Book review

June 2005/Volume 18/No6

Coping with copulas

Risk magazine

Copula Methods in Finance

by Umberto Cherubini, Elisa Luciano and Walter Vecchiato

John Wiley and Sons

310 pages, £60

ISBN 0470863447

You would be hard pressed to find a market practitioner or empirically orientated academic who still believes asset returns are well described by a normal distribution. Nonetheless, it would not be hard to find someone who still uses linear correlation as their sole measure of dependence between risky assets or exposures, even though linear correlation is unable, for instance, to capture the fact that equities exhibit a greater tendency to crash together than to boom together. What's more, it is not a satisfactory measure of dependence between the payouts from different options, which are in general strongly non-normally distributed.

Copulas are a powerful framework for modelling dependence between risky assets, and are applicable in both of the above problems. Thus, copula theory should be of interest to anyone who has to deal with multiple sources of risk. Umberto Cherubini, Elisa Luciano and Walter Vecchiato have written the first book on copula theory for finance practitioners.

Copula theory has its roots in the arcane field of probabilistic metric spaces, and there they remained until the early 1990s, at which time they gained increasing attention from statisticians. From there it was a small jump to finance, and the last decade or so has witnessed an explosion in the number of papers on the application of copulas to financial problems – many written by Cherubini, Luciano and Vecchiato. The authors have done an impressive job of synthesising this research in their book.

Loosely speaking, the copula generalises linear correlation as a measure of dependence in the same way that the entire distribution of returns generalises variance as a measure of risk. If returns are normally distributed, then variance completely describes risk, and linear correlation completely describes dependence. However, if returns are not normally distributed, then variance is not a complete description of risk, and alternative summary measures such as value-at-risk or expected shortfall may be more appropriate. Similarly, if returns are not normally distributed, then correlation no longer completely describes the dependence between the returns.

Using copulas (otherwise known as dependence functions) to construct joint distributions allows us to specify the distributions of individual returns separate from each other and separate from the dependence structure. Clearly, this dramatically increases the flexibility we have in specifying multivariate distributions. More importantly, it provides a more flexible framework to consider dependence between risky assets.

The authors state in the preface that their aim is to introduce copulas from the viewpoint of mathematical finance applications, which is a commendable goal. In the first chapter, they present an introduction to copulas by considering the problem of pricing a digital bivariate option written on the Nikkei 225 and the S&P 500 indexes. That is, an option that pays £1 if both indexes are less than some pre-specified levels. Depending on the reader's background, this introduction may be more intuitive than the standard statistical introduction to copulas, which is given in the following chapter.

Throughout the book, the authors illustrate copula concepts with applications to option pricing, risk management and credit risk. One particularly interesting problem covered is that of pricing

'vulnerable' derivatives. The growth of the over-the-counter market for derivatives has led to an increase in concern about counterparty risk. The fact that a counterparty to a derivatives transaction may not survive to make payment automatically turns the problem of pricing and hedging from a univariate one to a bivariate one: even if the derivative contract was written on a single underlying asset, the fact that the counterparty to the transaction may default makes the total payout from this contract a function of two sources of risk. The authors provide a very clear and detailed discussion of this topic, with numerous applications.

Cherubini, Luciano and Vecchiato do a fine job of illustrating the estimation and simulation of copulas in financial applications, but one area that is perhaps lacking coverage is copula model evaluation and comparison. Numerous copula models are discussed – how do we determine which of these works best? Methods to answer this question are available in the academic literature but are not covered in this book.

Much of the first half closely resembles existing books on copulas – for example, the very good statistical introduction to copulas by Nelsen (1999, Springer-Verlag). Cherubini, Luciano and Vecchiato really come into their own in the second half of the book, where they apply copulas to credit swaps, collateralised debt obligations, vulnerable derivatives and derivatives based on multiple underlying assets.

This book is written in a style that should be accessible to most people with a background either in mathematical finance, or finance and econometrics. It provides an introduction to copulas that many in the finance industry will find more accessible than the statistical introductions currently available. Further, it provides a wealth of financial examples and applications that illustrate and highlight the potential for copulas to assist us with financial problems.

With the growing recognition that linear correlation is not the last word in dependence modelling, I am sure that many practitioners and academics would benefit from reading this book.

Andrew Patton

London School of Economics