# Live laboratory will analyse real-time market data

A collaboration between industry and academia has produced a unique research centre that promises new insights into the complexity of today's markets. *Vanessa Spedding* reports.

On 10 October this year, a new approach to modelling the world's financial markets came into being, with the launch of the Oxford Centre for Computational Finance (OCCF) at the University of Oxford, UK.

Before dismissing this statement as grandiose puff, take note: the Deputy Governor of the Bank of England and the Chief Secretary to the Treasury were at the ceremony to officially open the centre with supporting speeches. What's more, there is convincing evidence that OCCF will be deploying a genuinely innovative approach to analysing market data.

OCCF is the brainchild of an industrial and academic collaboration that was just 16 months in the making. Its impetus came from a desire to study the world's financial markets in a way that reflects their highly quantitative, fast-moving, data-driven nature, and to provide the ability to react quickly to extreme market events.

The collaboration came up with a solution in the form of a 'live laboratory', in which real-time market data feeds (the output of the 'experiment') are analysed by means of a sophisticated hardware and software infrastructure from the commercial partners, combined with academic expertise from the mathematics, computing and physics departments at Oxford University. One of the OCCF's three directors, Neil Johnson of the university's physics department, explained.

'OCCF is a laboratory for studying today's (rather than yesterday's) financial markets. This point is absolutely crucial. As we are always told, past performance carries no guarantee of future success. An event such as 11 September means that historical studies of past data (which are the norm)—in this case data taken prior to 11 September—may be meaningless, or even dangerously misleading, after 11 September.' Not only will OCCF benefit from current data, there is also the advantage that model testing can be done truly 'out-of-sample'—in other words, forecasts are made about the actual future, before it has happened. Those forecasts can then be tested without using preselected historical datasets for comparison, avoiding the risk of false positive results.

Johnson is very excited about the potential of OCCF. 'Not only is the real-time nature of its market analysis unique', he says, 'but so too is its infrastructure and the ongoing partnership between academia, the IT industry and the finance industry that has created it. What's more, there is a possibility that it could offer a deeper

understanding of the basic science of complex systems'.

The infrastructure comprises a combination of elements, each powerful in itself, which, when put together, constitute a formidable package that will enhance leading-edge financial research already underway at Oxford. Sun Microsystems, one of the partners, has contributed most of the hardware, including a state-of-the-art, 96-processor Grid machine for distributed computing applications and supporting workstations. Numerical Algorithms Group (NAG) is providing its software libraries for data analysis and IRIS Explorer for data visualization. IBM has contributed the Informix IDS database software, which allows real-time storage and analysis of huge databases of financial data. Market Information Services (MIS) has supplied data management tools for faster access and analysis and Reuters is supplying the live data feeds from the financial markets.

The partnership itself evolved in a remarkably rapid and cooperative fashion. While at a conference in Germany in the summer of 2000, Ian Reid of NAG had the idea to create a numerical centre of excellence. At the same time, Sun was planning a suite of centres of excellence worldwide. It seemed natural to combine their initiatives, and between them they opted for finance as the most exciting application area. Oxford University were chosen to host the centre, which works well for NAG: the company spun-out from the university sector some 30 years ago, and still maintains links.

Once the requirements became clear, NAG pulled in additional partners, namely IBM Informix for the database, Reuters for the data-feed and MIS for data integration. 'The partners' products are very complementary' said Johnson, 'and each is interested in knowing how their own product integrates with others. Hence they see a potential benefit on various levels in being involved with OCCF.' All partners have stressed the benefits of an ongoing relationship in which models, ideas, software and even hardware are developed and shared in a cooperative way.

There are plans to include other sponsors, in particular to fund staff positions (such as graduate studentships, post-doctoral fellowships and faculty posts). Several financial institutions are already said to be showing interest. Sponsors can also provide grants for specific research projects, and request that sensitive research is 'ring-fenced' to protect their interests.

A primary focus of research at OCCF will be to investigate novel, real-time approaches to risk assessment that respond to the complex dynamics of modern finanical markets. The centre is particularly concerned with improving the understanding of large movements and extreme events, typically ill-served by standard models. Its stated aims include developing quantitative models for factors such as herding and speculation; linkages between various components of global markets; and external perturbations and control mechanisms. Artificial markets, running on OCCF's distributed computer network, will be used to stress-test various market scenarios and the effects of certain financial strategies.

David Clementi, Deputy Governor of the Bank of England, put this focus into a real-world context in his opening speech. He explained the Bank of England's role in issues of financial stability and discussed recent threats to that stability, such as the tragic events of 11 September. He described how formal models of market and credit risk have influenced the design of regulatory systems and how additional safeguards are necessary to improve the chances of maintaining financial stability.

'Over the past quarter century, total output losses during banking crises have averaged around 15–20% of the GDP in the countries in which they have occurred' he observed. 'We are, of course, still working our way through the implications of the dreadful events in the US [in September]. Uncertainty about the near-term outlook increased quite markedly following the attack ... [contributing to] some sharp adjustments in equity values ... . In other ways, though, the aftermath of the attacks on the US has highlighted the robustness of the international financial system.'

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'The robustness of a system' suggested Clementi, 'depends on reliable contingency plans and effective means of risk measurement and management'. Value-at-Risk (VaR) models, he pointed out, have been important in allowing banks to calculate measures of the aggregate risks associated with entire portfolios and to manage day-to-day risk. VaR models are now supported for market risk calculations by the Basel Accord (which stipulates the economic capital required to offset risk). 'But,' warned Clementi, 'care is needed, not least because these models tend to be least robust in precisely the circumstances of most interest—i.e. those rather rare cases in which losses are very large, hidden away in the lowest parts of the bottom tail of the probability distributions.'

Clementi also discussed the implications of credit risk and operational risk and looked forward to seeing OCCF's contributions in these areas. 'Responding to new types of risk demands an increasingly sophisticated combination of technology and intellectual thought, and I can think of few places as well suited to this exciting and challenging task as Oxford' he stated.

Neil Johnson, meanwhile, is confident that OCCF will meet these challenges. 'I think that [OCCF research will result in] improvement of existing industry-standard models for institutions and also maybe for regulatory bodies. At the higher end, we believe that [OCCF] will open a new paradigm for finance theory, breaking free from the assumptions typically made and appealing instead to the market data as the ultimate cornerstone.'

He speculated that, on a more abstract level, new ideas in the more general field of complex systems may also emerge from the approaches offered by OCCF, since it offers a window onto a highly complex system and the means by which to study it.

Johnson's research interests focus on complexity, so his interest in, and particular view of the financial markets is not surprising. He says that markets represent the dynamic output from the evolving interaction between a population of competing, adaptive agents. This is why they can be described as an archetypal complex system. Complex systems are normally studied by developing models and comparing them with real data. Such systems can be observed in disciplines as far apart as biology, economics and artificial intelligence but advancements in their understanding are often hindered by a lack of good data for comparison with the models. 'Here we have a laboratory for doing this. So in addition to a unique finance centre, maybe OCCF is also a unique centre for the empirical study of complex systems' enthused Johnson.

His particular interest is extreme events. 'Risk assessment, management and strategies depend fundamentally on an understanding of extreme events' he said. Extreme events are important because they tend to dominate the future evolution of the system in question. They are often assumed to occur randomly, yet the markets have their own dynamics even in the absence of significant external news. So Johnson and colleagues are postulating that a large, internally-produced change looming in the near future may actually be 'encoded' in the make-up of the system, and could be exposed using the appropriate tools. Johnson's approach is to use multi-agent market models.

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Of course, his are not the only methods that will be enabled by the OCCF. The other two directors, also at Oxford, represent the other departments involved in the venture, namely Jeff Dewynne in mathematics and Professor Mike Giles from the computing laboratory. Dewynne is interested in derivative pricing using numerical (Monte Carlo) and asymptotic approaches, while Giles, a computational fluid dynamics expert, brings his experience in computational numerical analysis, specifically in designing algorithms for partial differential equations to run across distributed computing systems.

What difference will the OCCF make? Time will tell, but for the academics, the OCCF will give them something they are not used to: a real-life laboratory, in which they can see events unfolding in the markets as they happen, learn how information moves around, test their ideas, then modify them and test them again. Insight into how other organizations work will also be an asset. 'The partnership companies will be able to try out new technology with OCCF, we will be able to try out new financial technology in the City and the City will try out its outstanding problems through OCCF' Johnson explained.

For Johnson himself, the tantalizing dream is without doubt that of understanding extreme events. 'Can they be predicted, controlled, and even avoided? Previously it has been very difficult to even attempt addressing such questions' he admitted. 'OCCF gives us a lifeline to do this.' It would appear that right now at least, there is no other place in the world that offers quite the same combination as does the OCCF.

## Further information

The Oxford Centre for Computational Finance (OCCF): www.occf.ox.ac.uk
NAG: www.nag.co.uk/bdu/partners/occf
IBM Informix: www-4.ibm.com/software/data/informix/
Sun: www.sun.com
Market Information Services: www.marketinfoserv.com
Reuters: www.reuters.com

## Correction

In the feature by D Gkamas in *Quantitative Finance* **1** 292–7 (May 2001 issue), panel C of figure 3 contained the wrong diagram. The correct version is published here.