reform to minimize the possibility of another interbank network failure and to make the financial network more robust. The shortcomings of the regulatory framework exposed by the crisis lead to the design and implementation of new instruments aimed at the insuring the stability of the financial system. One of these instruments, now in use in several European countries, is a special banking levy/tax. The levy/tax aims not only to raise funds to reduce the cost to taxpayers incurred with past (or future) rescues of the financial infrastructure but also to provide banks with the correct incentives for risk taking. The purpose of this paper is twofold: (i) to analyze within a dynamic network formation game how macroeconomic conditions, such as investors' risk appetite, affect rollover decisions and (ii) to determine the effects that a levy has on the endogenous dynamics of network formation. We find that because the existence of linkages between market participants generates an informational externality, the newly formed network is strongly conditioned by past network architectures. Simulations show that this inertia is strongly dependent

on macroeconomic conditions, such as investors' risk appetite. The numerical exercises reveal that for intermediate values of the risk appetite parameter, the inability to maintain a threshold number of linkages may push the market into a gridlock. Moreover, this tipping point property implies that the recovery from a market freeze situation requires good conditions of a magnitude considerably greater than the magnitude of the bad conditions precipitated the crisis in the first place – leading to a network induced inertia. Finally, since we model the special banking levy as a cost to the activation of interbank connections, we find that a substantial decline in the tax burden is required in order to re-start lending activity when the market experiences severe stress situations. Thus while we find that banking levy instruments play an important role in aligning private and social incentives for risk taking - and therefore, constitute an important part of the regulatory landscape - if the activation of each interbank connection has an externality that is particularly onerous during periods of financial stress, the weight of this instrument (i.e. banking levies) should be counter-cyclical, as are the recent capital requirement proposals supported both by academia and regulatory bodies.

- **15.00-15.30: Mapping the UK Interbank Market**

Sam Langfield, European Systemic Risk Board, Germany and UK

Coauthors: Tomohiro Ota and Zijun Liu

This paper describes the features of the UK interbank system, using a newly available regulatory dataset on counterparty-level interbank exposures. To our knowledge, this dataset is the most granular representation of a large interbank market available worldwide. We present recently developed metrics which characterise the network from the point of view of financial-system stability. We pay particular attention to four complexities. Firstly, the network exhibits multiple layering: nodes are connected by up to 150 types of financial instruments, including prime lending, fixed income, CDS, repos, derivatives and others, at a spectrum of maturities. Secondly, each link is directed from bank A to bank B. Thirdly, each link has a weight, which corresponds to the pound sterling value of the exposure or funding source. Fourthly, nodes are diverse in their balance sheet characteristics. Comprehensive matching between the interbank exposures dataset, a regulatory balance-sheet dataset and public data allows us to capture this heterogeneity. The interbank network clearly exhibits a 'hub and spoke' structure. Most of the 176 banks resident in the UK are exposed to a handful of money-centre banks. We infer that the UK interbank system is 'robust yet fragile': it is resilient against random shocks, but vulnerable to targeted attacks. We conclude by suggesting avenues for future research, particularly on how financial policy might respond to such network structure in order to improve financial-system stability.

- **16.00-16.45: Globalization and Social Networks**

Fernando Vega-Redondo, European University Institute Florence, Italy

We propose a stylised dynamic model to understand the role of social networks in the phenomenon we call "globalization". This term refers to the process by which even agents who are geographically far apart come to interact, thus overcoming what would otherwise be a fast saturation of local opportunities. A key feature of our model is that the social network is the main channel through which agents search and exploit new opportunities. Thus only if the social network becomes global (heuristically, "reaches far") can global interaction be steadily sustained. To shed light on the conditions under which such a transformation may, or may not, take place is

the main objective of the paper. One of our interesting insights is that in order for a local social network to turn global, the economy needs to display a degree of "geographical cohesion" that is neither too high (for then global opportunities simply do not arise) nor too low (in which case there is too little social structure for the process to take off). And if globalization does arise, we show that it often occurs abruptly and consolidates as a robust state of affairs. We also show how it is affected by improvements in the flow at which information travels in the network, or the range at which the social network helps to monitor behavior.

- **16.45-17.30: Networks of Knowledge**

Pier-Paolo Saviotti, Universität Hohenheim, Germany

In this paper the representation of the knowledge base of firms, research organizations or fields of knowledge as a network will be described. Networks of this type have nodes constituted by units of knowledge defined at a given level of aggregation and links determined by the interactions of such units. Examples of such units are the technological classes associated to patents or the themes that can be identified in scientific publications or patents. The paper will describe the application of this approach to the dynamics of knowledge in firms, research organizations or fields of knowledge by mapping the changes occurring in the structure of knowledge and by measuring some relevant properties of the of the knowledge bases, such as their coherence, variety or cognitive distance. Among other applications this approach can allow us to detect the presence of knowledge discontinuities, such as technological paradigms, and their impact on the behaviour of firms or research organizations.

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