Institution:
University of Oxford

Unit of Assessment:
18 – Economics and Econometrics

Title of case study:
Designing financial instruments to protect against financial stress.

1. Summary of the impact

Research by Oxford econometricians provided the basis for innovative new methods for predicting periods of potential financial stress and providing protection for investors against extreme events. During periods of financial stress, equity funds tend to sharply lose value while volatility tends to increase. Adding some long volatility exposure to a standard equity portfolio can significantly improve the tail behaviour of a portfolio. However, it is expensive to continually hold volatility contracts due to the volatility risk premium. Researchers at Man Group have applied the Oxford research to create new strategies to protect against tail risk and these are incorporated in their Tail Protect fund launched in October 2009.

2. Underpinning research

Researchers Involved:

- Professor Neil Shephard joined Oxford University in 1991, first as a Research Fellow, then as an Official Fellow at Nuffield College, Oxford, and since 1996 he has been a Professor of Economics. In 2007, he founded the Oxford-Man Institute for Quantitative Finance with core funding from the Man Group, which he directed until 2011.
- Dr Kevin Sheppard has been a University Lecturer since 2004 and is a Fellow of the Oxford-Man Institute.
- Professor Ole Barndorff-Nielsen is Professor Emeritus at the Thiele Centre for Applied Mathematics in Natural Science, University of Aarhus.
- Dr Diaa Noureldin was appointed to a Postdoctoral Research Fellowship in Economics in 2011, and prior to this he was a DPhil student in the Department of Economics and supervised by Professor Shephard and Dr Sheppard.

The Oxford-Man Institute of Quantitative Finance (OMI) was established in 2007 with core funding from the Man group, under the directorship of Shephard, as a multidisciplinary centre for research on quantitative aspects of finance. The OMI provides an innovative model of collaboration between academic researchers and their counterparts in the commercial world with the OMI co-located with the Man Research Laboratory (MRL) which houses long-term commercial researchers from AHL. AHL is a dedicated group within the Man Group who specialise on using purely quantitative investment strategies. The two centres are independent - OMI's focus is on academic research for the public domain whilst AHL's research is commercial and profit driven – but researchers come together for seminars, workshops and conferences, allowing OMI researchers to benefit from practitioner expertise and Man's commercially-focused staff to benefit from discussions with leading academics in the field. This research was born in, and benefits from, this co-creative environment and is a product of direct engagement beyond academia with the financial sector.

From the late 1990s onwards, Professor Shephard has carried out significant work with Prof Barndoff-Nielsen, developing new statistical methods which allow researchers to extract econometrically useful long and medium term information from high frequency financial data. These methods have been very widely applied in academic research, allowing various researchers to develop a new generation of predictive models to be built for financial volatility, a major component of financial risk.

Shephard's early work **[Section 3: R1]** showed how to frame realised volatility as a simple non-parametric estimator of the increment to quadratic variation and derived a central limit theory for this estimator. This theory was used to provide a principled and simple way of carrying out volatility forecasting using a non-parametric continuous time stochastic volatility model. This research has been extended to the multivariate case in Barndorff-Nielsen and Shephard **[R3]** and has been further developed to explore how to mitigate the impact of market microstructure effects **[R2]**.

Other extensions to the research include the development of the first non-parametric quantifiers of the importance of jumps in financial markets **[E.G. R4**Since these first papers there has been extensive econometric research in this area, allowing researchers to have a better gauge of extreme price moves in equity markets. Unusual moves are critical in terms of the pricing of risk, but also for their potential spillover into the macroeconomy.

In more recent Oxford research, Sheppard and Shephard produced a simple volatility forecasting model called the high-frequency-based volatility (HEAVY) model **[R5]**. Building on the results of Shephard's earlier 2002 paper **[R2]**, this used high frequency data to make low frequency volatility forecasts. In subsequent research, the techniques were extended to the multivariate case **[R6]**The key advantage to this kind of model, compared to traditional GARCH or RiskMetrics models, is that it is able to react quickly to abrupt changes in the level of volatility, which is a feature of nearly all periods of financial distress. The reason for this is that it is built using realised volatility measures of daily volatility, rather than using absolute daily returns. These realised volatility measures are simply much more informative, which means it is not necessary to temporally average them over many months to produce coherent medium term forecasts. Such models can be used to adjust portfolio allocations and potentially to value volatility contracts.

3. References to the research

[R1] Barndorff-Nielsen, O.E. and N. Shephard (2002) "Econometric analysis of realised volatility and its use in estimating stochastic volatility models", *Journal of the Royal Statistical Society*, Series B, 63, 2002, 253-280.

[R2] **Barndorff-Nielsen, O.E., P.R. Hansen, A. Lunde and N. Shephard (2008) "Designing realised kernels to measure the ex-post variation of equity prices in the presence of noise", *Econometrica*, 2008, 76, No. 6, 1481–1536.

[R3] *Barndorff-Nielsen, O.E. and N. Shephard (2004) "Econometric analysis of realised covariation: high frequency based covariance, regression and correlation in financial economics", *Econometrica*, 2004, 72, 885-925

[R4] Barndorff-Nielsen, O.E. and N. Shephard (2006) "Econometrics of testing for jumps in financial economics using bipower variation", *Journal of Financial Econometrics*, 2006, 4, 1-30.

[R5] **Sheppard, K.K. and N. Shephard (2010) "Realising the future: forecasting with high frequency based volatility (HEAVY) models", *Journal of Applied Econometrics,* 25, 197-231. *(Revised version of* Department of Economics Discussion Paper Series 438, July 2009) *Winner of the Richard Stone Prize in Applied Econometrics 2012.*

[R6] **Noureldin, D., N. Shephard and K.K. Sheppard (2012) **"**Multivariate high-frequency-based volatility (HEAVY) models", *Journal of Applied Econometrics*, 27, 907-933.*(Revised version of* Department of Economics Discussion Paper Series 533, Feb 2011)

Research quality
Econometrica is a 'top-five' world leading general interest economics journal. It was rated as "4*" by the ESRC-RES International Benchmarking Review of UK Economics in 2008 and is classed as "AAA" in the Combes-Linnemer (2010) ranking.
Journal of Applied Econometrics is a leading field journal for econometrics and is classed as "A" in the Combes-Linnemer (2010) ranking.
Journal of Financial Econometrics is a leading field journal for econometrics.
Journal of the Royal Statistical Society (series B) is a leading statistics journal, focusing on statistical methodology.

4. Details of the impact

As described above (section 2), the OMI provides a fruitful co-creative collaborative environment

for researchers and their counterparts in the commercial world via co-location within the Man Research Laboratory (MRL) and a series of collaborative seminars, workshops and conferences. It was through the research seminars that AHL researchers became aware of Professor Shephard's research on volatility, and, in particular, of the predictive model that he had developed with Dr. Kevin Sheppard **[R6]**. The predictive research methodology of Shephard and Sheppard provided the basis for a decision rule developed by AHL researchers to generate what they termed the 'spike detection strategy'. This tool was then used by AHL to attempt to statistically hedge significant 'tail events'. Shephard and Sheppard were consulted over the subsequent development of the spike detection strategy, providing feedback on the approach adopted and pointing to some fruitful directions for subsequent work **[Section 5: C1].**

Shephard and Sheppard's research was particularly pertinent because, for some time before AHL became aware of the work **[R6],** Man Group had identified the need to build an investment fund that protected a hedge fund portfolio against so-called 'tail events' **[C1]** . These 'tail events' (very bad monthly equity portfolio returns) are difficult to predict and can lead to challenging periods both for institutional investors (e.g. pension companies) or fund managers. Various asset classes have traditionally been used to provide some insurance against severe equity losses. The most famous are bonds, although, in recent years, bond and equity returns have been positively correlated.

AHL researchers recognised that volatility contracts are a class of investable assets which do perform well during periods of financial stress **[C1]**. (A simple version of such a contract has a payoff related to the square root of the sum of squares of daily returns of the underlying measured over a pre-specified period). Realised volatility has nearly always been very high during periods where equity indexes have fallen significantly. There are various economic theories as to why this may be the case. Overall, however, it means that buying volatility contracts provides a form of statistical insurance on equity positions. If equities rally, the contract will tend to pay off little; if equities fall dramatically, it will tend to pay off very substantially. This suggests that an equity portfolio could have some of its 'left hand tail' risk reduced by holding a small amount of volatility contracts. The difficulty with this conclusion, and the resulting action, is that the expected long-run payoff of variance contracts is substantially negative. The size of expected loss is called the volatility risk premium, and it rewards sellers of volatility contracts for being exposed to the risk of substantial losses at the same time as equities are losing.

The critical value of the predictive model developed by Shephard and Sheppard **[R6**] is that it provided the methodological basis for a strategy to predict periods of stress in the financial markets, and so reduce the costs of holding volatility contracts **[C1]**. Man Group's 'spike detection' strategy, derived from Shephard and Sheppard's predictive model [**R6]** "looks at noise in the markets and tries to translate that noise into when a crisis is likely to take place" **[C2]**. When a challenging period is detected, exposure to volatility is increased to provide greater protection. The spike detection strategy is a key component of the Man group's TailProtect Fund. In a 2012 interview, Sandy Rattray (CEO of AHL) described the strategy as the "more creative and innovative part" of the Man Group's TailProtect Fund (Dickinson, 2012) **[C2].** The TailProtect fund opened to external investors in January 2011, and in 2012 won the annual European award for most innovative hedge fund **[C3].**

5. Sources to corroborate the impact

[C1] Chief Scientist, Man Group, confirms that the research by Shephard and Sheppard provided the basis for the spike detection strategy that forms an important component of Man group's TailProtect fund. (Letter on file.)

[C2] Dickinson, C. (2012) "Man Tail Protect: Man Investments/GLG Partners", Hedge Funds Review, 01 June 2012. (http://www.risk.net/hedge-funds-review/profile/2245251/man-tail-protect-man-investments-glg-partners)

[C3] http://www.hedgefundsreviewawards.com/singlemanager/static/2012-winners