The New York Times
nytimes.com

October 1, 2008

OP-ED CONTRIBUTOR

This Economy Does Not Compute

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A FEW weeks ago, it seemed the financial crisis wouldn't spin completely out of control. The government knew what it was doing — at least the economic experts were saying so — and the Treasury had taken a stand against saving failing firms, letting Lehman Brothers file for bankruptcy. But since then we've had the rescue of the insurance giant A.I.G., the arranged sale of failing banks and we'll soon see, in one form or another, the biggest taxpayer bailout of Wall Street in history. It seems clear that no one really knows what is coming next. Why?

Well, part of the reason is that economists still try to understand markets by using ideas from traditional economics, especially so-called equilibrium theory. This theory views markets as reflecting a balance of forces, and says that market values change only in response to new information — the sudden revelation of problems about a company, for example, or a real change in the housing supply. Markets are otherwise supposed to have no real internal dynamics of their own. Too bad for the theory, things don't seem to work that way.

Nearly two decades ago, a classic economic study found that of the 50 largest single-day price movements since World War II, most happened on days when there was no significant news, and that news in general seemed to account for only about a third of the overall variance in stock returns. A recent study by some physicists found much the same thing — financial news lacked any clear link with the larger movements of stock values.

Certainly, markets have internal dynamics. They're self-propelling systems driven in large part by what investors believe other investors believe; participants trade on rumors and gossip, on fears and expectations, and traders speak for good reason of the market's optimism or pessimism. It's these internal dynamics that make it possible for billions to evaporate from portfolios in a few short months just because people suddenly begin remembering that housing values do not always go up.

Really understanding what's going on means going beyond equilibrium thinking and getting some insight into the underlying ecology of beliefs and expectations, perceptions and misperceptions, that drive market swings.

Surprisingly, very few economists have actually tried to do this, although that's now changing — if slowly — through the efforts of pioneers who are building computer models able to mimic market dynamics by simulating their workings from the bottom up.

The idea is to populate virtual markets with artificially intelligent agents who trade and interact and compete with one another much like real people. These "agent based" models do not simply proclaim the truth of market equilibrium, as the standard theory complacently does, but let market behavior emerge naturally from the actions of the interacting participants, which may include individuals, banks, hedge funds and other players, even regulators. What comes out may be a quiet equilibrium, or it may be something else.

For example, an agent model being developed by the Yale economist John Geanakoplos, along with two physicists, Doyne Farmer and Stephan Thurner, looks at how the level of credit in a market can influence its overall stability.

Obviously, credit can be a good thing as it aids all kinds of creative economic activity, from building houses to starting businesses. But too much easy credit can be dangerous.

In the model, market participants, especially hedge funds, do what they do in real life — seeking profits by aiming for ever higher leverage, borrowing money to amplify the potential gains from their investments. More leverage tends to tie market actors into tight chains of financial interdependence, and the simulations show how this effect can push the market toward instability by making it more likely that trouble in one place — the failure of one investor to cover a position — will spread more easily elsewhere.

That's not really surprising, of course. But the model also shows something that is not at all obvious. The instability doesn't grow in the market gradually, but arrives suddenly. Beyond a certain threshold the virtual market abruptly loses its stability in a "phase transition" akin to the way ice abruptly melts into liquid water. Beyond this point, collective financial meltdown becomes effectively certain. This is the kind of possibility that equilibrium thinking cannot even entertain.

It's important to stress that this work remains speculative. Yet it is not meant to be realistic in full detail, only to illustrate in a simple setting the kinds of things that may indeed affect real markets. It suggests that the narrative stories we tell in the aftermath of every crisis, about how it started and spread, and about who's to blame, may lead us to miss the deeper cause entirely.

Financial crises may emerge naturally from the very makeup of markets, as competition between investment enterprises sets up a race for higher leverage, driving markets toward a precipice that we cannot recognize even as we approach it. The model offers a potential explanation of why we have another crisis narrative every few years, with only the names and details changed. And why we're not likely to avoid future crises with a little fiddling of the regulations, but only by exerting broader control over the leverage that we allow to develop.

Another example is a model explored by the German economist Frank Westerhoff. A contentious idea in economics is that levying very small taxes on transactions in foreign exchange markets, might help to reduce market volatility. (Such volatility has proved disastrous to countries dependent on foreign investment, as huge volumes of outside investment can flow out almost overnight.) A tax of 0.1 percent of the transaction volume, for example, would deter rapid-fire speculation, while preserving currency exchange linked more directly to productive economic purposes.

Economists have argued over this idea for decades, the debate usually driven by ideology. In contrast,

Professor Westerhoff and colleagues have used agent models to build realistic markets on which they impose taxes of various kinds to see what happens.

So far they've found tentative evidence that a transaction tax may stabilize currency markets, but also that the outcome has a surprising sensitivity to seemingly small details of market mechanics — on precisely how, for example, the market matches buyers and sellers. The model is helping to bring some solid evidence to a debate of extreme importance.

A third example is a model developed by Charles Macal and colleagues at Argonne National Laboratory in Illinois and aimed at providing a realistic simulation of the interacting entities in that state's electricity market, as well as the electrical power grid. They were hired by Illinois several years ago to use the model in helping the state plan electricity deregulation, and the model simulations were instrumental in exposing several loopholes in early market designs that companies could have exploited to manipulate prices.

Similar models of deregulated electricity markets are being developed by a handful of researchers around the world, who see them as the only way of reckoning intelligently with the design of extremely complex deregulated electricity markets, where faith in the reliability of equilibrium reasoning has already led to several disasters, in California, notoriously, and more recently in Texas.

Sadly, the academic economics profession remains reluctant to embrace this new computational approach (and stubbornly wedded to the traditional equilibrium picture). This seems decidedly peculiar given that every other branch of science from physics to molecular biology has embraced computational modeling as an invaluable tool for gaining insight into complex systems of many interacting parts, where the links between causes and effect can be tortuously convoluted.

Something of the attitude of economic traditionalists spilled out a number of years ago at a conference where economists and physicists met to discuss new approaches to economics. As one physicist who was there tells me, a prominent economist objected that the use of computational models amounted to "cheating" or "peeping behind the curtain," and that respectable economics, by contrast, had to be pursued through the proof of infallible mathematical theorems.

If we're really going to avoid crises, we're going to need something more imaginative, starting with a more open-minded attitude to how science can help us understand how markets really work. Done properly, computer simulation represents a kind of "telescope for the mind," multiplying human powers of analysis and insight just as a telescope does our powers of vision. With simulations, we can discover relationships that the unaided human mind, or even the human mind aided with the best mathematical analysis, would never grasp.

Better market models alone will not prevent crises, but they may give regulators better ways for assessing market dynamics, and more important, techniques for detecting early signs of trouble. Economic tradition, of all things, shouldn't be allowed to inhibit economic progress.

Mark Buchanan, a theoretical physicist, is the author, most recently, of "The Social Atom: Why the Rich Get Richer, Cheaters Get Caught and Your Neighbor Usually Looks Like You."