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EDITORIAL

Economics, Modelling and the Financial Crash

Every year when the placements at the Indian Institutes of Management (IIM) are complete, the newspapers carry reports of the remarkable salaries offered to some members of the graduating class. A career path which seems most rewarding is one that takes a student from the Indian Institutes of Technology (IIT) through the IIMs and on to an investment banking firm on Wall Street. My admiration for the modern day banker, of both the conventional and investment varieties has been unbounded; conditioned by own upbringing. Having grown up, decades ago, in a financially conservative, middle class environment, I have been taught to avoid taking loans (although one is sometimes compelled to give them) and to view credit cards with suspicion. Spending money that one does not have and to spend time coveting that which is unaffordable were activities that were best avoided. Clearly, these are not attributes that are compatible with the modern age. Banks are no longer safe havens for depositing one's money; they are instruments which provide loans to feed every desire; borrowing and lending are practices to be encouraged and large profits are generated by banks when the going is good. I would never have worried about banks and bankers if the current global financial crisis had not exploded with such intensity. The sudden collapse of once famous investment banks must intrigue even laymen, like me, who are completely unschooled in the ways of high finance. Curiously, not long before the stock market collapse of October, I had heard colleagues proposing a course in mathematical finance. This seemed an area that was completely distinct from the 'finance courses' normally taught to students of accountancy. Over a decade ago, courses in financial mathematics became popular in the United States and the term 'financial engineering' began to appear both in journals and the popular press. The use of the suffix 'engineering' in terms that describe new and emerging disciplines can sometimes be a pointer to future controversies; genetic engineering and geoengineering are examples. For nearly twenty years Wall Street investment banks have hired Ph Ds in physics and mathematics to man their 'derivatives trading desk'. These quantitative analysts ('quants') are key figures in the investment banking firms that are now in the limelight. Has a completely misplaced faith in quantitative modelling led financial institutions in the West to the brink of disaster? The consequences of the collapse of banks and insurance companies, which provide risk covers for loans, can damage large numbers of individuals and societies. In the globalized economy the shocks are felt almost everywhere. Should not the subject of 'financial engineering' and the assumptions that underlie quantitative analysis be scrutinized more rigorously and the application of the tools of the trade be regulated with greater diligence?

The journal *Nature* recently published a provocative essay, which argues that 'economics needs a scientific revolution'. The author, Jean-Phillipe Bouchaud, notes that 'compared with physics the quantitative success of economic sciences has been disappointing'. He asks: 'What is the flagship achievement of economics? Only its recurrent inability to predict and avert crises, including the current worldwide credit crunch'. He recalls a view advanced by Newton that 'modelling the madness of people is more difficult than modelling the motion of planets'. Physicists who have entered the field of finance and economics come armed with techniques that allow the prediction of the behaviour of large collections of particles and molecules, even though the individuals seem to move chaotically. Order can emerge from complexity and chaos. Bouchaud emphasizes that 'the crucial difference between modelling in physics and economics lies . . . in how the fields treat the relative roles of concepts, equations and empirical data'. His thesis that 'financial engineers have put too much faith in untested axioms and faulty models' will undoubtedly stir debate. His verdict on financial markets may find many supporters in the present situation, where talk of stock market crashes and impending recession is widely heard: 'In reality, markets are not efficient, humans tend to be over-focused in the short term and blind in the long-term, and errors get amplified, ultimately leading to collective irrationality, panic and crashes. Free markets are wild markets' (Bouchaud, J.-P., *Nature*, 2008, **455**, 1181).

The alarm bells warning the financial industry of the dangers of naively believing the methods and results obtained by 'modellers' have also been rung by the *New Scientist*. An editorial column, headlined 'Blinded by science: Financial regulators have allowed themselves to be bamboozled', does not mince words in heaping criticism on the quantitative analysts. The column notes that the collapse of a hedge fund called 'Long-Term Capital Management' exactly ten years ago should have alerted the financial community. This collapse 'was particularly notable because its founders had set great store by their use of statistical models designed to keep tabs on the risks inherent in their investments'. The continued use of such models points to the fact that 'models' ostensibly based on the sound principles of physics and mathematics can be misleading when applied to complex areas of human activity. It would appear that the area of financial risk modelling may be resting on inherently weak foundations; key assumptions in models may sometimes be hidden from critical evaluation. The *New Scientist* assessment is harsh: 'Now that disaster has struck again, some financial risk modellers – the 'quants' who have wielded so much influence over modern banking – are saying they know where the gaps in their knowledge are and are promising to fill them. Should we trust them? Their track record does not inspire confidence. Statistical models have proved almost useless at predicting the killer risks for individual banks, and worse than useless when it comes to risks to the financial system as a whole'. The editorial is categoric in its advice: 'Banks should be careful not to assume that they have it right and the rest of the world has it wrong. And regulators – who have lately allowed themselves to be blinded by science – should have no qualms about shutting down activities they do not understand' (*New Scientist*, 2008, Sept. 27, p. 5). An accompanying article in the same issue of the journal attempts to analyse why risk modellers can be so wrong. The conclusion is that 'each liquidity crisis is inevitably different from its predecessors, not least because major crises provoke changes in the shape of markets, regulations and the behaviour of players'. Researchers in the area of risk assessment 'still lack the tools to predict when the next liquidity crisis will come' (Jameson, R., *New Scientist*, 2008, Sept. 27, pp. 8–9). What are the 'models' that researchers in 'mathematical finance' investigate? A quick search on the internet led me to a sample paper posted on the physics archive entitled 'Higher order potential forces observed in bubbles and crashes in financial markets' (Watanabe, K. *et al.*, arXiv:0808.3339v1, 25 August 2008). While I am ill equipped to understand such a paper the application of complex mathematical methods to predict financial crashes left me uneasy. Would the managements in financial institutions that invest their customer's money rely on modellers who are 'certain that the existence of a cubic potential function is a precursor of a big risk that might be encountered in the near future'.

Modelling and predicting the behaviour of monsoons, earthquakes, and financial markets is an inherently hazardous exercise. The parameters are many and the assumptions often untenable. Nevertheless, physicists and mathematicians have been employed in large numbers by Western financial institutions. Skills and familiarity with probability theory, calculus and partial differential equations have long been a pre-requisite for scientists and engineers to obtain well paid jobs in the financial sector. Nearly a decade ago a study commissioned by the UK's Engineering and Physical Sciences Research Council came to the conclusion that physicists are preferred over mathematicians. The reason advanced by a bank is compelling: 'Physicists want to find the answers to problems. Mathematicians have all the answers and want problems to solve' (*Physics World*, Editorial, 1999, June 3). Even a decade ago the gulf between academic research and the requirements of banks seemed unbridgable. There appears to have been limited progress in the years that have passed.

The connections between physics and finance go back a long way in capitalist or free market economies. The theory of Brownian motion has a precursor in Louis Bachelier's study of the fluctuations in the prices of stocks and shares, which he suggested 'could be viewed as a random walk' (*Physics World*, 1999, Jan. 1). The financial crash of 2008 has introduced lay readers to many new terms, 'sub-prime loans', 'option pricing' and 'derivatives' all of which seem critical in understanding what went wrong all of a sudden. Mathematical modellers are always on the look out for problems to solve. From biology to economics the same equations seem to surface. Analogies from physics can sometimes be enlightening, but are most often misleading. Eugene Wigner wondered many years ago about 'the unreasonable effectiveness of mathematics in physics'. Recent events suggest that it might be wise to reflect on the ineffectiveness of physics and mathematics in economics.

P. Balaram