EUROPEAN SCIENCE FOUNDATION
SETTING SCIENCE AGENDAS FOR EUROPE

Exploratory Workshop Scheme

Standing Committee for Social Sciences (SCSS)

ESF Exploratory Workshop on

Information and Behaviour in Networks

Oxford (United Kingdom), 8-11 December 2010

Convened by:
Marcel Fafchamps, Edoardo Gallo and Sanjeev Goyal

SCIENTIFIC REPORT

Co-sponsored by

Nuffield College, University of Oxford

Executive Summary

A growing body of theoretical and empirical research has firmly established that network structure plays a key role in diffusion processes and in influencing the behavior of economic agents. The spectrum of diffusion processes where networks matter spans from the spread of information, technologies and diseases in social networks to the spread of a financial shock in a network of financial institutions. The behavior of individual consumers, firms, financial institutions and even countries is influenced by the network of ties that connect them and by their position in these complex network structures.

The multitude of biological and social phenomena where networks play a key role calls for an interdisciplinary approach to the quest to discover the fundamental principles governing these phenomena. Moreover, the difficulty of gathering the large amount of data required to identify empirically network effects calls for a close collaboration between theoretical and empirical researchers to coordinate efforts to test the most promising theoretical results and to collect data to discover new phenomena.

Early empirical studies in sociology showed the importance of acquaintances in, for example, determining consumer choices and the spread of innovation, but only in the last decade economists have included social interactions in models of learning. This work has shed light on several questions including (i) what are the structural properties of networks that help sustain diversity of opinions, (ii) who are the most influential individuals in a network, (iii) which structural features facilitate the adoption of optimal actions, and (iv) how rapidly individuals converge to a common action/opinion.

However, a lot of questions are still unanswered. A fundamental feature of individuals' strategic choices is that they update their opinion depending not just on their acquaintances' opinion, but also on how these acquaintances have formed those opinions depending on their acquaintances' opinions, and so on. The information individuals have about the network structure, the information they have about other individuals and the updating rule they use are key determinants of the final outcomes, but a lot of research still needs to be done on the role played by these factors. Moreover, the more sophisticated is individuals' updating rule, the more difficult it is to obtain general theoretical results for networks that are complex and/or involve a large number of individuals.

Parallel to the theoretical work in economics, researchers in epidemiology and physics have explored probabilistic models of, for example, the diffusion of diseases on social networks. This work has highlighted the importance of the structural properties of the network to determine the threshold number of individuals that have to be infected for the disease to spread to the whole network, and the crucial position of some individuals to the robustness of the network to random and targeted attacks. The methodological approach adopted in this line of work allows the derivation of very general theoretical results that are valid for any network independently on its complexity and/or number of

individuals. However, these models are too simple to describe processes that are not exclusively probabilistic, and that reflect the more sophisticated, strategic choices that individuals make and that are at the root of most social phenomena of interest.

A hybrid approach that combines the strategic and probabilistic models of diffusion could yield important insights on how the behavior of a large number of individuals is related to the network of ties that connects them. Moreover, this work would be applicable beyond social networks. A prominent example nowadays is the role that the network of financial institutions plays in the evolution of a financial crisis: the agents, e.g. banks, make sophisticated, strategic choices and they are embedded in a complex environment with a large number of different institutions. Research along these lines is in its infancy, and one of the major barriers to its development is the lack of communication across disciplinary boundaries.

It is fair to say that the nascent empirical literature on networks has lagged substantially behind the developments of the theoretical literature. A key conceptual problem with empirical work on networks is the identification of network effects: the network itself is endogenous and shaped by individuals' choices. If we want to investigate whether a certain phenomenon is influenced by the structural properties of the network, then we need to properly account for the fact that the phenomenon itself may affect the emergence of the social structure.

The economics literature has attempted to address this problem in a number of different ways. A first approach is to use instrumental variables: if there is an exogenous variable, the instrument, that affects the structural properties of the network then we can use this instrument to study how changes in the network affect the phenomenon of interest. A second approach is to exploit the time structure of the data: if we show that the current decisions of an individual depend on the past decisions of his/her peers then causation is clear. A third approach is to run an experiment where variations in network structure are random by design.

The common theme across empirical studies that attempt to identify social network effects is the sheer scale of the task. It is costly and time-consuming to collect extensive datasets of the personal and network characteristics of a large number of individuals and their evolution over a sufficiently long time frame. It is difficult to come across natural experiments that cause an exogenous variation in social structure, or to engineer such a variation on a large enough scale. The best way to overcome these barriers is to pool resources, methodologies and talents from different disciplines. Furthermore, it is crucial to ensure a close collaboration between theorists and empiricists so that the key theoretical results are identified and prioritized in the planning for empirical projects.

An explicit objective of this workshop was to bring together researchers from all over Europe and across disciplines to contribute to the definition of a collaborative agenda for research on networks. The goals of the workshop were

twofold. The first was to share views, methodologies and results from different disciplines and identify a set of open questions where an interdisciplinary approach is crucial to move forward. The second was to identify a list of theoretical results to prioritize for empirical testing and to discuss how these empirical projects can be carried out.

Scientific Content

The first day of the workshop began with an introduction by the convenor, Professor Marcel Fafchamps. Marcel spoke of the goals of the workshop and expressed hopes that through the two days of presentations and discussions the participants would be able to develop a better sense of where research on social networks stands today, and the direction where research should be headed. Marcel emphasized how the researchers in the workshop came from a wide set of backgrounds in terms of research in networks, and thanked the participants for agreeing to present and participate to the workshop.

Next the ESF representative, Professor Javier Esparcia Pérez, presented the objectives of the ESF Exploratory Workshops. He also offered a detailed description of other sources of funding available from the European Science Foundation to further the objectives of this initial workshop.

The first morning session featured two presentations by Antonio Cabrales and Matthew Jackson. Antonio Cabrales discussed how networks can be used to analyze the trade-off between the risk-sharing benefits to firms of becoming more highly interconnected versus the large-scale costs resulting from an increased risk exposure. Next Matthew Jackson presented on informal exchange of favors among the members of a society. He presented data on networks in 75 villages in rural India that exhibit a frequency of support that is significantly higher than a standard 'clustering' measure. Their results also found some significant contrasts between support levels in favor networks and purely social networks.

The second morning session featured two presentations by Marcel Fafchamps and Margherita Comola. Marcel Fafschmaps presented a study on gift exchange in a village in Tanzania consisting of 115 households with the objective of testingwhether loans and gift exchanges correspond to a unilateral or a bilateral linking process. He showed that there is support for the unilateral link formation hypothesis, which implies that households find it difficult to extricate themselves from social and familial obligations to assists others in need. Next Margherita Comola presented on how information circulates through informal channels by estimating the magnitude of information spillovers. Using data from three rural villages in Nepal where an educational radio program about family planning and modern contraception methods is broadcasted she showed that targeting network-based opinion leaders has important implications in terms of designing efficient intervention programs.

The third morning session featured two presentations by Werner Raub and Ana Mauleon. Wrner Raub discussed the results of finitely repeated Trust Games in a laboratory experiment looking at the trustfulness of a trustor and the trustworthiness of a trustee. He showed that the trustor's own experiences, the experiences of the other trustor, as well as the trustor's own sanction opportunities affect trustfulness. Interestingly, he also showed that the experimental findings are quite consistent with findings from other studies employing complementary research designs such as surveys and vignette studies. Ana Mauleon discussed a network formation experiment to test various equilibrium notions that have been proposed in the theoretical literature to characterize the set of stable/equilibrium networks. The results of the experiment provide support for farsighted stability, which assumes that individuals are forward looking in their linking decisions.

The first afternoon session featured two presentations by Edoardo Gallo and Bhaskar Dutta. Edoardo Gallo presented a model of social learning in which the

network describes the environment where individuals move. He showed that the dependence of the speed of learning on the network crucially depends on the number of individuals in the society. In small societies a heterogeneous network is conducive to fast learning, while the opposite holds in large societies. Next, Bhaskar Dutta discussed a model of word of mouth advertising in a context in which potential buyers are connected in a fixed network. He showed that larger networks and networks which are not “too well-connected” are more likely to support efficient diffusion of the good product.

The first afternoon session featured two presentations by Matteo Marsili and Eleonora Patacchini. Matteo Marsili presented theoretical results on repeated prisoner’s dilemma on networks to study the emergence of collaboration in a networked society. He showed that cooperation emerges if the cost of defection is small, but if this cost if large then cooperation may require a critical mass and convergence to an equilibrium is not guaranteed. Eleonora Patacchini focused on peer effects of education. Using a large data sample from the U.S. over two time periods she showed that there are strong and persistent peer effects in education.

The second afternoon session featured two presentations by Felix Reed-Tsochas and Simon Weidenholzer. Felix Reed-Tsochas presented an empirical study of innovation adoption in an online social network. Simon Weidenholzer presented a model that looks at the structure of a firm or an organization as a network and considers minimum-effort games played on this network as a metaphor for cooperations failing due to coordination failures. Using a family of behavioral rules, he showed that inefficient conventions arise independently of the interaction structure, if information is limited to the interaction neighborhoods.

The second day of the workshop started with a session featuring two presentations by Sanjeev Goyal and Yves Zenou. Sanjeev Goyal used an extensive dataset on coauthorship in economics to study how knowledge about the social network of an individual researcher --
as embodied in his coauthor relations -- helps in developing a more accurate prediction of his future productivity. One of the findings was that incorporating information about coauthor networks leads to a modest improvement in the accuracy of forecasts on individual output, over and above what we can predict based on the knowledge of past individual output. Yves Zenou presented a model to identify the key player in adolescent delinquent networks, and he used a dataset on adolescents in American high schools to test the predictions of the model. He finds that key players are more likely to be a male, have less educated parents, are less attached to religion and feel socially more excluded.

The second morning session featured two presentations by Gabrielle Demange and frank Schweitzer. Gabrielle Demange talked about how to measure the threat that a bank imposes on a financial system. Gabrielle then used that measure to determine how to optimally inject capital into a financial network so as to optimally reduce the losses due to defaults, or to assess the contributions of the individual institutions to the risk in the system. In his talk Frank Schweitzer discussed two main ingredients for systemic risk in networks: (a) topology, and (b) agent heterogeneity. He highlighted the importance of agent's position in the network, the number of neighbors (degree distribution), and cycles (closed loops of directed links) between agents, to determine systemic risk.

The third morning session featured two presentations by Arno Riedl and Roberta Dessi. Arno Riedl presented the results of an experimental study of coordination games played on a network. He explored two treatments: in the first one the network was exogenously given, while in the second one the network was chosen

by the subjects. Interestingly, behaviour differs in the two treatments and it is more efficient when subjects can choose their neighbors. Roberta Dessi presented the results of an experiment to test individuals' ability to memorize and recall information about friendship networks, and used this data to test how this ability affects behaviour.

The afternoon session featured two presentations by Adam Szeidl and Sergio Currarini. Adam Szeidl presented the results from an experiment that investigates social learning in a large real-world social network. The experiments allowed a test between the DeGroot model of social learning in which agents "double-count" information reaching them through multiple paths, and a "streams" model where agents tag the source of information. The results are consistent with the streams model combined with imperfect information transmission. In the last session of the workshop Sergio Currarini talked about long-run integration in networks, which requires that as a node ages, the type distribution of the nodes connected to it approaches the overall type distribution of the population. He showed that long-run integration occurs if and only if the search part of the network formation process is unbiased, and that eventually the search process dominates in terms of the new links that an older node obtains.

In the round table discussion Marcel Fafchamps, Sanjeev Goyal, Matthew Jackson, Werner Raub, frank Schweitzer and Felix Reed-Tsochas were asked to reflect on the research presented at the workshop with a particular focus on interdisciplinary dialogue and the integration of theoretical and empirical/experimental research. Matthew Jackson emphasized the need to build large datasets to test the current theoretical models and to make these datasets available to the broad community of network researchers. Werner Raub remarked that the comparison of different empirical/experimental methodologies can be an effective way to validate findings. Felix Reed-Tsochas emphasized the need to build closer links between the prevailing theoretical methodogy in the physical sciences, based on stochastic models in which agents follow predefined behavioural rules, and the game-theoretic approach prevailing in economics.

Assessment of the results, contribution to the future direction of the field, outcome

The feedback of the participants to the workshop was overwhelmingly positive. Everyone felt that the closed door format allowed the creation of a committed and engaging discussion of the work presented. Moreover, the presence of researchers from a variety of disciplines (including economics, sociology, physics and mathematics) encouraged a lively comparison of methodologies and approaches.

The round table discussion highlighted some pressing needs for future research on networks across different disciplines. The first one is the testing of current theoretical models using either lab experiments or empirical data. The second one is the creation of shared databases that researchers can have access to for testing theoretical models. The third one is the theoretical challenge of making the network endogenous in current network theory models. Finally, the need to form closer bridges between research on networks across different disciplines.

The Convenors informally discussed with several participants the idea of starting a two-year project that would have the objective to further experimental research on networks. The idea would be to organize a series of 4 workshops over 2 years aimed at presenting a combination of (i) presentations of research designs for future experimental projects and (ii) presentations of results from experimental projects. The balance between the two would change over time: the first workshop would mainly consist of presentation of research designs, while the last workshop would mainly consist of presentation of experimental results. This would fulfill the dual purpose of giving researchers feedback before the beginning of an experimental project and provide a commitment device for the researchers involved to complete the experimental project within a 2-year period. At the end of the last workshop the experimental data would be shared with the broader scientific community after the researchers involved have taken a first cut at examining the data.

Final Workshop Programme

Thursday, December 9th, 2010

Location: Large Lecture Room, Nuffield College

08.30-09.00	*Coffee / Tea*
09.00-09.10	**Welcome by Convenor** **Marcel Fafchamps** (University of Oxford, Oxford, UK)
09.10-09.30	**Presentation of the European Science Foundation (ESF)** **Javier Esparcia Pérez** (Standing Committee for Social Sciences (SCSS))
	Morning Session
09.30-10.30	**"Risk-sharing and contagion in networks"** (joint with Gottardi and Vega-Redondo) **Antonio Cabrales** (Universidad Carlos III de Madrid, Madrid, Spain)
	"Network patterns of favor exchange" **Matthew Jackson** (Stanford University, Stanford, United States)
10.30-10.45	*Coffee / Tea Break*
10.45-11.45	**"Are gifts and loans between households voluntary?"** (joint with Margherita Comola) **Marcel Fafchamps** (University of Oxford, UK)
	"Educational programs in rural Nepal: Peer communication and information spillovers" **Margherita Comola** (PSE, Paris, France)
11.45-12.45	**"Trust in triads"** **Werner Raub** (Utrecht University, Utrecht, Netherlands)
	"Myopic or farsighted? An experiment on network formation" (joint with Marco Mantovani, Georg Kirchsteiger and Vincent Vannetelbosch) **Ana Mauleon** (Facultés Universitaires Saint-Louis, Brussels, Belgium)
12.45-14.00	*Lunch*
	Afternoon Session
14.00-15.00	**"Social learning by chit-chat"** **Edoardo Gallo** (University of Oxford, UK)
	"Word of mouth advertising, credibility and learning in networks" (joint with Kalyan Chatterjee) **Bhaskar Dutta** (Warwick University, Warwick, UK)
15.00-16.00	**"Collaborative equilibria in repeated prisoner dilemma on networks"** **Matteo Marsili** (ICTP, Trieste, Italy)
	"Dynamic aspects of peer effects" (joint with Edoardo Rainone and Yves Zenou) **Eleonora Patacchini** (Università di Roma La Sapienza, Rome, Italy)
16.00-16.30	*Coffee / tea break*
16.30-17.30	**"Innovation adoption in an online social network"** **Felix Reed-Tsochas** (University of Oxford, Oxford, UK)

	"Imitation and the role of information in overcoming coordination failures" **Simon Weidenholzer** (University of Vienna, Vienna, Austria)
18.30-19.30	*Reception*
19.30	*Dinner*

Friday, December 10th, 2010

Location: Large Lecture Room, Nuffield College

	Morning Session
08.30-09.00	*Coffee / Tea*
09.00-10.00	**"Social networks and research output"** **Sanjeev Goyal** (Cambridge University, UK)
	"Criminal networks: Who is the key player?" **Yves Zenou** (Stockholm University, Stockholm, Sweden)
10.00-10.30	*Coffee / Tea Break*
10.30-11.30	**"Contagion in financial networks: External costs"** **Gabrielle Demange** (Ecole normale supérieure, Paris, France)
	"Systemic risk in economic networks" **Frank Schweizer** (ETH, Zurich, Switzerland)
11.30-12.30	**"Neighborhood choice and efficient coordination"** (joint Ingrid Rhode and Martin Strobel) **Arno Riedl** (Maastricht University, Maastricht, Netherlands)
	"Network cognition and individual behavior" (joint with Edoardo Gallo and Sanjeev Goyal) **Roberta Dessi** (Toulouse School of Economics, Toulouse, France)
12.30-14.00	*Lunch*
	Afternoon Session:
14.00-15.00	**"Treasure Hunt: Social Learning in the Field"** (joint with Markus Mobius and Phan) **Adam Szeidl** (University of California, Berkeley, United States)
	"Long-run integration in social networks" (joint with Matthew Jackson and Paolo Pin) **Sergio Currarini** (Università Ca' Foscari di Venezia, Venice, Italy)
15.00-15.30	*Coffee / Tea Break*
15.30-16.30	**Round Table Discussion**

Final list of participants

1) *Convenor:* Marcel Fafchamps, University of Oxford, UK
2) *Co-convenor:* Edoardo Gallo, University of Oxford, UK
3) *Co-convenor:* Sanjeev Goyal, Cambridge University, UK
4) *ESF Representative:* Javier Esparcia Pérez (SCSS), Spain
5) Antonio Cabrales, Universidad Carlos III de Madrid, Spain
6) Margherita Comola, Paris School of Economics, France
7) Sergio Currarini, Università Ca' Foscari di Venezia, Italy
8) Gabrielle Demange, Paris School of Economics – EHESS, France
9) Roberta Dessi, Toulouse School of Economics, France
10) Bhaskar Dutta, Warwick University, UK
11) Jeanne Hagenbach, University of Mannheim, Germany
12) Matthew Jackson, Stanford University, USA
13) Matteo Marsili, International Centre for Theoretical Physics (ICTP), Italy
14) Ana Mauleon, Facultés Universitaires Saint-Louis (FUSL), Belgium
15) Eleonora Patacchini, Università di Roma La Sapienza, Italy
16) Werner Raub, Utrecht University, The Netherlands
17) Felix Reed-Tsochas, University of Oxford, UK
18) Arno Riedl, Maastricht University, The Netherlands
19) Frank Schweitzer, ETH Zurich, Switzerland
20) Adam Szeidl, University of California, Berkeley, USA
21) Vincent Vannetelbosch, Université catholique de Louvain, Belgium
22) Simon Weidenholzer, University of Vienna, Austria
23) Yves Zenou, Stockholm University, Sweden

Statistical information on 23 participants

Institutional participation by country

Austria	1	Belgium	2	France	3	Germany	1
Italy	3	Netherlands	2	Spain	2	Sweden	1
Switzerland	1	UK	5	USA	2		

Participation by gender

Female	6	Male	17