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Delay Stochastic Dynamical Systems in Finance

The volatility process is an important concept in financial modeling. This process can be stochastic or deterministic. In quantitative finance, we consider the volatility process to be stochastic as it allows to fit the observed market prices under consideration, as well as to model the risk linked with the future evolution of the volatility, which deterministic model cannot. Heston model (1993), e.g., is one of the most popular stochastic volatility models in the industry as semi-closed formulas for vanilla option prices are available, few (five) parameters need to be calibrated, and it accounts for the mean-reverting feature of the volatility. In this talk we will focus on newly developed so-called delayed Heston model (2014) that significantly improve classical Heston model with respect to the market volatility surface fitting by 44%. In this model, we take into account not only current state of volatility at time t but also its past history over some interval $[t - \tau, t]$, where $\tau > 0$ is a constant and is called the delay. In this way, our model incorporates path-dependent history for volatility. We will show how to model and price variance and volatility swaps (forward contracts on variance and volatility for an underlying asset) for the delayed Heston model and how to hedge volatility swaps using variance swaps. Review of some other delay stochastic models in finance will be given as well.