Economists must broaden their horizons

It's rather unusual that a senior figure at the Bank of England should deliver a public speech touching on topics including Enrico Fermi's calculations of neutron transport during the development of the atomic bomb and recent high-performance computations of instabilities in dense fusion plasmas. His audience of bankers, finance experts and economists must have been somewhat puzzled as he ranged wider still — exploring computer simulations of pattern formation in traffic flows and pedestrian motion, in the dynamics of sorting in granular mixtures, and in the cellular development of the bacterium *Mycoplasma genitalium*. This was not your typical speech from a chief economist at the Bank of England.

But Andrew Haldane is not a typical central banker, and his thinking isn't constrained by long specialist training in finance and economics, though he of course has that. He's convinced that much of what has gone wrong with economic and financial policy making in recent years can be traced to the excessively narrow conceptual training of economists, and the field's reluctance to borrow useful ideas from the rest of science. In many ways, economics still celebrates the Newtonian model of science, emphasizing certainty over uncertainty and seeking elegant closed-form mathematical theories and tidy solutions. Economists haven't noticed that the rest of science is no longer like that — it now embraces a much messier world of chaos, instability and uncertainty — and has developed a host of techniques for dealing with these realities.

The most prominent technique is probably computational simulation, which is often crucial for gaining insight into complex systems of many interacting parts, especially if those interactions are too strong to permit much analytical insight. We call these molecular dynamics simulations if the subject matter is a simple fluid or plasma, or climate models if the parts are components of the Earth-system such as the atmosphere, oceans or biota. Or, they're often called agent-based models if the parts to be modelled — be they anything from bacteria to pedestrians to firms in an electrical power market — possess agency, and act in pursuit of goals. All such problems share the essential commonality that interactions often lead to collective patterns or dynamics of decisive importance, yet these cannot in

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any way be linked directly to the properties of the individual things.

Of course, this is all well known to physical scientists. To economists, not so much. A first criticism they often make is that such models aren't realistic because they treat people too simply, as if individuals follow mechanical rules, rather than being extremely adaptive and rational in adjusting their actions. A second is that, though these might one day be useful, no one has done anything useful with them yet. In his speech, Haldane shows where these criticisms go wrong.

The first criticism, he suggests, actually reflects an effort among economists to eliminate serious uncertainty from the subject, so as to proceed on the basis of deductive mathematics. Standard models in macro-economics and finance do consider risk and decision strategy when facing known probabilities for a range of possible outcomes. Such risk can be accounted for rationally, and hedged away in financial markets; agents can be thought of as optimizing their decisions in the face of uncertainty. Yet this kind of risk isn't quite like that of the real world, where we often do not even know the kinds of things that might happen, let alone their probabilities.

In the real world it is often, if not usually, impossible to foresee the range of possible future outcomes, and even less possible to compute how likely they are. In this case — as psychologists such as Gerd Gigerenzer have shown — agents actually make better and more rational decisions not through intricate calculations but by relying on simpler 'rules of thumb' or heuristics. In a world of uncertainty, heuristics aren't arbitrary or suboptimal, but actually represent an adaptive means for making decisions.

Hence, as Haldane notes, the fact that agent-based models treat people or firms as following heuristic rules makes it closer to reality than the ordinary approach of economics. The alleged weakness cited by economists is actually a major strength.

The second excuse — that agent-based models haven't had any great successes in economics and finance — is also not true. As he notes, financial firms in the 1990s developed agent-based models as highly practical tools to forecast important variables — for example, the prepayment rates for individual mortgages, which affect the return a bank ultimately gets on its loans. These models predicted behaviour over ensembles of mortgages with great accuracy. Researchers have more recently used these to do a 'post mortem' examination of the recent US housing bubble — using mortgage data on more than two million households in the Washington area — and were able to predict out of sample data very well. The study provided strong evidence that the main cause of the bubble wasn't low interest rates, but leverage — people buying houses with mostly borrowed money and very little down payment.

Other research has used agent-based models to achieve more general scientific ends, such as showing why volatility in markets tends to cluster into intense periods of upheaval, separated by intervals of relative quiescence, which also happens in many physical and biological systems. Others have shown how relaxing just a few of the stringent assumptions of standard theories of whole economies leads naturally to an expectation of ongoing fluctuations, in which economies may flip between states of high and low unemployment quite unexpectedly, and without any major cause.

It's encouraging to see an economist with the very public position of Haldane offering constructive suggestions about where economists should look to become more interdisciplinary and to benefit from the best ideas in the rest of science. His two key ideas: take some tips from psychology on how to model real human behaviour when facing legitimate uncertainty of the kind that can't be handled with probability theory; and learn to use computational simulations as a tool to explore the surprising things that often happen due to amplifying feedbacks, as researchers throughout the sciences have done.

Finally, accept that useful science will have to be a lot messier than the current elegant but useless theories. That's just the way it is. ❐

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