Economic systems in and out of equilibrium: network models of trade, systemic risk, and early-warning signals

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Abstract

The long-term evolution of economic systems and processes naturally alternates between (quasi-)stationary equilibrium and out-of-equilibrium regimes. While in the equilibrium regime the behaviour of the system can be reliably monitored and predicted in terms of a few explanatory variables, in the out-of-equilibrium regime this is generally impossible. Here we discuss a maximum-entropy method to assess whether a real economic system is in a quasi-stationary state by checking the consistency of its empirical evolution with that of appropriate equilibrium null models. As illustrative examples, we consider the evolution of two economic networks: the International Trade Network (ITN) and the Dutch Interbank Network (DIN). We find that the ITN is almost perfectly quasi-stationary over many decades. As a result, it can be reliably captured by a single time-dependent model that embeds the popular Gravity Model into a more realistic equilibrium network model. By contrast, we find that the DIN undergoes periods of equilibrium and non-equilibrium. At equilibrium, the network can be accurately reconstructed from bank-specific aggregate data, a result holding for other interbank networks as well and implying that the level of interbank systemic risk can be reliably estimated from partial information. Out of equilibrium, we find that the entity of the deviation from quasi-stationarity contains precious information that allows us to identify remarkable early warning signals of the interbank crisis of 2008. These results illustrate the value of maximum-entropy ensembles either as predictive equilibrium models or as unbiased null models to empirically detect departures from stationarity.

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