Journal Of Investment Management, Vol. 13, No. 4, (2015), pp. 111–113


www.joim.com

# BOOK REVIEW

Mark Kritzman, Senior Editor

## Portfolio Management Under Stress: A Bayesian-Net Approach to Coherent Asset Allocation

*Riccardo Rebonato and Alexander Denev*
(*Reviewed by Cel Kulasekaran*)

Riccardo Rebonato and Alexander Denev deliver an exceptional reference to using Bayesian networks in asset allocation and risk management. *Portfolio Management Under Stress: A Bayesian-Net Approach to Coherent Asset Allocation* (2013, Cambridge) is an in-depth extension of their 2012 paper, *Coherent Asset Allocation and Diversification in the Presence of Stress Events* (Rebonato and Denev, 2012), and Rebonato's *Coherent Stress Testing* (Rebonato, 2010) text.

Rebonato and Denev set out to deliver a solution for asset managers to identify an optimal portfolio construction framework in the presence of stress events with subjective probabilities. Their framework does not necessarily offer a definitive solution to the asset allocation problem, but rather a powerful technology that can be used to integrate empirical and subjective probabilities[1] of stress events.

Bayesian networks are a type of probabilistic graphical model that represent and enable the calculation of joint probability distributions over a specified set of random variables. What has made this technology particularly intuitive is that it is a direct representation of real-world problems. In quantitative finance, part of the challenge in modeling is that we often rely on historical data, which is good for explaining the past but insufficient for predicting the future. Bayesian networks address this by providing a framework to model potential stress events by drawing upon available statistical data and expert knowledge.

Bayesian networks are not new. They are widely used in various disciplines, including quantitative finance—Kalman-filters, Hidden Markov Models, and Neural Networks are all special cases of a Bayesian network. Rebonato and Denev's work is novel in their application of this technology in the asset allocation process. They have structured a process for using Bayesian networks to communicate joint conditional probabilities intuitively and to construct event-sensitive optimal portfolios.

The book is well structured and is divided into ten parts. The first part, chapters 1–3, introduces the authors' philosophy and context on the subject matter. The second, chapters 4–6, describes dealing with extreme events by discussing predictability and causality in finance, econophysics, and extreme value theory. The third part, chapters 7–10, reviews diversification and stability issues in the context of modern portfolio theory. The authors also relate the Black-Litterman model and Meucci's entropy pooling solution to their approach.

Part four, chapters 11–12, and five, chapters 13–16, are the most exciting and important parts of the book, as Rebonato and Denev describe the theoretical foundations necessary for introducing the Bayesian network technology and its application in practice. Their command of the subject matter is deep and comes through in their ability to explain Bayesian networks in an intuitive manner. In chapter 14, the authors offer pragmatic suggestions to elicitation problems, when practitioners are unable to specify or compute the necessary set of subjective inputs required by the Bayesian-network with confidence. This is refreshing as implementation issues are often omitted from most technical texts.

At the end of part five, they reinforce the material by applying it to a real-life example of building a realistic Bayesian network, centered upon a sovereign entity default in the European Union. Part six, chapters 17–19, and seven, chapters 20–21, are dedicated to the statistics of the body ("normal") of return distributions and combining the tails of the distribution. Part eight, chapters 22–23, further extends the subject matter in order to adapt it to expected utility maximization. Part nine, chapters 24–25, describes numerical techniques to implement approximations and expected utility optimization.

Finally, part ten, chapters 26–28, walks us through a realistic and complete asset allocation process with the application of Bayesian networks as part of the solution. This is the most applicable part of the book.

Initiates may opt to read *Portfolio Management Under Stress* in chapter order, while the experienced practitioner may find it more productive to read part ten's practical example and part five's core theory (in that order) prior to diving into the details of the rest of the book.

Rebonato's precursor to the current text, *Coherent Stress Testing* (Rebonato, 2010), offered a more general description of the technology and its application for stress testing. Readers will find *Portfolio Management Under Stress* relatively more comprehensive in supporting the application of Bayesian networks in asset allocation and stress testing. The current text does not skimp on diagrams, tables, and charts, which complements the subject matter well. Nevertheless, it would have helped readers to include a visualization similar to Figure 1 from their 2012 paper (Rebonato and Denev, 2012) explicitly in this book, particularly in part ten. This figure illustrates the novel process of the authors' work and how different components (including Bayesian networks) fit together within the asset allocation process.

This book does not set out to describe proofs, but rather present results and their applications—much to the delight of the practitioner. There are plenty of references listed to encourage further reading for academics. The authors also include an Appendix to describe links to the Black-Litterman model, a popular approach to distorting market equilibrium subjective to economic and stress test views.

I highly recommend picking up Rebonato and Denev's *Portfolio Management Under Stress: A Bayesian-Net Approach to Coherent Asset Allocation* for your next read. Rebonato and

Denev's work enables the reader to build practical Bayesian networks in finance as well as to help understand the depth of underlying algorithms, mechanics, and its theory with ease.

## Note

[1] A similar Bayesian approach, for example, is the Black-Litterman model which integrates empirical and subjective probabilities to obtain a posterior view for expected returns in the asset allocation process.

## References

Rebonato, R. and Denev, A. (2012). "Coherent Asset Allocation and Diversification in the Presence of Stress Events," *Journal of Investment Management* **10**(4), 19–53.

Rebonato, R. (2010). *Coherent Stress Testing*: *A Bayesian Approach to the Analysis of Financial Stress*, John Wiley and Sons, Ltd., Chichester, UK.