Multivariate asset models using Lévy processes and applications

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Abstract. The aim of this paper is to introduce a simple, parsimonious and robust model for multivariate Lévy processes with dependence between components, which can be easily implemented for financial applications, such as the pricing of several types of basket options commonly used in the credit and the energy derivatives markets. The proposed model generalizes the approaches existing in the literature to any class of multivariate Lévy process, from time changed Brownian motions to jump diffusion models. Further, the model has a simple and intuitive economic interpretation. Our construction, in fact, is based on a parsimonious two-factor linear representation of the assets (log)-returns, in the sense that it uses a linear combination of two independent Lévy processes representing respectively the systematic factor and the idiosyncratic shock. Consequently, dependence between assets in a given portfolio is originated by the common component of the overall risk. As Lévy processes are invariant under linear transformations, our approach allows specifying any one-dimensional model for each of the components. In order to guarantee that the model still allows a calibration procedure to market prices of traded vanilla options, which is parsimonious and independent of the factor structure adopted for the asset (log)-returns, in this paper we also study the conditions under which dependence can be separated from the behaviour of the margins. The empirical analysis presented in this paper shows that our approach is flexible enough to accommodate the full range of possible dependence, from negative to positive dependence, from complete dependence to independence, but, at the same time, it is relatively parsimonious in terms of number of parameters involved, as this grows linearly with the number of names in the basket. Finally, we introduce a multivariate generalization of time changed Lévy processes in order to incorporate stochastic volatility features.

Keywords: Jump Diffusion process, Lévy processes, model calibration, multinames derivative contracts, time changed Brownian motions, time changed Lévy processes.