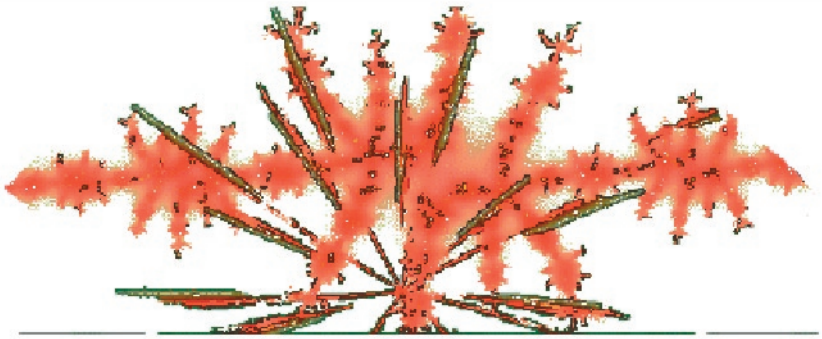
Special Issue of *Nonlinear Dynamics, Psychology, and Life Sciences*

Nonlinear Economic Dynamics and Social Science

in memory of John Barkley Rosser Jr.



Abstract: The pioneering work of John Barkley Rosser Jr. (1948-2023) in various subfields of economics emphasizes the fact that economic and social phenomena are inherently nonlinear and often discontinuous. From this standpoint, Barkley has contributed substantially to a paradigm shift in economic theory and modelling. Both his influential research work and his unceasing survey work on different approaches and schools of thought in economics and social science, carried out through the lens of complexity theory, have succeeded to develop a broader view on economic thinking and continue to inspire many researchers worldwide. The articles in this issue cover a number of research areas and themes that were central to Barkley's work, from technological progress to evolutionary competition between firms, from regional science to income inequality, from environmental economics to more general macroeconomic themes, such as bubbles and crashes, financial instabilities and policy issues.

Abstract: J. Barkley Rosser Jr. dedicated his career to the study of complexity and nonlinear dynamics applied to economic matters. From his extensive work, four ideas stand out: (a) relevant economic processes can be expressed under the form of relatively simple modelling apparatus; (b) low-dimensional nonlinear systems often involve complex patterns of evolution; (c) the identified nonlinearities have significant economic meaning, and (d) there is an inherent aesthetic beauty underlying the corresponding mathematical results. This article is composed by two blocks. In the first part, the work by J. Barkley Rosser Jr. is surveyed, with a special emphasis placed on the four above-mentioned items. In the second part, a two-equation discrete-time model of diffusion of ideas is proposed and subject to analytical and graphical treatment, with the objective of illustrating how a simple dynamic model may generate complex and visually attractive dynamics with economic meaning.

Abstract: This study considers dynamics generated by a three-species Lotka-Volterra competitive model with two discrete delays. The associated characteristic equation is a cubic exponential polynomial. Assuming the stability of the three-species positive stationary point in the no-delay model, we construct a stability switching curve on which the characteristic equation has a purely imaginary root. Thus, the stability may be lost. It is numerically confirmed that the stationary point bifurcates to a limit cycle via a supercritical Hopf bifurcation when the delay crosses the stability switching curve. It is also demonstrated that as the delay gets larger, two of three species are active, and the remaining one is inactive along the cycle. The birth of complicated dynamics will be discussed in our future research.

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Regulation and Enforcement in the Exploitation of the Groundwater Resource

Marta Biancardi, *University of Bari, Bari, Italy,* ***Lucia Maddalena,*** *University of Foggia, Foggia, Italy, and* ***Giovanni Villani,*** *University of Bari, Bari, Italy.*

Abstract: Sustainable pumping of water resource requires intervention by a public agency in order to avoid over-exploitation. We study the evolution of compliance and regulation of groundwater resource when farmers can decide whether to comply or not with pumping quotas in an imitation rule described by replicator dynamics. The public agency sets the optimal quotas and the farmers can choose between compliance or violation of them. We investigate the policy of the public agency which may impose sanctions to discourage withdrawals that deviate from the optimal quota. Using numerical simulations, we analyze the effects that parameters have on the equilibrium of the aquifer and on the farmers' behavior

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Complexity in Environment and Space - Sensitivity on Model Specification

Pasquale Commendatore, *University of Naples 'Federico II', Naples, Italy,* ***Ingrid Kubin,*** *Vienna University of Economics and Business Administration, Vienna, Austria, and* ***Iryna Sushko,*** *NASU Institute of Mathematics, Kyiv, Ukraine*

Abstract: In this paper, we study the complex interaction between environmental damage and location in space of firms and entrepreneurial households. We use a New Economic Geography (NEG) framework, suitably extended to account for environmental damage and the two mobility processes. The resulting model is a two-dimensional piecewise smooth map with two constraints for each variable, and we use analytic and numerical tools to explore its long-run dynamics. We pay special attention to the different types of fixed points and the structure of the respective basins of attraction. Their complexity re-enforces a core theme of the NEG: History matters for the long run location in space of economic activity.

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Exchange Rate Dynamics and Central Bank Interventions: On the (De)Stabilizing Nature of Targeting Long-Run Fundamentals Interventions

L. Gardini, *University of Urbino Carlo Bo, Urbino, Italy,* ***D. Radi,*** *Catholic University of Sacred Heart, Milan, Italy,* ***N. Schmitt,*** *University of Bamberg, Bamberg, Germany,* ***I. Sushko,*** *Institute of Mathematics, National Academy of Sciences of Ukraine, Kyiv, Ukraine, and* ***F. Westerhoff,*** *University of Bamberg, Bamberg, Germany.*

Abstract: We develop a foreign exchange market model in which a market maker adjusts the exchange rate with respect to the trading behavior of chartists, fundamentalists and a central bank. While chartists bet on the persistence of bull and bear markets, fundamentalists speculate on mean reversion. The central bank seeks to stabilize the foreign exchange market by placing buy (sell) orders when the undervaluation (overvaluation) of the exchange rate exceeds a certain threshold. Since a one-dimensional piecewise-linear discontinuous map with three branches determines the evolution of the exchange rate, we use a combination of analytical and numerical tools to explore the extent to which the central bank is able to tame the behavior of the foreign exchange market.

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A Note on the Global Income Distribution Curve ("The Elephant")

Antonio Palestrini, *Università Politecnica delle Marche, Ancona, Italy,* **Domenico Delli Gatti,** *Università Cattolica di Milano, Milano, Italy,* **Mauro Gallegati,** *Università Politecnica delle Marche, Ancona, Italy, and* **Ali Hosseiny,** *Shahid Beheshti University, Tehran, Iran*

Abstract: In this work, our objective is to explain the decline in the income share of the middle class and the increase in the share of the wealthy - a global empirical phenomenon, commonly referred to as "The Elephant" (Lakner & Milanovic, 2013; Milanovic, 2016) - by examining the different life-cycle income paths of heterogeneous income classes and the varying tax burden on labor and capital income. The model investigates the diverse life-cycle paths and their nonlinear behavior among the income classes under scrutiny. This approach enables us to dynamically analyze the divergence in the income distribution using one of the more important models in economics: The life-cycle and permanent-income framework.

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Recurrent Financial Crises and the U.S. Federal Reserve: Bubbles and Blisters

Mohammed H. I. Dore, *Brock University, St Catharines, ON, Canada*

Abstract: The U.S. Federal Reserve now controls a part of the money supply, but other financial institutions, called the "shadow" banks, issue a growing amount of the money supply, which remains outside the control of the U.S. Federal Reserve. Being unregulated, these shadow banks operate by offering highly risky amounts of credit, leading to lack of confidence and consequent run on such banks. However, due to competition with the shadow banks, the commercial banks have undergone structural change and are themselves engaged in trading the same financial assets as traded by the shadow banks. Hence the distinction between banks and shadow banks is now moot. Consequently, almost all large financial institutions operate like the shadow banks, and now are heavily engaged in speculative derivative futures trades. The second structural change is that the derivatives market now dominates the prices not only of financial futures but also the prices of all traded commodities, soft and hard, demonstrating oligopolistic market power. The unchecked growth of speculative activity in the futures markets has raised commodity prices and also increased price volatility. This in turn has rendered the entire financial system including the banking system to become unstable, leading to bank runs and financial "bubbles."

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