

# Modelling Volatility

Andrew Harvey

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## 1 Nonlinear models and changing volatility

Unobserved components. Introduction to DCS/GAS models. Nonlinear models: independence, uncorrelatedness and martingale differences. Distributions and heavy tails. Properties of financial returns. Standard volatility models: GARCH, EGARCH and stochastic volatility. Intra-day data, realized volatility, range and duration.

## 2 Dynamic conditional score (DCS) models

Location and robustness. EGARCH. Leverage, long memory, components. Skewness and asymmetry. Models for positive variables.

## 3 Correlations and copulas

Multivariate GARCH models. Dynamic correlation. Dependence and copulas, measures of association, dynamic copulas. Spatial association.

## 4. Recent developments

Multivariate-F covariance matrices. Changing shape. Censoring and zeroes. Adaptive filtering. Quantiles.

## Main references

Harvey, A. C. (2013) *Dynamic Models for Volatility and Heavy Tails*. Cambridge University Press.

Creal, D., Koopman, S.J., and A. Lucas (2013). Generalized autoregressive score models with applications. *Journal of Applied Econometrics*, **28**, 777-95.

Creal, D., Koopman, S.J. and A. Lucas (2011). A Dynamic Multivariate Heavy-Tailed Model for Time-Varying Volatilities and Correlations, *Journal of Business and Economic Statistics*, 29, 552-63.

**Websites**

[econ.cam.ac.uk/DCS](http://econ.cam.ac.uk/DCS); [gasmodel.com](http://gasmodel.com)