SOE 5: Financial and Economic Systems and Evolutionary Game Theory

Time: Tuesday 14:00–15:00 Location: SOEa

SOE 5.1 Tue 14:00 SOEa

Uncovering the Dynamics of Correlation Structures Relative to the Collective Market Motion — •Anton J. Heckens, Sebastian M. Krause, and Thomas Guhr — Universität Duisburg-Essen, Lotharstr. 1, 47048 Duisburg

Complex systems are characterized by a variety of interactions and often produce a strong correlated behavior of their system components. Stock markets are particularly well-suited as examples of such complex systems due to their abundance of data for the analysis of correlated phenomena. Münnix et al. [1] used correlation matrices over short time horizons, in order to analyze their dynamics with respect to their non-stationarity. Using a cluster procedure, it became apparent that there are quasi-stationary periods, so-called market states. They emerge, disappear or reemerge, but they are dominated by the collective motion of all stocks. To extract more refined information, we present a new approach by clustering correlation matrices which are free from the collective market motion [2]. The resulting dynamics is remarkably different, and the corresponding market states are quasi-stationary over a long period of time.

[1] M. C. Münnix, T. Shimada, R. Schäfer, F. Leyvraz, T. H. Seligman, T. Guhr and H. E. Stanley, Identifying States of a Financial Market, Scientific Reports 2, 644 (2012), arXiv:1202.1623

[2] A. J. Heckens, S. M. Krause, T. Guhr, Uncovering the Dynamics of Correlation Structures Relative to the Collective Market Motion J. Stat. Mech. 2020, 103402 (2020), arXiv:2004.12336

SOE 5.2 Tue 14:20 SOEa

Explosive amortization times in the dynamics of photovoltaic implementation? — •Raoul Schmidt, Malte Schröder, and Marc Timme — Chair for Network Dynamics, Institute for Theoretical Physics and Center for Advancing Electronics Dresden (cfaed), TU Dresden

To combat climate change, renewable energy supply such as through photovoltaics (PV) becomes increasingly important. The amortization time of a single PV unit relates the energy (and CO2) expended for production, transport and installation of a unit to its electric power generation (and thus potential savings in CO2 emissions). Here, we analyze the CO2 budgeting dynamics of many PV units continuously added by new installations [1,2]. Intriguingly, the resulting systemic amortization time necessarily is substantially larger than that of a single unit. We demonstrate analytically that already at constant installation rate, it already is twice the amortization time of a single unit, whereas at an exponentially increasing rate, it may be arbitrarily much larger, with resulting relevant time scales in between 10 and more than 30 years - potentially beyond the life time of a PV unit. Intriguingly, evaluating installation data of the past two decades indicates an exponential installation rate on the global scale that may cause such explosive increase of CO2 budget amortization times.

[1] N. von der Heydt, DPG Spring Meeting Berlin (2018). [2] R. Schmidt et al., in prep. (2021).

SOE 5.3 Tue 14:40 SOEa

Should the government reward cooperation? Insights from an agent-based model of wealth redistribution — Frank Schweitzer, Luca Verginer, and •Giacomo Vaccario — ETH, Zurich, Switzerlan

In our multi-agent model agents generate wealth from repeated interactions for which a prisoner's dilemma payoff matrix is assumed. Their gains are taxed by a government at a rate α. The resulting budget is spent to cover administrative costs and to pay a bonus to cooperative agents, which can be identified correctly only with a probability p. Agents decide at each time step to choose either cooperation or defection based on different information. In the local scenario, they compare their potential gains from both strategies. In the global scenario, they compare the gains of the cooperative and defective sub-populations. We derive analytical expressions for the critical bonus needed to make cooperation as attractive as defection. We show that for the local scenario the government can establish only a medium level of cooperation, because the critical bonus increases with the level of cooperation. In the global scenario instead full cooperation can be achieved once the cold-start problem is solved, because the critical bonus decreases with the level of cooperation. This allows to lower the tax rate, while maintaining high cooperation.