

# Workshop on Evolutionary Game Theory

October 4<sup>th</sup>, 2019

Oskar-Morgenstern-Platz 1  
9<sup>th</sup> floor

## Program

**10:00-11:00**

**Christian Hilbe** (Institute of Science and Technology Austria , Max-Planck Institute for Evolutionary Biology, Plön) "[Social dilemmas among unequals](#)"  
(joint with Oliver Hauser et al.)

**Christoph Kuzmics** (University of Graz, Department of Economics)  
"[A case of evolutionarily stable attainable equilibrium in the laboratory](#)"  
(joint with Daniel Rodenburger)

**11:00-11:30: Coffee**

**11 :30-12 :30**

**Andrea Gaunersdorfer** (University of Vienna, Department of Finance)  
"[Learning in unprofitable games](#)"  
(joint with Josef Hofbauer)

**Christina Pawlowitsch** (University of Panthéon-Assas, Paris II)  
"[Evolutionary dynamics of costly signaling](#)"  
(joint with Josef Hofbauer)

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**14 :00-15 :30**

**Karl Sigmund** (University of Vienna, Faculty of Mathematics)  
"[Corruption](#)"  
(joint with Joung-Hun Lee, Yoh Iwasa, and Ulf Dieckmann)

**Ana Ania-Martinez** (University of Vienna, Department of Economics)  
"[An evolutionary learning approach to laboratory federalism and the role of public funds sharing](#)"

**Ulrich Berger** (Vienna University of Economics and Business, Department of Economics)  
"[Reputation and the evolution of private property rights](#)"  
(joint with Hannelore De Silva)

**15:30-16:00: Coffee**

16 :00-17 :30

**Maarten Janssen** (University of Vienna, Department of Economics)

"[Information acquisition and diffusion in markets](#)"

(joint with Atabek Atayev)

**Laura Schmid** (Institute of Science and Technology Austria)

"[A unified framework for direct and indirect reciprocity](#)"

(joint with Christian Hilbe, Krishnendu Chatterjee, and Martin Nowak)

**Immanuel Bomze** (University of Vienna, Department of Statistics and Operations Research)

"[Does moral play equilibrate?](#)"

(joint with Werner Schachinger and Jörgen Weibull)

## Abstracts

**Ana Ania-Martinez**

"[An evolutionary learning approach to laboratory federalism and the role of public funds sharing](#)"

The literature on laboratory federalism hypothesizes that decentralization in a multi-jurisdictional system is conducive to efficient policies, since it provides a framework in which innovative jurisdictions can test new policies at low risk for the federation; new policies can then spread out to the entire federation if successful. The present work captures these ideas in a game-theoretic learning model of perturbed imitation and explores the effect of public funds sharing in the framework of decentralized, rich-to-poor redistribution with labor mobility à la Wildasin (1991). For the case of representative redistributive systems and assuming production technology in each jurisdiction is captured by a quadratic production function, we explore conditions under which funds sharing coupled with imitative learning leads to inefficiently high levels of redistribution.

**Ulrich Berger** (joint with Hannelore De Silva)

"[Reputation and the evolution of private property rights](#)"

Private property rights existed long before formal laws and institutional rights had been established. They have been explained as an equilibrium of the Hawk-Dove-Bourgeois game borrowed from biological models of animal territoriality. But in these models so-called anti-private-property equilibria exist which are not observed in the real world. We suggest a new evolutionary game-theoretic approach in which the interaction between the possessor of a valuable object and a potential taker is modeled as a symmetrized game of entry-deterrence where the taker has the additional option to obtain costly information on the possessor's past reactions to attempts of taking her object. Resisting these attempts, even though not credible in the one-shot interaction, allows possessors to gain a reputation of toughness which might deter such attempts in the future. For low information costs and under best-response dynamics the anti-private-property equilibrium's basin of attraction is quite small, while the private-property equilibrium component is asymptotically stable with a large basin of attraction. We use agent-based simulations to show that these results are qualitatively robust to the introduction of more realistic features of the underlying dynamics.

**Immanuel Bomze** (joint with Werner Schachinger and Jörgen Weibull)

["Does moral play equilibrate?"](#)

Some finite and symmetric two-player games have no (pure or mixed) symmetric Nash equilibrium when played by partly morally motivated players. The reason is that the "right thing to do" may be not to randomize. We analyze this issue both under complete information between equally moral players and under incomplete information between players of arbitrary degree of morality. We provide necessary and sufficient conditions for the existence of equilibrium and illustrate the results with examples and counter-examples.

**Andrea Gaunersdorfer** (joint with Josef Hofbauer)

["Learning in unprofitable games"](#)

A game is unprofitable if equilibrium payoffs do not exceed the maxmin payoff for each player. In unprofitable games, NE play has been notoriously difficult to justify. For some simple examples we analyze whether learning leads to NE.

**Christian Hilbe** (joint with Oliver Hauser, Krishnendu Chatterjee, and Martin Nowak)

["Social dilemmas among unequals"](#)

Direct reciprocity is a powerful mechanism for the evolution of cooperation on the basis of repeated interactions. It requires that interacting individuals are sufficiently equal, such that everyone faces similar consequences when they cooperate or defect. Yet inequality is ubiquitous among humans<sup>5,6</sup> and is generally considered to undermine cooperation and welfare. Most previous models of reciprocity do not include inequality. These models assume that individuals are the same in all relevant aspects. Here we introduce a general framework to study direct reciprocity among unequal individuals. Our model allows for multiple sources of inequality. Subjects can differ in their endowments, their productivities and in how much they benefit from public goods. We find that extreme inequality prevents cooperation. But if subjects differ in productivity, some endowment inequality can be necessary for cooperation to prevail. Our mathematical predictions are supported by a behavioural experiment in which we vary the endowments and productivities of the subjects. We observe that overall welfare is maximized when the two sources of heterogeneity are aligned, such that more productive individuals receive higher endowments. By contrast, when endowments and productivities are misaligned, cooperation quickly breaks down. Our findings have implications for policy-makers concerned with equity, efficiency and the provisioning of public goods.

**Maarten Janssen** (joint with Atabek Atayev)

["Information acquisition and diffusion in markets"](#)

Consumers can acquire information through their own search efforts or through their social network. Information diffusion via word-of-mouth communication leads to some consumers free-riding on their

"friends" and less information acquisition via active search. Free-riding has also an important positive effect, however, in that consumers that do not actively search themselves are more likely to be able to compare prices before purchase, imposing competitive pressure on firms. We show how market prices depend on the characteristics of the network and on search cost. For example, if the search cost becomes small, price dispersion disappears, while the price level converges to the monopoly level, implying that expected prices are decreasing for small enough search cost. More connected societies have lower market prices, while price dispersion remains even in fully connected societies.

**Christoph Kuzmics** (joint with Daniel Rodenburger)

["A case of evolutionarily stable attainable equilibrium in the laboratory"](#)

We reinvestigate data from the voting experiment of Forsythe et al. (Soc Choice Welf 10:223–247, 1993). In every one of 24 rounds, 28 players were randomly (re)allocated into two groups of 14 to play a voting stage game with or without a preceding opinion poll phase. We find that the null hypothesis that play in every round is given by a particular evolutionarily stable attainable

equilibrium of the 14-player stage game cannot be rejected if we account for risk aversion (or a heightened concern for coordination), calibrated in another treatment.

**Christina Pawlowitsch** (joint with Josef Hofbauer)

["Evolutionary dynamics of costly signaling"](#)

Costly-signaling games have a remarkably wide range of applications (education as a costly signal in the job market, handicaps as a signal for fitness in mate selection, politeness in language). The formal analysis of evolutionary dynamics in costly-signaling games has only recently gained more attention. In this paper, we study evolutionary dynamics in two basic classes of games with two states of nature, two signals, and two possible reactions in response to signals: a discrete version of Spence's (1973) model and a discrete version of Grafen's (1990) formalization of the handicap principle. We first use index theory to give a rough account of the dynamic stability properties of the equilibria in these games. Then, we study in more detail the replicator dynamics and to some extent the best-response dynamics.

**Laura Schmid** (joint with Christian Hilbe, Krishnendu Chatterjee, and Martin Nowak)

["A unified framework for direct and indirect reciprocity"](#)

Direct and indirect reciprocity are considered key mechanisms for the evolution of cooperation. The former is based on dyadic relationships, positing that we are more likely to help those who have helped us in the past. The latter carries reciprocity over to the population level, positing that we are more likely to help those who have been helpful in the past, even if we did not benefit directly. Direct reciprocity is thus based on personal experiences, whereas indirect reciprocity is based on reputations. Although the two modes of reciprocity are strongly related, they are typically studied in isolation. Here, we introduce a novel framework that unites the two approaches. Individuals interact in a series of pairwise social dilemmas. When they decide whether to cooperate they can choose whether to take into account third party information about the respective co-player. We find that individuals learn to draw on such information when players only meet occasionally and when information is reliable. In that case, players often adopt a strategy we term Generous Scoring. They always assign a good reputation to cooperators, but they occasionally also assign a good reputation to defectors. Generous Scoring thus extends the basic principle of Generous-Tit-for-Tat to indirect reciprocity. Using the recent theory of zero-determinant strategies, we prove that both Generous-Tit-for-Tat and Generous Scoring can maintain cooperation when errors are not too frequent and when individuals meet sufficiently often for reciprocity to unfold.

Our results highlight how individuals aggregate information from different sources, and how they learn to combine gossip and direct experiences to maintain cooperative relationships.

**Karl Sigmund** (joint with Joung-Hun Lee, Yoh Iwasa, and Ulf Dieckmann)

["Corruption"](#)

Corruption is widely perceived as a major problem. Bribery of judicial institutions undermines the trust needed for joint efforts and economic investments. Transparency can reestablish trust, but at the cost of constant supervision of the institutions. Reducing such vigilance is advantageous in the short term. In the long run, it leads to more cheating and less cooperation. This can create cyclic outbursts of corruption or maintain corruption at a stable level.

Workshop organized by:

Josef Hofbauer and Christina Pawlowitsch

