PAPER *Applications of Physics in Financial Analysis 4, 13 - 15 November 2003, Warsaw University of Technology, Warsaw, POLAND*

Risk-neutral Density Extraction from Option Prices: A New Non-parametric Approach.

J V Healy [$], *M Dixon* [$*], *B J Read* [$] *and F F Cai* [$]
[$] *CCTM, London Metropolitan University, 31 Jewry Street, LONDON EC3N 2EY,UK.*

Recovering information from market prices of options is an established practice; the best known example is implied volatility(IV). Options can be priced in terms of a discounted expectation with respect to a risk neutral density function [1]. In recent years there has been much interest in the recovery of the complete risk neutral density (RND). Market participants use RND's for investment decisions. For risk management, knowledge of the entire RND provides more information for Value-at-Risk calculations than IV alone [2]. Monetary authorities use RND's to gauge market sentiment concerning future asset prices, to help in formulating monetary policy.

We present a new non-parametric method for extracting such risk-neutral densities from observed option prices. The aim is to obtain a continuous, smooth, monotonic, and convex pricing function which is twice differentiable. Thus, irregularities such as negative probabilities which afflict many existing RND estimation techniques [3] are reduced. Our method employs neural networks to obtain a smooth pricing function, and a central finite difference approximation to the second derivative to extract the required gradients. A new method of estimating confidence intervals is applied to evaluate the precision of the extracted RND's. It is robust to heteroskedasticity, suitable for use with commercial tools[1], and does not require bootstrapping or special programming.

We applied our approach to a large set of LIFFE intraday options data on the FTSE 100. In preliminary tests, we have observed that the (risk adjusted) means of the recovered RND's are unbiased and efficent estimates of the means of the historic price distributions for the FTSE 100 over the maturities of the options. The standard deviations of the RND's contain some information on the standard deviations of the historic price distributions but are biased estimates. However, the skewness and kurtosis of the RND's contain no information on the skewness and kurtosis of the historic price distributions. The different shapes of the two distributions may indicate the option market and equity market assess risks differently.

---

[*] Visitor BITD, Rutherford Appleton Laboratory, Chilton, DIDCOT, Oxon, OX11 0QX

[1] We used the commercial data mining software SPSS Clementine.

[1] Cox, John C and Ross, Stephen A., 1976. "*The Valuation of Options for Alternative Stochastic Processes*", Journal of Financial Economics 3, p 145-166.

[2] Ait-Sahalia, Y., and Lo, A. W., 2000. "*Nonparametric Risk Management and Implied Risk Aversion*", Journal of Econometrics 94, p 9-51.

[3] Bahra, Bhupinder., 1997. *"Implied Risk-Neutral Probability Density Functions From Option Prices: Theory and Applications"*, Bank of England, Threadneedle Street, London, EC2R 8AH.