Games in rigged economies

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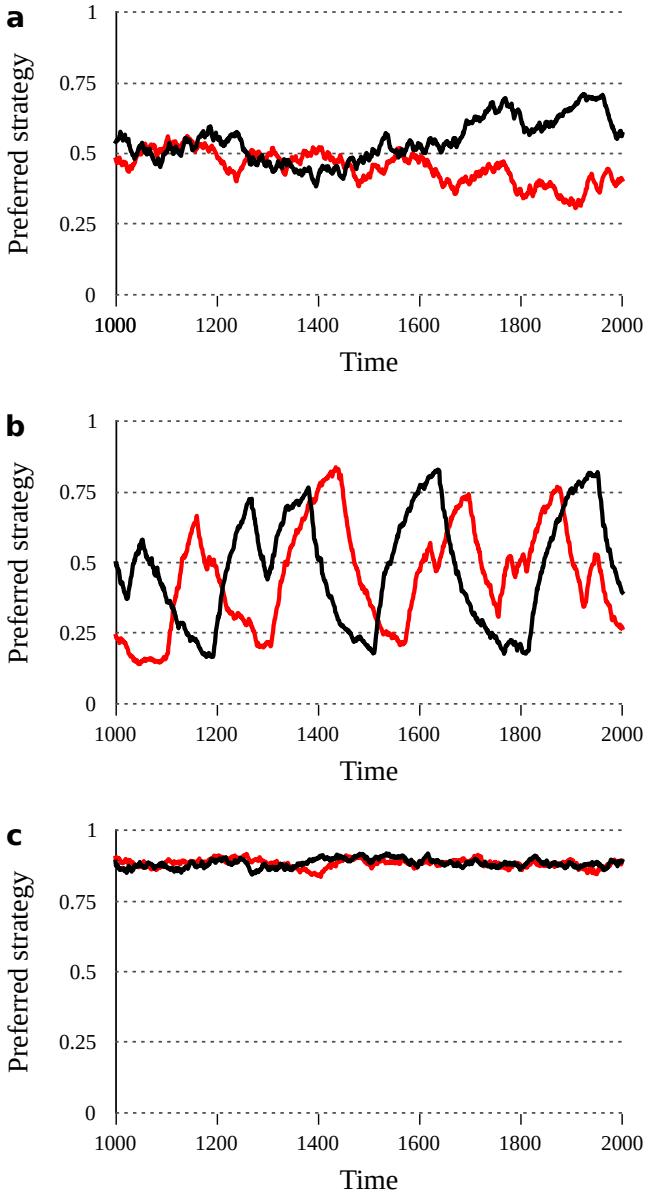

Fig. 1. **Three regimes with increased 'rigging' of** 2 **economic games**. **a** With little intervention, economic DOF are minority games. As agents attempt to play the minority option, an evolving population splits itself equally between the two strategies available. **b** Intermediate 'rigging' prompts structured fluctuations: each game is temporarily manipulated in a direction or the other. **c** Large 'rigging' turns economic DOF into majority games, which the population agrees to play and rig in the same direction.

Modern economies evolved from simpler human exchanges into very convoluted systems. Today, a multitude of aspects can be regulated, tampered with, or left to chance; these are economic degrees of freedom (DOF) which together shape the flow of wealth.

Economic actors can exploit them, at a cost, and bend that flow in their favor [1]. If intervention becomes widespread, microeconomic strategies of different actors can collide or resonate, building into macroeconomic effects. How viable is a rigged economy? How do growing economic complexity and wealth affect it?

Here we capture essential elements of 'rigged economies with a simple model [2]. Nash equilibria of payoff matrices in tractable cases show how increased intervention turns economic DOF from minority into majority games through a dynamical phase. These stages are reproduced by agent-based simulations of our model (Figure 1), which allow us to explore scenarios out of reach for payoff matrices.

Increasing economic complexity is then revealed as a mechanism that spontaneously defuses cartels or consensus situations. But excessive complexity enters abruptly into a regime of large fluctuations that threaten the systems viability. This regime results from non-competitive efforts to intervene the economy coupled across DOF, becoming unpredictable. Thus high economic complexity can result in negative spillover from non-competitive actions. Simulations suggest that wealth must grow faster than linearly with complexity to avoid this large fluctuations regime and keep economies viable in the long run.

Our model provides testable conclusions and phenomenological charts to guide policing of rigged economies. We discuss the recent, real-world case of the Game Stop short-squeeze, in which multiple economic actors got coordinated through social media to invest in allegedly undervalued stocks. This resulted in an emergent upset of the stock market and still-ongoing investigations of market manipulation.

[1] D. Wolpert and J. Grana. *How Much Would You Pay to Change a Game before Playing It?*, Entropy **21**(7), p.686 (2019).

[2] L. F. Seoane. *Games in Rigged Economies*, Phys. Rev. X **11**(3), p.031058 (2021).