Financial network risk

Both macroeconomics and financial theory have failed to deal adequately with systemic risk. However, other disciplines have much to teach us about the stability and fragility of complex dynamic systems, argues ***David Rowe***

Systemic risk is all the rage these days, exemplified by the widespread call for macro-prudential supervision. It is tempting to feel that, like the weather, everybody talks about systemic risk but nobody does anything about it. That situation may now be changing. Discussion is growing around the need for financial theory and analysis to absorb lessons from other disciplines concerning the behaviour of complex adaptive dynamic systems. These other disciplines include epidemiology, aircraft safety, power grid management, telecommunications and pharmaceuticals.

An interesting example of this line of thinking is in a recent paper by Andrew Haldane, executive director for financial stability at the Bank of England.[1] He points to four key factors that contribute to making sense of recent financial market events: connectivity, feedback, uncertainty and innovation.

Two characteristics of connectivity are especially interesting. One is the degree distribution of a network. The degree of any node in the network is the number of connections it has to other nodes. If pair-wise connections were distributed randomly, the degree distribution of the network would be normal, with a fat centre and rapidly thinning tails. In fact, many networks exhibit degree distributions that are thin in the middle and fat in the tails. Both nodes with very few links and ones with a great many links are over-represented. Two obvious examples of such networks are the internet (think Google, MSN, Yahoo! and Facebook) and derivatives markets (think JP Morgan, Goldman Sachs, Citigroup, Royal Bank of Scotland, Barclays Capital, Credit Suisse, Deutsche Bank, and so on).

Haldane points out that networks with "long-tailed distributions have been shown to be more robust to random disturbances, but more susceptible to targeted attacks". This is because most random shocks strike at the periphery of the network where their impact is distributed and can be absorbed easily. On the other hand, failure of one of the massively connected nodes can have catastrophic consequences throughout the whole network by placing severe stress on a large number of other connected nodes. One implication is that long periods of apparent stability, where peripheral shocks are readily damped and absorbed, does not offer useful insight into the impact of a shock that mortally wounds a super node.[2]

Another characteristic of fat-tailed networks is the 'small world' property. The mechanics of 'six degrees of separation' works through super-connected individuals. (I happen to have worked for Alan Greenspan who – I assume – knows Nicolas Sarkozy. That leaves me four remaining links to reach everyone in France.) One implication of this small world property of networks is the potential for local disturbances to make long leaps. For example, the swine flu started in Mexico but spread globally by infected carriers moving among major world airports (transportation super nodes.) This is also how the subprime collapse infected money-centre banks (another form of super node) around the world.

Feedback, uncertainty and innovation can be closely related. Innovation often leads to added complexity that increases uncertainty. This, in turn, fosters a flight reaction when a shock hits. Not having a clear idea of who may be a safe counterparty, the tendency is to avoid any interactions if possible. Thus, when banks were suddenly unsure of each other's capital adequacy, they became unwilling to lend to each other for fear of who would be next to announce a big financial loss.

Another interesting relationship is between nodal diversity and network stability. When the nodes in a network pursue diverse strategies, the network tends to be stable. When nodes are broadly similar, the network is increasingly susceptible to systemic crises. This is true of ecological systems such as fisheries and also of financial institutions. When many institutions pursue similar strategies and measure risk in similar ways, the whole system becomes susceptible to a significant failure in one area. Quite clearly, the widespread tendency to view AAA subprime mortgage tranches as completely safe and highly liquid allowed the exposure to these instruments to pervade the system, creating a systemic crisis when the market collapsed.

While I don't agree with all of Haldane's prescriptions, he is surely correct about the need for a massive improvement in our ability to map the financial network. Without far more detailed, timely and complete data on inter-institutional contingent claims, we will have no basis to apply the lessons about network behaviour from other disciplines to improving the stability of the global financial system. ■

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[1] *Haldane, A:* Rethinking the Financial Network, *April 2009, available at http://www.bankofengland.co.uk/publications/speeches/2009/speech386.pdf*
[2] *This is similar to the point emphasised by Nassim Nicholas Taleb that observations in the middle 99% of a distribution don't give reliable insight to behaviour in the tails*