Macroeconomic Dynamics, **20**, 2016, 461–465. Printed in the United States of America.
doi:10.1017/S1365100514000261

ARTICLES

INTRODUCTION TO *MACROECONOMIC DYNAMICS* SPECIAL ISSUE ON COMPLEXITY IN ECONOMIC SYSTEMS

APOSTOLOS SERLETIS
University of Calgary

In the aftermath of the global financial crisis, questions have been raised regarding the value and applicability of modern macroeconomics. Motivated by these developments and recent advances in dynamical systems theory, the papers in this special issue of *Macroeconomic Dynamics* deal with specific aspects of the economy as a complex evolving dynamic system.

Keywords: Complex Economic Dynamics, Endogenous Business Cycles

The 1,000-point tumble in the Dow Jones Industrial Average on May 6, 2010 "*was just a small indicator of how complex and chaotic, in the formal sense, these systems are. ... Our financial system is so complicated and so interactive—so many different markets in different countries and so many sets of rules. ... What happened in the stock market is just a little example of how things can cascade or how technology can interact with market panic*."

—Ben Bernanke, Interview with the *International Herald Tribune* (May 17, 2010)

Following the powerful critique by Lucas (1976), the modern core of macroeconomics includes both the real business cycle approach (known as freshwater economics) and the New Keynesian approach (known as saltwater economics) and makes systematic use of the *dynamic stochastic general equilibrium* framework, originally associated with the real business cycle approach. It assumes rational expectations and forward-looking economic agents, relies on market-clearing conditions for households and firms, relies on shocks and on mechanisms that amplify the shocks and propagate them through time, and is designed to be a quantitative mathematical formalization of the aggregate economy.

Address correspondence to: Apostolos Serletis, Department of Economics, University of Calgary, Calgary, Alberta T2N 1N4, Canada; e-mail: Serletis@ucalgary.ca.

© 2014 Cambridge University Press 1365-1005/14

https://doi.org/10.1017/S1365100514000261 Published online by Cambridge University Press

However, in the aftermath of the global financial crisis, the Great Recession, and the European debt crisis, policy makers, the media, and a number of economists have raised questions regarding the value and applicability of modern macroeconomics. For example, Caballero (2010, p. 89) wrote that

> by some strange herding process the core of macroeconomics seems to transform things that may have been useful modeling short-cuts into a part of a new and artificial "reality," and now suddenly everyone uses the same language, which in the next iteration gets confused with, and eventually replaces, reality. Along the way, this process of make-believe substitution raises our presumption of knowledge about the workings of a complex economy and increases the risks of a "pretense of knowledge" about which Hayek warned us [in his (1974) Nobel-prize acceptance lecture].

There are many criticisms of the modern core of macroeconomics—see, for example, Farmer and Geanakoplos (2008) and Kirman (2010). One is of the assumption that economic agents act in isolation and the only interaction between them is through the price system. This is clearly unrealistic, as it fails to capture the interdependence, interaction, and economic networks of the real world. Another is of the aggregation assumption, according to which the behavior of the aggregate (or macro) economy corresponds to that of the representative economic agent, consistent with the reductionist belief that "the whole is the sum of its parts." The key property, however, of economic systems (as well as of other natural systems such as brains, immune systems, and insect colonies) is nonlinearity, implying that "the whole is different from the sum of the parts." This realization led to a move away from the traditional paradigm of reductionism and the development of new sciences such as systems biology, chaos and information theory, and evolutionary economics to explain complex and adaptive systems, systems in which large numbers of entities with limited communication among themselves collectively produce complicated global behavior and, in some cases, evolve and learn. Macroeconomists, however, have handicapped themselves by not taking a complex systems approach to explaining the dynamics of apparently self-organizing economic systems.

Another criticism of the current mainstream approach to macroeconomics concerns the definition of rational expectations. Expectations play an important role in economics and finance, but the definition of rational expectations used in the dynamic stochastic general equilibrium approach to macroeconomics needs to be modified, because it applies to a stationary world. As Hendry and Mizon (2010, p. 13) argue,

> the present treatment of expectations in economic theories of intertemporal optimization is inappropriate—it cannot be proved that conditional expectations based on contemporaneous distributions are minimum mean-square error 1-step predictors when unanticipated breaks occur, and the law of iterated expectations then also does not hold

https://doi.org/10.1017/S1365100514000261 Published online by Cambridge University Press

> inter-temporally. One consequence is that dynamic stochastic general equilibrium models are intrinsically non-structural, and must fail the Lucas critique since their derivations depend on constant expectations distributions.

Finally, another serious criticism of the modern core of macroeconomics pertains to its formalization of the origins of business cycles (short-run fluctuations). As Kocherlakota (2010, p. 16) puts it, "the difficulty in macroeconomics is that virtually every variable is endogenous, but the macroeconomy has to be hit by some kind of exogenously specified shocks if the endogenous variables are to move." Typically, state-of-the-art dynamic stochastic general equilibrium models attribute short-run fluctuations to high-frequency shocks to fundamentals such as preferences, technologies, or government policy. This, however, is highly unsatisfactory. As Angeletos and La'O (2013) recently put it in their Conclusion, "if taken literally, these shocks seem empirically implausible. Instead, short-run phenomena appear to have a largely self-fulfilling nature—one that leads many practitioners to attribute these phenomena to more exotic forces such as 'animal spirits,' 'sentiments,' or 'market psychology,' and one that standard macroeconomic models have failed to capture."

It is for these reasons that in recent years there has been a revival of interest in dynamical systems theory, and there is a group of economists who use ideas from complex systems research to look at economic fluctuations as deterministic phenomena, endogenously created by market forces and aggregator (utility and production) functions. Motivated by these developments and recent advances in complex systems research, this special issue brings together a number of papers dealing with specific aspects of the economy as a complex evolving dynamic system. In what follows, I briefly describe these papers.

The first paper, by Alan Kirman, "Ants and Nonoptimal Self-Organization: Lessons for Macroeconomics," looks at the analogy often used for the economy with the way in which social insects self-organize. The argument normally heard is that social insects have adapted optimally over millions of years and this accounts for the efficiency of their collective systems. This has been used to suggest that individuals in markets have learned to behave optimally and that this accounts for the efficiency of those markets. Kirman argues that just like ants, contrary to the usual account, market participants are far from optimality and efficiency, and that systems with noisy interacting agents operating with simple rules will constantly evolve, will necessarily pass through crises, which will be endogenous, and will never be in what could be considered to be an equilibrium state in the normal sense.

The second paper, by Roger Farmer, "The Evolution of Endogenous Business Cycles," surveys the class of endogenous business cycle models that Farmer has developed based on indeterminacy and externalities and relates them to broader themes in the history of macroeconomics. The survey focuses on a distinction between two generations of endogenous business cycle models. The first generation uses dynamic indeterminacy (a situation in which a dynamic equilibrium

https://doi.org/10.1017/S1365100514000261 Published online by Cambridge University Press

model is associated with a unique steady state but with multiple steady state paths that converge to it) to get endogenous fluctuations around a deterministic steady state. This is in contrast to the standard models of exogenous business cycles, which usually have a unique dynamic equilibrium and a unique steady state. The second generation exploits the search and matching frictions in the labor market to get not just dynamic indeterminacy, but also indeterminacy of the steady state (many steady-state equilibria). Farmer argues that models that exploit steady-state indeterminacy provide a microfoundation for Keynesian macroeconomics and in particular for the idea that high unemployment can persist as an equilibrium phenomenon.

The third paper, by Jess Benhabib, Alberto Bisin, and Shenghao Zhu, "The Distribution of Wealth in the Blanchard–Yaari Model," applies dynamic asset pricing theory to derive some implications in an overlapping-generations model with intergenerational transmission of wealth, lifetime uncertainty, and redistributive fiscal policy. The authors show that idiosyncratic investment risk and uncertain lifetime can generate a stationary double Pareto wealth distribution. This is confirmed to be asymptotically robust even under government lump-sum redistribution policy. Moreover, it is shown, using data from the Survey of Consumer Finances, that this distribution matches up well with the data.

The fourth paper, by Costas Azariadis and Leo Kaas, "Capital Misallocation and Aggregate Factor Productivity," proposes a financial theory of aggregate productivity that connects the sectoral allocation of capital with sectoral productivity shocks and credit frictions. The authors emphasize frictions arising from insufficient collateral for secured loans and from limited enforcement of unsecured loans, both of which lead to endogenous debt limits. They offer some interesting insights into the complex dynamic patterns of competitive equilibria in economies with endogenous debt limits and show that endogenous debt limits slow the reallocation of capital, preventing the equalization of sectoral productivities and sectoral rates of return. The theory may be useful in answering important questions in macroeconomics, such as why relatively mild financial market frictions may be responsible for endogenous fluctuations and an inefficient allocation of capital.

The fifth paper, by Gaetano Antinolfi, Costas Azariadis, and James Bullard, "The Optimal Inflation Target in an Economy with Limited Enforcement," formulates a simple model to study the central bank's problem of selecting the optimal inflation rate in monetary economies with heterogeneous agents and limited enforcement. It assumes two types of agents, cash agents who can buy consumption only with money and credit agents who can buy consumption with money and with credit and must voluntarily repay debts (limited enforcement). The authors show that the optimal rate of inflation is positive, because inflation reduces the value of the outside option for credit agents and raises their debt limits.

The next paper, by Kazuo Nishimura, Carine Nourry, Thomas Seegmuller, and Alain Venditti, "Public Spending as a Source of Endogenous Business Cycles in a Ramsey Model with Many Agents," considers a Ramsey model with heterogeneous agents and introduces public spending financed through consumption taxes

https://doi.org/10.1017/S1365100514000261 Published online by Cambridge University Press

that affects preferences as an externality. It shows that the existence of such an externality is a source of endogenous business cycles under a set of sufficient conditions that do not involve empirically implausible increasing returns in production, an implausibly low elasticity of substitution between capital and labor, or an implausibly elastic labor supply with respect to wages.

The next paper, by Quamrul Ashraf, Boris Gershman, and Peter Howitt, "How Inflation Affects Macroeconomic Performance: An Agent-Based Computational Investigation," provides a theoretical and computational framework for the investigation of the macroeconomic effects of inflation. It takes an agent-based computational approach to show how inflation can worsen macroeconomic performance by disrupting the market processes that coordinate economic activity in a decentralized market economy. The authors find that increasing the trend rate of inflation above 3% has powerful adverse effects on macroeconomic performance, but lowering it below 3% has no significant economic effects. This finding is qualitatively robust to changes in parameter values and to modifications to the model that partly address the Lucas critique.

The last paper, by William Barnett and Unal Eryilmaz, "An Analytical and Numerical Search for Bifurcations in Open-Economy New Keynesian Models," explores bifurcation phenomena in an open-economy New Keynesian model, extending earlier work by Barnett and his co-authors to the open-economy case. The authors provide a detailed stability and bifurcation analysis of the model's equilibrium and show the existence of bifurcations within the feasible parameter range of the model. They find that the introduction of parameters related to the openness of the economy affects the values of bifurcation parameters and changes the location of bifurcation boundaries. They conclude that the bifurcation stratification of the confidence regions remains a serious issue in the context of this open-economy New Keynesian model, as previously found in closed-economy New Keynesian functional structures.

REFERENCES

Angeletos, George-Marios and Jennifer La'O (2013) Sentiments. *Econometrica* 81, 739–779.

Caballero, Ricardo J. (2010) Macroeconomics after the crisis: Time to deal with the pretense-of-knowledge syndrome. *Journal of Economic Perspectives* 24, 85–102.

Farmer, J. Doyne and John Geanakoplos (2008) The virtues and vices of equilibrium and the future of financial economics. *Complexity* 14, 11–38.

Hayek, Friedrich A. (1974) The Pretence of Knowledge. Prize Lecture, The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel.

Hendry, David F. and Grayham E. Mizon (August 2010) On the Mathematical Basis of Inter-temporal Optimization. Working paper, Department of Economics, Oxford University.

Kirman, Alan (2010) The economic crisis is a crisis for economic theory. *CESifo Economic Studies* 56, 498–535.

Kocherlakota, Narayana (2010) Modern macroeconomic models as tools for economic policy. *The Region*, 5–21.

Lucas, Robert E., Jr. (1976) Econometric policy evaluation: A critique. *Carnegie-Rochester Conference Series on Public Policy* 1, 19–46.

https://doi.org/10.1017/S1365100514000261 Published online by Cambridge University Press