Cross-Dependent Volatility

Julien Guyon*[1,2,3]

[1]Bloomberg – United States
[2]Columbia University – United States
[3]NYU Courant – United States

Abstract

Local volatilities in multi-asset models typically have no cross-asset dependency. In this talk, we propose a general framework for pricing and hedging derivatives in cross-dependent volatility (CDV) models, i.e., multi-asset models in which the volatility of each asset is a function of not only its current or past levels, but also those of the other assets. For instance, CDV models can capture that stock volatilities are driven by an index level, or recent index returns. We explain how to build all the CDV models that are calibrated to all the asset smiles, solving in particular the longstanding smiles calibration problem for the "cross-aware" multidimensional local volatility model. CDV models are rich enough to be simultaneously calibrated to other instruments, such as basket smiles, and we show that the model can fit a basket smile either by means of a correlation skew, like in the classical "cross-blind" multi-asset local volatility model, or using only the cross-dependency of volatilities itself, in a correlation-skew-free model, thus proving that steep basket skews are not necessarily a sign of correlation skew. We can even calibrate CDV models to basket smiles using correlation skews that are opposite to the ones generated by the classical cross-blind models, e.g., calibrate to large negative index skews while requiring that stocks are less correlated when the market is down. All the calibration procedures use the particle method; the calibration of the implied "local in basket" CDV uses a novel fixed point-compound particle method. Numerical results in the case of the FX smile triangle problem illustrate our results and the capabilities of CDV models.

*Speaker