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Uncovering the dynamics of bubbles

By John Bonaccolta

The trading desks of major investment banks and hedge funds have long sought maths and physics talent to try to turn science into profit. And since the dawn of markets, alchemists of all stripes have been trying to build the ultimate device that will allow a few to profit consistently.

But in the 1990s, physicists began looking at ever more robust data coming from economics and finance as a way to look at market dynamics and other economic principles in a new light. The movement, for lack of a better term, was coined econophysics, although in recent years its popularity has waned.

Didier Sornette, a trained statistical physicist and geophysicist and now professor of finance on the chair of entrepreneurial risks at the Swiss Federal Institute of Technology in Zurich, does not seem bothered by the waning enthusiasm for the multi-disciplinary approach. Rather, he is doing what he has done for much of his career, which is publishing not only in leading physics journals but also leading finance ones.

Prof Sornette, author of *Why Stock Markets Crash* (2004), is essentially trying to better understand the dynamics of bubbles. He is alone - or one of very few - in leading three concurrent fields in the analysis of complex systems: pure physics, applied economics and econometrics, and market practitioners.

"Being a physicist looking at finance, I'm the ugly duckling, out of my familiar realm," says Prof Sornette.

Perhaps. But then again, being alone versus being part of the herd is also a large part of Prof Sornette's research. Financial markets, unlike earthquakes or other natural phenomena, express what Prof Sornette refers to as reflexivity - or the expectations of others' behaviour. In other words, analysing seismic data to look for the appearance of cracks and the frequency of such appearances to judge the stability of a system is one thing. Analysing price behaviour, which is a mere human perception of fundamental value, is something else entirely.

But markets are endemically heterogeneous, according to Prof Sornette. And that makes them more predictable than "purer" homogeneous systems.

"What we are trying to do is examine evidence of precursory stress in the build-up to a crash - while it's impossible to determine the crash itself, most complex systems show signs of stress as they become dislocated," says Prof Sornette. He gives the counter-example of a quartz crystal. A single pure quartz crystal does not show any foreshock as a force is applied to it, it simply breaks when it can no longer withstand the pressure.

"The more homogeneous the system, the less it's generally predictable - but markets work best when they're chaotic, it's when they become less chaotic that they become less stable," says Prof Sornette.

He is speaking about the principle of singularity, whereby a complex system converges towards a consensus, in the case of markets, and can no longer justify a balance between buyers and sellers.

"Singularity signals a regime change - it's a sign that a major, abrupt change is about to occur," says Prof Sornette. He notes the US and Chinese financial markets as moving towards this notion of singularity, China being further along than the US.

"Singularity is a move into the unknown - it's what we experience before an assembly of molecules changes form, from a liquid to a gas, or from magnetism to non-magnetism, for example - we're on the brink of this," says Prof Sornette.

However, not all regime changes are crashes, it is important to note. Prof Sornette distinguishes between endogenous and exogenous crashes: the former account for two thirds of the cases he has studied, and show clear signs of bubbles characterised by superexponential growth that finish in a crash. The other third, exogenous crashes, show no signs of bubble activity or build-up phase.

It is this last third that Prof Sornette wryly claims obey the laws of economic theory, which wants to claim that crashes should result from some exceptional new piece of information being introduced. But for the two thirds majority - the endogenous ones - the crash does not need a new piece of information.

"This is where physicists have perhaps been at the forefront," says Prof Sornette. "The understanding of the interaction between many atoms and molecules, which in physics we refer to as the 'N-body problem', requires information throughout the whole sample. It's a phenomenon whereby the global collective system behaves as one - this is the hardest part for economists to grapple with."

Traders trying to act on the evidence of a bubble might for the moment be frustrated, however. As Prof Sornette himself concedes, it would be an error to exit the market too early. Prof Sornette's theories are actually aimed at estimating the lifetime of such bubbles.

Equity market valuations in 1998-99 showed signs of being severely dislocated, which is a classic endogenous bubble characteristic, according to Prof Sornette. Leaving too early would have nevertheless left a tidy sum on the table. And leaving too late ended more than a few careers.

Learning more about the dynamics of bubbles is undoubtedly invaluable. And looking to fields beyond economics and finance can only broaden the dialogue. But do not expect a magic formula for how to trade markets.



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