

Guest Editorial

Special Issue on Complex Systems in Finance and Economics

FINANCE and economics are complex domains, in which multiple components such as investors, trading venues, or intermediary firms frequently interact to generate aggregate outcomes that may be desirable or undesirable, intended or unintended. The behavior of the underlying elements is often adaptive and the aggregate dynamics can be highly nonlinear. The resulting complexity can therefore be difficult to measure, model, and control. The recent financial crisis revealed how interconnections between institutions can provide feedback loops and propagation channels across the financial system, nationally and globally, spilling into the real economy. There is a great need for advances in the ways in which financial and economic systems are modeled, simulated, designed, controlled, and regulated. The techniques and hybrid approaches emerging from the ongoing efforts of the systems community can help address the challenge.

The financial system is not formally engineered, but has emerged organically as an amalgam of firms, trading venues, industry sectors, jurisdictions, and regulations. Operational risks are monitored and managed primarily at the level of system components (firms and trading venues), leaving a significant gap in our understanding of vulnerabilities at the level of the system as a whole and for various subsystems. The management of systemic financial fragilities is better and improving rapidly since the 2007–09 crisis but much remains to be done. In this regard, we should highlight the importance of new research on key areas like the measurement, analysis, and management of operational and financial hazards arising from the interaction of participants and subsystems of the financial system.

A large and growing fraction of financial flows among system participants occur in the context of securities markets, both organized exchanges and decentralized over-the-counter markets. Understanding the financial system therefore requires a detailed understanding of securities market microstructures. Relevant research topics in this space include empirical analyses, theoretical models, and simulation studies of trading architectures, payment flows, and collateral deliveries.

Economists have long recognized the important role of emergent, system-level phenomena, such as liquidity, complexity, and fragility, for the smooth functioning of the financial system. However, developing models and measures for these system-level phenomena can be maddeningly challenging, and most

extant research has focused on isolated subsystems, such as equities markets, foreign exchange markets, etc. More research is needed to model emergent phenomena, especially as they affect multiple subsystems simultaneously.

It is clear that financial stress can generate interesting dynamics, such as default spillovers and fire-sale feedback loops, as shocks propagate through the system. These dynamics can be very difficult to capture in closed-form theoretical models. System simulations, including agent-based simulations, are a natural alternative research methodology in this context. Interesting topics include simulation of the dynamics of global, national, or local financial systems or subsystems.

The study of system dynamics naturally involves government supervisors, who have the resources and legal authorities to intervene in exigent circumstances. Policymakers' responses to evolving circumstances can have a significant impact—for good or for ill—on the ultimate outcome. There is therefore an important need for research into design of optimal policies for regulatory decision-making and analysis to control of systemic dynamics.

Historically, systemic monitoring has involved a hodge-podge of supervisors, central banks, market participants, and self-regulatory organizations relying on public market data, accounting statements, and on-site examinations to track the status of the system. As the pace of activity changes—for example, through the growth of high-frequency trading—the need also increases for improved tools and techniques for system instrumentation and monitoring, especially during episodes of financial crisis, when system state may evolve very rapidly and unpredictably.

Systemic crises are rare events, typically with important idiosyncrasies. This presents significant challenges to purely econometric or statistical methodologies. A better understanding is needed of the appropriate tools, techniques, and policy frameworks for ex-post forensic data collection and analysis for systemic financial events, so that supervisors and system participants can draw the appropriate lessons from them.

In this special issue we present two interesting articles focused on this space.

In the first one, Germán Creamer focuses his contribution on the study of the mechanisms of financial instability and risk that result from the interaction of the dynamics of social groups and financial products. In his article, “Network Structure and Systemic Risk in the European Equity Market,” he introduces

a methodology to calculate systemic risk using qualitative and quantitative variables that capture communicative and financial activity within equity networks. His analysis illustrates how changes in the network structures might be associated with volatility changes or with systemic risk. The author proposes a component causality index based on centrality indicators that anticipates or moves together with volatility during the period 2005–11.

In the second article, Gerasimos Rigatos and Pierluigi Siano present a systematic method for forecasting default probabilities for financial firms that service power corporations. The solution that they introduce is based on the concept that credit risk is determined by the distance between the debt value and the asset value. They estimate the latter through its relationship with company's market value using a variation on the derivative-free nonlinear Kalman filter. The authors redesign the derivative-free nonlinear Kalman filter as an m-step ahead predictor to obtain estimates of the company's future option values. This information subsequently allows forecasting the associated asset value and volatility and, with that, the default risk.

In our opinion, these two articles pose significant contributions to the field of complex systems in Finance and Economics.

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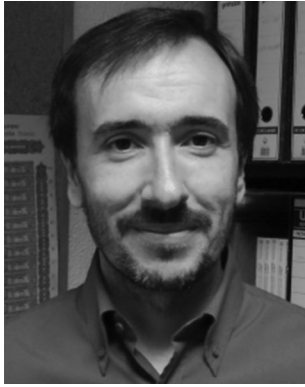
He has taught finance and business at universities in the U.S. and Canada, and worked as a Financial Economist on issues of regulatory policy and risk management with the Federal Reserve Bank of St. Louis, the Office of Thrift Supervision, the Federal Housing Finance Board, and the Federal Housing Finance Agency. He was a founding member of the Committee to Establish a National Institute of Finance. He is currently a Research Principal with the Treasury's Office of Financial Research, Washington, DC, USA. His research has appeared in a number of scholarly journals, including the *Review of Financial Studies*, the *Annual Review of Financial Economics*, *Quantitative Finance*, the *Journal of International Money and Finance*, the *Federal Reserve Bank of St. Louis Review*, and in the two-volume *Handbook of Financial Data and Risk Information*

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