"Dependence Modeling with Applications to Portfolio Choice and Risk Management"

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Part 1: Introduction to dependence modeling and extreme dependence.

This first lecture is about the modeling of multivariate dependence (copulas, factor models) and of dependence uncertainty. We will discuss issues from a theoretical perspective in dimensions 2 and higher. We will also present the rearrangement algorithm of Embrechts, Puccetti and Ruschendorf (2012) as a practical tool to deal with dependence, as well as its latest improvements.

C. Bernard, X. Jiang and R. Wang, "Risk Aggregation with Dependence Uncertainty", Insurance Mathematics and Economics, 2014, 54, 93-108.

C. Bernard and D. McLeish (2015). "Algorithms for Finding Copulas Minimizing Convex Functions of Sums." ArXiv working paper.

Embrechts, P., Puccetti, G. and L. RÃijschendorf (2013). "Model uncertainty and VaR aggregation". Journal of Banking and Finance.

B Wang, R Wang (2011) "The complete mixability and convex minimization problems with monotone marginal densities". Journal of Multivariate Analysis

Part 2: Optimal portfolio selection and cost-efficiency.

We will introduce the concept of cost-efficiency and discuss its implications in terms of optimal portfolio choice, expected utility maximization, preferences representation (behavioral finance) and optimal portfolio under state-dependent constraints. This lecture makes use of Frechet-Hoeffding bounds on copulas and specifically the concept of comonotonicity.

C. Bernard, L. Rueschendorf, S. Vanduffel, "Optimal Claims with Fixed Payoff Structure," 2014, Journal of Applied Probability, Vol 51A, 175-188.

C. Bernard, J. Chen, S. Vanduffel "Rationalizing InvestorsâĂŹ Choices," 2015

C. Bernard, F. Moraux, L. Ruschendorf, S. Vanduffel, "optimal portfolio under state-dependent preferences," 2015, Quantitative Finance, forthcoming.

C. Bernard, P. Boyle, S. Vanduffel, "Explicit Representation of Cost Efficient Strategies", 2014, Finance, June, vol 2.

Part 3: Risk management and model risk assessment.

In this lecture, we will talk about how to assess model risk on dependence in the presence of additional information. A central problem for regulators and risk managers concerns the risk assessment of an aggregate portfolio defined as the sum of d individual dependent risks Xi. This problem is mainly a numerical issue once the joint distribution of (X1,X2, . . . ,Xd) is fully specified. Unfortunately, while the marginal distributions of the risks Xi are often known, their interaction (dependence) is usually either unknown or only partially known, implying that any risk assessment of the portfolio is subject to model uncertainty.

Previous academic research has focused on the maximum and minimum possible values of a given risk measure of the portfolio when only the marginal distributions are known. This approach leads to wide bounds, as all information on the dependence is ignored. In this lecture, we will show how to integrate, in a natural way, available information on the multivariate dependence. We make use of the Rearrangement Algorithm (RA) of Embrechts, Puccetti, and Rueschendorf (2013) to provide bounds for the risk measure at hand. We add information about the variance or higher moments of the portfolio or about a well-fitted multivariate model. We show that it may, or may not, lead to much tighter bounds, a feature that also depends on the risk measure used. In particular, the risk of underestimating the Value-at-Risk at a very high confidence level (as used in Basel II) is typically significant, even if one knows the multivariate distribution almost completely.

Our results make it possible to determine which risk measures can benefit from adding dependence information (i.e., leading to narrower bounds when used to assess portfolio risk) and, hence, to identify those situations for which it would be meaningful to develop accurate multivariate models.

C. Bernard, L. Ruschendorf, S. Vanduffel, "VaR bounds with variance constraint," 2015, working paper.

C. Bernard, S. Vanduffel, "A new Approach to Assessing Model Risk in High Dimensions," 2015, Journal of Banking and Finance, forthcoming.

C. Bernard, M. Denuit, S. Vanduffel, 2015 "Value-at-Risk aggregation with higher-order information", working paper.

C. Bernard, L. Ruschendorf, S. Vanduffel, J. Yao 2015 "How robust is the VaR of credit risk portfolios?", working paper.