LETTERS

Edited by **Jennifer Sills**

Financial complexity: Regulating regulation

IN THEIR POLICY FORUM "Complexity theory and financial regulation" (19 February, p. 818), S. Battiston *et al.* present a compelling case that complexity theory—the science of complex adaptive systems—offers insights into how the interconnected economic and financial macrosystem works and, more important, how it fails. They argue that, just as complexity theory has been applied in ecology, so too will these insights lead to better understanding of how the interconnectedness between banks and positive feedback channels move information through the system, which in turn will provide a better understanding of system stability, robustness, and resilience. However, they recognize that this improved model of the financial system will require substantial advancements in the availability of data and the development of quantifiable metrics, and therefore call for such an effort to build a "policy dashboard" that monitors systemic risk and stress-tests the global financial system in real time as we do for the weather. Putting aside how far off it will be before that quantitative modeling project bears fruit, it will be important that it launches with sound premises and foundations.

First, many legal researchers have used complexity theory to shine light on the challenges that regulatory systems face when managing, for example, intellectual property (*1*), the Internet (*2*), the environment (*3*), health care (*4*), and telecommunications (*5*). These efforts, while no further along than those the authors propose for the financial system, nonetheless suggest that legal expertise should be a part of the interdisciplinary team designing the quantitative research project.

Second, there is as much reason to believe that regulatory systems—as highly structured, heterogeneous social systems—are complex adaptive systems as there is to believe that the financial system (and the Internet, environment, and health care) is a complex adaptive system (*6*). Regulatory systems and the socioeconomic systems they are intended to control thus comprise systems of coevolving systems. To be of value, therefore, a "policy dashboard" for the financial system must include a way to monitor the financial regulatory system itself, detect its systemic risk, stress-test its resilience capacity, and understand how it coevolves with banking and other financial system component behaviors. Legal researchers have begun exploring such policy dashboards for policy (*7*), and have also begun quantitative studies of the regulatory system's complex adaptive system behaviors (*8*, *9*).

Third, some answers may be staring us in the face without the need for a full policy dashboard. It does not take complexity theory to know that pollution is bad for the environment. Likewise, some financial system experts have identified low-hanging policy fruit that could lead to substantial stability gains for the system (*10*).

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Understanding how the financial system and financial regulation interact could help prevent market failures.

Financial complexity: Accounting for fraud

THE POLICY FORUM "Complexity theory and financial regulation" (S. Battiston *et al.*, 19 February, p. 818) offers some interesting suggestions regarding the complex dynamics of markets, but it does not address fraud.

How does "traditional economic theory" account for fraud? The role of fraud seems to be rampant at all levels in the case of the 2008 financial crisis in the United States: There was fraud in real estate appraisals (*1*), fraud among accounting firms (*2*), fraud in how the risks associated with novel financial instruments were presented to investors (*3*), and fraud in interbank lending (*4*).

Economist James Galbraith has argued that the existence of a bubble in a stable, regulated market like housing is prima facie evidence of fraud (*5*). William Black, another economist, has asked why neither the U.S. Securities and Exchange Commission nor the Federal Reserve employs a criminologist (*6*).

Explaining the 2008 market failure, and market failures in general, is not a scientific problem so much as a regulatory and enforcement problem. Rather than develop more elaborate models to analyze markets, one simple place to start may be to reinstate regulation like the Glass-Steagall Act (*7*) and to investigate fraud more aggressively.

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Response

IN OUR POLICY FORUM, we argued for the development of a policy dashboard to manage complex financial-economic systems based on an interdisciplinary network analysis and behavioral modeling approach.

Ruhl's first point is that legal expertise should be included in the research design. We agree that this may be useful for developing models. In fact, behavioral agent-based models should incorporate legal regulation and market institutional details.

Protesters accuse CEO Richard S. Fuld Jr. of fraud as he leaves the U.S. Capitol after testifying on the collapse of Lehman Brothers.

Ruhl's second point is that the regulatory system itself should be part of the research and model building. We also agree that the regulatory system and the financial system are coevolving and that ideas from complex systems can be useful to think about this relationship. This is reminiscent of the Lucas critique: Regulation itself affects human behavior through mutual adaptive feedback between individual behavior and regulation (*1*).

However, incorporating the evolution of the regulatory system is more difficult than managing the economic-financial system alone. Research on these coevolving complex systems so far has been mainly qualitative. Haldane's "microscopes and telescopes" (*2*) stresses that the financial-economic system is a complex adaptive "system of systems," including a policy architecture with a layer of national financial systems and economies, a layer of monetary policy, and a layer of global financial architecture.

Even if we do not understand how the regulatory system will evolve, we can test its possible effects and assess plausible alternatives that might improve it. What we advocate should contribute to making evolution of the regulatory system more effective in relation to systemic risk. We can do this even without understanding the long-term evolutionary dynamics of regulation. Complex system models will be not only useful, but essential to gauge effects of regulations.

Finally, Ruhl argues that effective reform measures can already be taken before model building. This may be true, but the point of complexity modeling is to identify possible unintended consequences of regulations. A realistic complexity-based policy dashboard can help to empirically assess reforms before implementing them in real markets. The policy dashboard we propose provides a test bed for such potentially stabilizing regulatory policies.

Witzling argues that fraud played an important role in the financial crisis of 2008. Of course, society has to fight fraud, but removing fraud would not solve the problem. The threat exists already within what is legally possible at the moment. Witzling refers to James Galbraith when he says that "the existence of a bubble in a stable, regulated market like housing is prima facie evidence of fraud." However, one of the essential insights from complex systems is that the bubble and crisis would have occurred without any fraud at all. For example, simple agent-based models of the housing markets, calibrated to U.S. data, generate housing bubbles as soon as leverage levels are turned up to levels that were actually used, and were perfectly legal (*3*, *4*). Furthermore, bubbles and crashes have been frequently observed in controlled laboratory experimental asset markets as the emergent outcome of positive feedback environments (*5*, *6*). The problems that caused the financial crisis of 2008 came from the legal use of excessively high leverage, which generated systemic risk. A model of the reforms developed by the Basel Committee on Bank Supervision illustrates this dramatically (*7*). As soon as the banking sector grows to a certain size, and as soon as it exceeds a leverage threshold that is considerably smaller than that actually used, 10- to 15-year oscillations arise that resemble the Great Moderation (the reduction in economic volatility that began in the 1980s) and subsequent crises, both in magnitude and time scale. Fraud may, of course, amplify these instabilities or may push the system beyond a tipping point, but it is not the primary driving force, as these instabilities are an emergent outcome of complex financial networks (*8*).

The argument about fraud is not one against models or our complexity approach, and economic theory offers ways to investigate what fraud and breaching of trust would do to a system. For example, methods and insight from the theory of evolutionary biology and evolutionary game theory can be used to include agents that "cheat" the system by not following accepted sets of rules in their behavior (*9*, *10*).

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Editor's Summary

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