

International Workshop

" Workshop on Networks: Dynamics, Information, Centrality, and Games "

May 17-18, 2017

Centre d'Économie de la Sorbonne, 106-112 Boulevard de l'Hôpital, 75013 Paris, **6th floor**

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

INVITED SPEAKERS:

Nizar Allouch (*University of Kent*)

Christophe Bravard (*Université Grenoble 2*)

René van den Brink (*Free University Amsterdam*)

Frédéric Deroïan (*Aix-Marseille University*)

Jean-Jacques Herings (*Maastricht University*)

Penélope Hernández (*University of Valencia*)

Maia King (*Queen Mary, University of London*)

Michael König (*University of Zurich*)

Elena Orlova (*Université Paris 1 Panthéon-Sorbonne & Bielefeld University*)

Thomas Rivera (*HEC Paris*)

Philippe Solal (*Université de Saint-Etienne*)

Nikolas Tsakas (*University of Cyprus*)

Sponsors: *Labex OSE (Ouvrir la Science Economique) – DT4 (Fondements des comportements individuels, stratégiques et sociaux) & Agence Nationale de la Recherche – Project DynaMITE (ANR-13-BSH1-0010-01, Dynamic Matching and Interactions: Theory and Experiments)*

Organization: Agnieszka Rusinowska (agnieszka.rusinowska@univ-paris1.fr)

PROGRAM (UPDATED: 09/05/2017)

WEDNESDAY, May 17

- 10:00 – 10:20 *Welcome Coffee (6th floor)*
- 10:20 – 11:10 *Maia King, Whom Can You Trust? Reputation and Cooperation in Networks*
- 11:10 – 12:00 *Nikolas Tsakas, Communication and the Emergence of a Unidimensional World*
- 12:00 – 13:30 *Lunch (for registered participants, 2nd floor)*
- 13:30 – 14:20 *Nizar Allouch, Aggregation in Networks*
- 14:20 – 15:10 *Christophe Bravard, Mutual Insurance Networks and Unequal Resource Sharing in Communities*
- 15:10 – 15:30 *Coffee Break (6th floor)*
- 15:30 – 16:20 *Penelope Hernandez, Freedom of Association, Social Cohesion and Welfare*
- 16:20 – 17:10 *Elena Orlova, Heterogeneity in Games on Networks*
- 19:30 – *Dinner (for participants registered to the dinner)*

THURSDAY, May 18

- 9:30 – 10:20 *Jean-Jacques Herings, Matching with Myopic and Farsighted Players*
- 10:20 – 10:40 *Coffee Break (6th floor)*
- 10:40 – 11:30 *Michael König, Network Formation with Local Complements and Global Substitutes: The Case of R&D Networks*
- 11:30 – 12:20 *Philippe Solal, Axiomatic and Bargaining Foundations of an Allocation Rule for Ordered Tree TU-Games*
- 12:20 – 14:00 *Lunch (2nd floor)*
- 14:00 – 14:50 *René van den Brink, Centrality Measures as Utility Functions over Positions in Networks*
- 14:50 – 15:40 *Frédéric Deroïan, The Value of Network Information: Assortative Mixing Makes the Difference*
- 15:40 – 16:00 *Coffee Break (6th floor)*
- 16:00 – 16:50 *Thomas Rivera, Incentives and the Structure of Communication*

ABSTRACTS

Nizar Allouch, *Aggregation in Networks*

We show that a concept of aggregation can hold for games played on networks. We first provide a condition on a group of players in a network, called a module, which ensures that the group can behave like a single player. Furthermore, we show that a partition of players of a game into modules gives rise to an aggregate game, whose Nash equilibria, together with the Nash equilibria of the games played at the module level, correspond to Nash equilibria of the game. Then, we show that fitting aggregate games into each other in an appropriate way provides a hierarchical decomposition of the game, which can inform a recursive computation of Nash equilibria. Finally, we provide an application to the model of public goods in networks to illustrate the usefulness of our results.

Christophe Bravard, *Mutual Insurance Networks and Unequal Resource Sharing in Communities* (joint work with Pascal Billand, Sudipta Sarangi and Stephan Sémirat)

We study formation of mutual insurance networks in a model where agents who obtain more resources share a fixed amount of resources with all directly linked agents that obtain fewer resources. We identify the pairwise stable networks and efficient networks in a basic model where agents are identical. Then, we introduce in the model two types of heterogeneity: an exogenous one, where agents differ in their income or in their preferences over the transfer scheme, and an endogenous heterogeneity where the costs of linking to an agent depends on the number of links the latter has already formed in the network. We examine the impact of these heterogeneities on stability and efficiency.

René van den Brink, *Centrality Measures as Utility Functions over Positions in Networks* (joint work with Agnieszka Rusinowska)

One of the most famous network centrality measures is the degree measure which assigns to every position in a weighted network the sum of the weights of all links with its neighbours. We show that this degree measure can be seen as a von Neumann-Morgenstern expected utility function. We do this in three steps. First, we characterize the degree measure as a centrality measure for weighted networks using four natural axioms. Second, we relate these network centrality axioms to properties of preference relations over positions in networks. In particular, we consider the property of neutrality to ordinary risk. Third, we prove that the utility function is equal to a multiple of the degree measure if and only if it represents a regular preference relation that is neutral to ordinary risk. In this way we build a bridge between the social network literature on network centrality, and the economic literature on preferences and utility.

Frédéric Deroïan, *The Value of Network Information: Assortative Mixing Makes the Difference* (joint work with Mohamed Belhaj)

We study the value of network information in the context of monopoly pricing under local network externalities. Under complete information, both monopoly and consumers know the network structure and consumers' private preferences. Under incomplete information, consumers only know the joint distribution of preferences, in-degrees and out-degrees, and

the monopoly knows the characteristics of each consumer. The analysis reveals that, under assortative mixing, network information increases profit and consumer surplus.

Jean-Jacques Herings, *Matching with Myopic and Farsighted Players* (joint work with Ana Mauleon and Vincent Vannetelbosch)

We study stable sets for one-to-one matching problems under the assumption that one side of the market is myopic while the other side may contain both myopic and farsighted agents. We assume the men to be myopic and the women to be myopic or farsighted. We introduce the new notion of the myopic-farsighted stable set, which is based on the notion of a myopic-farsighted improving path. A myopic-farsighted stable set is the set of matchings such that there is no myopic-farsighted improving path from any matching in the set to another matching in the set (internal stability) and there is a myopic-farsighted improving path from any matching outside the set to some matching in the set (external stability). Under the assumption that the top choice of each man is a farsighted woman, we show that the singleton consisting of the woman-optimal stable matching is a myopic-farsighted stable set, so the most farsighted side of the market is favored. We present examples where this is the unique myopic-farsighted stable set and farsighted agents are able to select their most preferred core element. We also present examples of myopic-farsighted stable sets consisting of a core element different from the woman-optimal matching or even of a non-core element.

Penelope Hernandez, *Freedom of Association, Social Cohesion and Welfare* (joint work with Sanjeev Goyal, Guillem Martinez-Canovas, Frederic Moisan, Manuel Munoz-Herrera and Angel Sanchez)

How does freedom of association shape social cohesion, individual behavior and welfare, in heterogeneous populations? To answer this question, we develop a theoretical model and conduct experiments with human subjects. We study a network formation and action choice game in which individuals benefit from selecting the same action as their neighbours. However, one group of individuals prefers to coordinate on one action, while the rest prefers to coordinate on the other action. There exist multiple equilibria, which come in two forms: one, integration where the network is fully connected, and every player conforms to the same action and two, segregation where the network is composed of two complete components and all members of the same component select the same action, which is different from what members of the other component select. We also show that social welfare is (uniquely) maximized with full integration and conformity on the majority's action. In the experiment we observe that clear segregation and diversity: individuals of different preferences separate themselves completely and within the « network component » choose their preferred action. We find that this result is robust, as we lower the costs of linking. To understand the role of freedom of association, we then turn to a setting where the network is exogenous. Again there exist a variety of equilibria displaying conformism and diversity, but in the experiment we observe that subjects almost always choose the action preferred by the majority. We therefore conclude that the freedom of association sustains diversity in a population. We discuss potential theoretical explanations – based on dynamic stability and team reasoning – for the critical role of linking.

Maia King, *Whom Can You Trust? Reputation and Cooperation in Networks*

We use network theory to examine the extent of trust and cooperation between players in a community, when information about players' reputations travels by word-of-mouth in the network connecting them. The model is based on Dixit (2003) and identifies two aspects of trust: players are trustworthy if others can communicate about them, which depends on cycles in the network; and players are trusting if they receive more information from the network, which is linked to a new measure of network centrality. To solve the model, we identify a new simple function to find the probabilities of information transmission between nodes in a network, based on the diffusion process of Banerjee, Chandrasekhar, Duflo and Jackson (2013).

Michael König, *Network Formation with Local Complements and Global Substitutes: The Case of R&D Networks* (joint work with Chih-Sheng Hsieh and Xiaodong Liu)

In this paper we introduce a stochastic network formation model where agents choose both actions and links. Neighbors in the network benefit from each other's action levels through local complementarities and there exists a global interaction effect reflecting a strategic substitutability in actions. The tractability of the model allows us to provide a complete equilibrium characterization in the form of a Gibbs measure, and we show that the structural features of equilibrium networks are consistent with empirically observed networks. We then use our equilibrium characterization to show that the model can be conveniently estimated even for large networks. The policy relevance is demonstrated with examples of firm exit, mergers and acquisitions and subsidies in the context of R&D collaboration networks.

Elena Orlova, *Heterogeneity in Games on Networks*

In most of the literature on games on networks, players do not differ in their individual characteristics and can only be distinguished by their structural position in the network. We introduce heterogeneity by allowing players to have individual preferences over available actions. Extending the framework of Hernandez et al. (2013), we analyze equilibria outcomes for a wide range of games. We show that, in most of the cases, the set of equilibria in a heterogeneous network is different from the analogous set in a homogeneous network, and that there is no inclusion in either direction. In the new framework, we develop a new efficiency measure, apart from the standard aggregate payoff, and use both of them for comparison of possible equilibria.

Thomas Rivera, *Incentives and the Structure of Communication*

This paper analyzes the incentives that arise within an organization when communication is restricted to a particular network structure (e.g., a hierarchy). We show that restricting communication between the principal and agents may create incentives for the agents to misbehave when transmitting information and tasks throughout the organization. To remedy this issue, we provide necessary and sufficient conditions on the topology of the network of communication such that restricting communication to a particular network does not restrict the set of (communication equilibrium) outcomes that the principal could otherwise achieve. We show that for any underlying incentives and any outcome available when

communication is unrestricted, there exists a communication scheme restricted to a particular network that implements this outcome (i.e., does not induce agents to misbehave in the communication phase) if and only if that network satisfies our conditions.

Philippe Solal, *Axiomatic and Bargaining Foundations of an Allocation Rule for Ordered Tree TU-Games* (joint work with Sylvain Béal, Sylvain Ferrières and Eric Rémila)

We consider the class of ordered tree TU-games, i.e. a tree TU-game augmented by a linear order over the set of edges of the tree. An interpretation is that the edges are added one-by-one according to this order. An example is a set of bridges that are sequentially built to connect a set of islands. Firstly, we introduce three axioms for allocation rules on this class. The first one is the classical axiom of Standardness (Hart and Mas-Colell, 1989, Ecta). Top-consistency is an invariance axiom with respect to a restricted ordered-tree TU-game defined over the set of agents contained in one of the two components existing before the addition of the top edge (the edge eventually added). The worth of this component is computed by assuming that the agents outside the component leave the game with their payoffs. The worth of each sub-coalition of the component is not affected. The tree and the order in this restricted situation are defined as the restriction of the original tree and order. Top-consistency says that all payoffs are invariant to this restriction. Contraction is also an invariance axiom. Consider an operation of edge contraction which removes an edge from the tree while simultaneously merging its two incident agents. The coalition function is altered accordingly: the worth a coalition not containing the merged agent is not affected; otherwise it is equal to the worth of the corresponding coalition containing the two merged agents. Contraction imposes that the payoffs of the agents incident to an edge which enters after the contracted edge are not affected by this contraction. The combination of these three axioms yields a unique efficient allocation rule, for which we provide a natural expression constructed recursively by following the order over the edges. Secondly, we provide a bargaining foundation of this allocation rule by designing a bidding mechanism. First, the order of the edges is taken into account in the construction of the bidding mechanism. The latter starts with the top edge. Both agents incident to this edge play in a bidding stage and, in a second stage, bargain over the surplus of cooperation. At this end of the bargaining stage, both agents obtain an intermediary payoff. Then, the mechanism continues its route on both components that the top edge connects, and so on until there is no edge to consider. We show that this bidding mechanism implements the above-mentioned allocation rule in subgame perfect Nash equilibrium.

Nikolas Tsakas, *Communication and the Emergence of a Unidimensional World* (joint work with Philippos Louis and Orestis Troumpounis)

We provide theoretical and experimental support on the emergence of a unidimensional world through communication. Both theoretical and experimental results suggest that when boundedly rational individuals communicate their opinions over multiple issues, disagreement can eventually be summarized on a unidimensional spectrum, even when imposing very little structure on the communication process. The presence of structured social networks is however crucial in determining whether an individual forms moderate or extreme views.

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