

## How science can prevent the next bubble

By Richard Olsen and Clive Cookson

Since the world became aware in the summer of 2007 of an imminent financial crisis, people have asked why so few experts saw it coming. There have been many calls for an early warning system for the world economy – but little has been said about how to build one.

To construct a global early warning system we have to overcome the predicament Alan Greenspan, the former US Federal Reserve chairman, highlighted 12 years ago. “How do we know when irrational exuberance has unduly escalated asset values?” he asked. “We should not underestimate ... the complexity of the interactions of asset markets and the economy.”

Macroeconomic data alone cannot provide sufficient information to determine whether asset prices are inflated. We need to dig deeper and track the complexity of interactions in financial markets and the economy.

We can do this by collecting and analysing the tick-by-tick data that markets spew out. More than 1m financial instruments are traded; for the most liquid, 100,000 price quotes are generated each day. They can offer an early warning of dangerous misalignments between prices and risk premiums. Price changes are not just noise; their sequence is driven by the flow of buy and sell orders, second by second. The bigger the order the larger the price change.

By tracking tick-by-tick prices we can infer how market participants build and close positions. The next step is to map the size of positions and infer what positions have been established at the various price levels – and what profits and losses different groups of traders and investors are incurring.

The position information indicates which groups of traders and investors are most likely to run into losses so big that they face margin calls and are forced to close out their positions. Margin calls can cause a dangerous acceleration of price moves.

We can then create “weather maps” of the positions that traders have established and the circumstances that would force them to close their positions, causing a cascade of further margin calls. The recent violent sell-offs in currency, commodity, equity and bond markets were because of whole groups of traders being hit by margin calls, adding momentum to the price moves.

Building a financial forecasting service to uncover this information is no small task. We have to collect tick-by-tick data from all the main financial markets and add auxiliary information. While there have been some private initiatives to collect tick-by-tick data, the job has hardly started. Once the data have been collected they must be “cleaned and scrubbed”, and we have to generate synthetic information, for example about volatility and liquidity.

No bank or government agency has access to such a comprehensive data repository today. The study of economics and finance has only recently started to analyse the statistical properties of tick-by-tick data. For too long, academia has followed the classical economic model, assuming that financial markets follow a random walk and that second-by-second market data are unworthy of further scrutiny. Banks have focused on daily profit-making not on creating a tradition of research.

In natural sciences, we take it for granted that researchers have to be well equipped to do experiments. Governments spend billions of dollars on huge particle accelerators to understand the inner workings of atoms. In economics and finance, however, universities struggle to get even a small budget to buy tick-by-tick data for one or two financial market instruments.

To build up the resources and tools to model the intricate flow of capital in financial markets and predict the likely fallout will not be cheap, though the spending is small compared with the turnover of the banking and financial services industry – or the \$1,000bn (€779bn, £702bn) lost by the banking system in the crisis. A sum of \$2bn over five years would go a long way to building a huge data repository, launching a research initiative and developing a comprehensive predictive service for the global economy.

The proposal is to set up an independent agency to raise money from banks, other financial institutions, governments and international organisations. All the work would be collaborative, making full use of the internet and grid computing. Some of the money might fund prizes. The aim is to provide governments, regulators and the private sector with enough warning when the next financial storm is brewing for them to take avoiding action.

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