*International Workshop*

**"Strategic Interactions, Information Transmission and Externalities in Networks"**

***May 24-25, 2016***

*Centre d'Economie de la Sorbonne, 106-112 Boulevard de l'Hôpital, 75013 Paris*

*Metro: line 5 (Campo Formio), line 6 (Place d'Italie)*

**INVITED SPEAKERS**:

Sylvain Béal (*Université de Franche-Comté*)

Yann Bramoullé (*Aix-Marseille University*)

Christophe Bravard (*Université Grenoble 2*)

René van den Brink (*Free University Amsterdam*)

Nicolas Carayol (*Université de Bordeaux*)

Sidartha Gordon (*Université Paris-Dauphine*)

Sanjeev Goyal (*University of Cambridge*)

Jeanne Hagenbach (*Ecole Polytechnique*)

Ana Mauleon (*Université Saint-Louis – Bruxelles & CORE - UCL*)

Noemi Navarro (*Université de Bordeaux*)

Eduardo Perez-Richet (*Ecole Polytechnique*)

Simon Schopohl (*Université Paris 1 Panthéon-Sorbonne & Bielefeld University*)

Emily Tanimura (*Université Paris 1 Panthéon-Sorbonne*)

Alex Teytelboym (*University of Oxford*)

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**Participation**: Registration for participation is compulsory. If you would like to participate in the workshop, please contact agnieszka.rusinowska@univ-paris1.fr by ***May 8, 2016.***

**PROGRAM (UPDATED: 17/05/2016)**

***TUESDAY, May 24***

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| *10:00 – 10:30* | *Welcome Coffee* |
| 10:30 – 11:15 | Sanjeev Goyal , *"Geography, resources and conflict"* |
| | (joint work with Marcin Dziubinski and David Minarsch) |
| 11:15 – 12:00 | Eduardo Perez-Richet, *"Altruism in networks"* |
| | (joint work with Renaud Bourlès and Yann Bramoullé) |
| *12:00 – 13:30* | *Lunch (for registered participants)* |
| 13:30 – 14:15 | Noemi Navarro, *"The strategic formation of interbank networks"* |
| | (joint work with Fabio Castiglionesi) |
| 14:15 – 15:00 | Sidartha Gordon, "*Waiting for my neighbors*" |
| | (joint work with Emeric Henry and Pauli Murto) |
| *15:00 – 15:20* | *Coffee Break* |
| 15:20 – 16:05 | Alex Teytelboym, *"A simple model of cascades in networks"* |
| | (joint work with Yongwhan Lim and Asuman Ozdaglar) |
| 16:05 – 16:50 | Christophe Bravard, "*Network formation when players seek confirmation of information*" |
| | (joint work with Pascal Billand, Jurjen Kamphorst and Sudipta Sarangi) |
| *16:50 – 17:00* | *Short (Coffee) Break* |
| 17:00 – 17:45 | René van den Brink, "*Power measures and solutions for games under precedence constraints*" |
| | (joint work with Encarna Algaba and Chris Dietz) |
| *19:30 –* | *Dinner (On invitation)* |

***WEDNESDAY, May 25***

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| 9:15 – 10:00 | Yann Bramoullé, "*Hiring through networks: Favors or information?*" |
| | (joint work with Kenan Huremovic) |

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| 10:00 – 10:45 | Nicolas Carayol, *"How do inventors networks affect urban invention?"* |
| | (joint work with Laurent Bergé et Pascale Roux) |
| *10:45 – 11:05* | *Coffee Break* |
| 11:05 – 11:50 | Emily Tanimura, *"Competition for the access to and use of information in networks"* |
| | (joint work with Philipp Moehlmeier and Agnieszka Rusinowska) |
| 11:50 – 12:35 | Sylvain Béal, "*Sequential equal surplus division rule*" |
| | (joint work with Amandine Ghintran, Eric Rémila and Philippe Solal) |
| *12:35 – 14:00* | *Lunch* |
| 14:00 – 14:45 | Ana Mauleon, *"Constitutions and social networks"* |
| | (joint work with Nils Röhl et Vincent Vannetelbosch) |
| 14:45 – 15:30 | Jeanne Hagenbach, *"Communication with evidence in the lab"* |
| | (joint work with Eduardo Perez-Richet) |
| *15:30 – 15:50* | *Coffee Break* |
| 15:50 – 16:35 | Simon Schopohl, *"Communication games with optional verification"* |

## ABSTRACTS

**Sylvain Béal, "*Sequential equal surplus division rule*"**

**(joint with Amandine Ghintran, Eric Rémila & Philippe Solal)**

(Béal et al., 2015, Theory & Decision) introduce a new allocation rule, called the sequential equal surplus division for rooted forest TU-games and provide two axiomatic characterizations for this allocation rule. In this article, we provide a strategic implementation of the sequential equal surplus division rule . Precisely, we design a non-cooperative mechanism of which the unique subgame perfect equilibrium payoffs correspond to the sequential equal surplus division outcome of a superadditive rooted tree TU-game. This mechanism borrowed from the bidding mechanism designed by Pérez-Castrillo and Wettstein (2001, J. Econ. Theory), but takes into account the direction of the edges connecting any two players in the rooted tree, which reflects some dominance relation between them. Our proofs rely on interesting properties that we provide for a general class of bidding mechanisms.

**Yann Bramoullé, "*Hiring through networks: Favors or information?*" (joint with Kenan Huremovic)**

In many different contexts, connected candidates are more likely to be hired or promoted than unconnected ones. This may be due to favoritism or better information on candidates' abilities. Attempts at identifiying both effects have generally relied on productivity measures collected after hiring. In this paper, we develop a new method to identify favors and information from data on hiring. Under natural assumptions, we show that observable characteristics have a lower impact on the probability to be hired for connected candidates and that this reduction precisely captures the information effect. We then show how to recover biases due to favors from overall shifts in hiring probabilities. We apply this new method on data on academic promotions in Spain. We find no evidence of information effects and strong evidence of favoritism. These results are consistent with those obtained from later productivities.

**Christophe Bravard, "*Network formation when players seek confirmation of information*"**

**(joint with Pascal Billand, Jurjen Kamphorst & Sudipta Sarangi)**

We study network formation in a situation where the network allows players to obtain information (signals) about other players. This information is important for making a payoff relevant decision. However, not all information is reliable and so players may have an incentive to check it. By obtaining multiple messages about the same player through the network, a player learns whether his information is reliable. We study the existence and architecture of strict Nash networks. We find that there exist key players: players that are involved in at least three links and sponsor all links they are involved in. These players are similar to the central players in center sponsored stars. Efficient networks are also analyzed and compared to strict Nash networks. We show that Nash networks can be over-connected as well as under-connected as compared to efficient networks. Finally, we extend the basic model to study heterogeneous populations. In the first scenario, we allow for the co-existence of players who only value checked information and players who also value information with unknown reliability. In the second scenario, players who do not care about checking their information co-exist with players who do. Our results are robust with respect to both types of heterogeneity, with one exception: the presence of a single player who cares only about checked information is enough to ensure that center sponsored stars are no longer stable.

**René van den Brink, "*Power measures and solutions for games under precedence constraints*"**

**(joint with Encarna Algaba and Chris Dietz)**

In the literature, there exist several models where a cooperative TU-game is enriched with a hierarchical structure on the player set that is represented by a digraph. We consider games under precedence constraints as presented by Faigle and Kern (1992) who also introduce a generalization of the Shapley value for such games, called the precedence Shapley value. In this paper, we introduce and axiomatize the hierarchical solution as a new solution for games under precedence constraints. Unlike the precedence Shapley value, this new solution satisfies the desirable axiom of irrelevant player independence which establishes that the payoffs assigned to relevant players are not affected by the presence of irrelevant players. This hierarchical solution is defined in a similar spirit as the precedence Shapley value but allocates the dividend of a coalition proportionally to the hierarchical measure, being a power measure for acyclic digraphs. We give an axiomatization of the

hierarchical solution using irrelevant player independence. Also, we axiomatize the hierarchical measure as a power measure on the class of acyclic digraphs. Moreover, we consider the class of precedence power solutions which arise when considering other power measures. Finally, with the purpose of establishing a clear difference between the precedence Shapley value and the hierarchical solution, we include them in the more general setting of weighted precedence solutions which lead us to consider the subclass called subgraph-invariant weight functions.

**Nicolas Carayol, *"How do inventors networks affect urban invention?"***

**(joint with Laurent Bergé et Pascale Roux)**

Despite the prominent place of networks in the mechanisms stimulating local innovation, there are little large scale econometric studies testing it. Actually, the only available results do not support the idea that professional inventor networks strongly influence local invention. We here propose a reassessment based on a simple rationale explaining how an inventor's production may be influenced by her network. We conceptualize inventor's productivity as depending positively on her collaborative connections and on the productivity of her partners (due to efforts' complementarity), and negatively on her partners' number of connections (rivalry). In this context, inventors' equilibrium outcomes should be proportional to the square of their network centrality, defined in a generic way which encompasses, as special cases, several well-known forms of centrality (Bonacich, Page-Rank, and degree). The insights of this simple heuristic model drive our empirical strategy. We use individual level patent data of about one hundred thousand French inventors between 1979 and 2003 previously cleaned, disambiguated and matched with company mandatory surveys data. Fixed-effect panel Poisson regressions at the employment area – technological domain level show that some of the specific forms of the network centralities of local inventors do have a positive influence on urban patenting. More precisely, we estimate the form of centrality that best fits the model, suggesting no rivalry but strong complementarity effects. These results are robust to numerous alternate specifications and robustness checks.

**Sidartha Gordon, "*Waiting for my neighbors*" (joint with Emeric Henry & Pauli Murto)**

We study a waiting game on a network where the payoff of taking an action increases each time a neighbor takes the action. We show that the dynamic evolution of the network starkly depends on initial parameters and can take the form of either a shrinking network, where players at the edges take the action first or a fragmenting network where over time the network splits up in smaller ones. We find that, in addition to the coordination inefficiency standard in waiting games, the network structure gives rise to a spatial inefficiency. The model applies in particular to the adoption of new technologies by firms organized in a network and in this context we study the welfare impact of different subsidy programs aimed at encouraging adoption and show how their benefits depend on the network characteristics.

**Sanjeev Goyal , *"Geography, resources and conflict"***

**(joint with Marcin Dziubinski and David Minarsch)**

A ruler controls resources. He can choose to fight with neighboring rulers to enlarge his control over resources. The winner of a war takes control of the loser's resources; he then decides on whether to

wage war against other neighbours, or to stay peaceful. The probability of winning depends on resources and on the technology of conflict. Rulers seek to maximize the size of resources they control. The game ends when either all rulers choose to be peaceful or when only one ruler is left. We study the influence of geography, initial resources, and the technology of conflict on war and peace. Our first result identifies a threshold property in the technology of conflict: above this threshold, every ruler wishes to wage war and, eventually, only one survives, i.e., hegemony obtains. Below the threshold, resources and networks both determine the prospects for peace and the number of kingdoms.

**Jeanne Hagenbach, *"Communication with evidence in the lab"* (joint with Eduardo Perez)**

We study communication with evidence in a collection of sender-receiver games in the lab. We find important differences between games with cyclic and acyclic masquerade relations. Overall, receivers take evidence into account and perform better in acyclic games, and with more precise messages. In acyclic games, they tend to be skeptical about vague messages, and more so over time. Sender types whose interests are aligned with those of the receiver fully disclose in all games, and sender types whose interests are not aligned with those of the receiver tend to use vague messages. When partially disclosing, senders tend to use weakly dominated strategies.

**Ana Mauleon, *"Constitutions and social networks"* (joint with Nils Röhl & Vincent Vannetelbosch)**

The objective of the paper is to analyze the formation of social networks where individuals are allowed to engage in several groups at the same time. These group structures are interpreted here as social networks. Each group is supposed to have specific rules or constitutions governing which members may join or leave it. Given these constitutions, we consider a social network to be stable if no group is modified any more. We provide requirements on constitutions and players' preferences under which stable social networks are induced for sure. Furthermore, by embedding many-to-many matchings into our setting, we apply our model to job markets with labor unions. We find a variation of Roth's "polarization of interests" (cf. Roth, 1984) between employers and employees.

**Noemi Navarro, *"The strategic formation of interbank networks"* (joint with Fabio Castiglionesi)**

We study the endogenous formation of an interbank network. Banks benefit from the connections in the network since they can coinsure their uncertain liquidity needs. However, the same connections can be risky since banks have an incentive to gamble with depositors' money when not sufficiently capitalized. The bankruptcy of a bank can negatively affect the banks connected to it in the network (counterparty risk). We establish conditions under which banks endogenously form an interbank network with a core-periphery structure, meaning that a group of banks (the core) is internally densely connected, and the rest of banks (the periphery) connect to a few (possible only one) bank in the core. Our conditions allow us to note that the core banks with counterparties in the periphery (the bridges) assume less risk in terms of investment behavior than core banks with only counterparties in the core. Nevertheless, the counterparty risk suffered by the core banks at the bridges make them in all more fragile than the core banks which only have counterparties in the core. We also find that banks that are identical a priori can take completely different positions in the network, and opposite investment behavior.

**Eduardo Perez-Richet, *"Altruism in networks"* (joint with Renaud Bourlès & Yann Bramoullé)**

We provide the first analysis of altruism in networks. Agents are connected through a fixed, weighted network and care about the well-being of their network neighbors. Given some initial distribution of incomes, agents may provide financial support to their poorer friends. We characterize the Nash equilibria of this transfer game for general networks and utility functions. We show that equilibria solve a well-behaved maximization program, related to classical problems of optimal transportation on networks. We build on this reformulation and establish existence, uniqueness in consumptions and generic uniqueness in transfers. We show that transfers are affected by the geometry of the altruistic network. They flow through shortest paths and chains of transfers emerge when the network is not transitive. We analyze the effects of changes in incomes and in the network. When an agent suffers a negative income shock, the equilibrium consumption of every agent decreases weakly. We characterize the impact of small redistributions and show that decreasing income inequality may increase consumption inequality. We also characterize the impact of a small increase in altruism. While altruistic networks reduce inequality, more altruism may lead to more inequality.

**Simon Schopohl, *"Communication games with optional verification"***

We consider a Sender-Receiver Game in which the Sender can send either a costless cheap-talk message or a costly verifiable message. While the Sender has private information about the state of the world, the Receiver chooses an action, which yields to a specific utility for both players. Since the preferences about the actions may differ, depending on the state of the world, the Receiver may or may not trust the messages if they are not verified. In a discrete setting we show under which conditions full revelation is possible and also describe the players optimal behaviour if full revelation is impossible. We also state necessary and sufficient conditions for fully revealing equilibria in a continuous model. In both models we distinguish between equilibria where just one type of message is sent and where the Sender chooses the type of message depending on the state of the world. Furthermore we take common used properties, such as increasing differences and state which other conditions have to hold for the existence of fully or partial revealing equilibria.

**Emily Tanimura, *"Competition for the access to and use of information in networks"***

**(joint with Philipp Moehlmeier & Agnieszka Rusinowska)**

In a network formation framework, where payoffs reflect an agent's ability to access information from direct and indirect contacts, we integrate negative externalities due to connectivity associated with two types of effects: competition for the access to information, and rivalrous use of information. We consider two separate models to capture the first and the second situations, respectively. In the first model we assume that information is a non-rivalrous good but that there is competition for the access to information, for example because an agent with many contacts must share his time between them and thus has fewer opportunities to pass on information to each particular contact. The main idea is that the probability that each neighbor receives the information decreases with the number of contacts the sender has. In the second model we assume that there is not competition for the access to information but that the use of information is rivalrous. Furthermore, it is assumed that people who receive the information before me have a more harmful effect on my utility than people who receive the information at the same time as me. Our results

concern pairwise stability and efficiency in both models and allow us to compare and contrast the effects of two kinds of competition for information.

**Alex Teytelboym, *"A simple model of cascades in networks"***

**(joint with Yongwhan Lim & Asuman Ozdaglar)**

We consider a linear threshold model of cascades in networks. An agent switches (e.g. adopts an innovation or spreads a rumor) if the proportion of his neighbors who have already switched exceeds his threshold. Agents' thresholds are drawn randomly at the start of the cascade process. We present a result for the expected number of switches in arbitrary finite networks with any initial seeds. We define a new measure of an agent's ability to influence a cascade in a given network, called cascade centrality, which is the expected size of the cascade when the agent is the only seed in the network. We then define complete cascade centrality, which is the probability that all agents switch when the node is a seed. For certain network topologies, we find analytic expressions for cascade centrality and complete cascade centrality and show that there may be tension between them. We then consider two economic applications. First, we look at how the network structure affects optimal prices when a profit-maximizing firm tries to spread an innovation. Optimal prices behavior can be fairly counterintuitive when firms price irreversible cascades. Second, we look at a setting in which two firms compete to spread rumors in a social network. Firms seed their rumors simultaneously and rumors propagate according to the linear threshold model. We provide a sharp characterization of networks that admit pure-strategy Nash equilibria (PSNE). We provide tight bounds for the efficiency of these equilibria and for the inequality in firms' equilibrium payoffs. We apply our results to competition over rumor spread in tree networks. In this case, a PSNE always exists and can be efficiently found. Our model can be extended in various ways.