Statistical and numerical methods in modeling of financial derivatives and valuation of risk

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Main problems and goals

Complex structured callable instruments

Callable interest rate products lead to high dimensional optimal stopping problems:
- Speed up by scenario selection methods: Bender, Kolodko, Schoenmakers, Quant. Fin. (2008)

Efficient sensitivities by Monte Carlo

Popular but naive Monte Carlo estimators may suffer from exploding variance. A new estimator resolves this problem:
\[
\frac{\partial I}{\partial x}(x) = \frac{1}{M} \sum_{m=1}^{M} \frac{\partial}{\partial x} p(x, g(x, m \xi)) u(g(x, m \xi)) \phi(x, g(x, m \xi))
\]
where \(g(x, \xi)\) is a proxy sampler with known density \(\phi\).

Realistic modeling of Libor rates

Libor model with jumps and stochastic volatility:
\[
\frac{dL_i(t)}{L_i(t)} = \Gamma_i^T dW^{(i+1)}(t) + \psi_i(t, u) \left( \mu - \nu^{(i+1)} \right) (dt, du)
\]
Belomestny, Schoenmakers, Quant. Fin. (to appear)

Future goal:
Multi-factor Jump-Libor modeling by infinite activity Lévy measures and Lévy copulas. Papapantoleon, Schoenmakers (in preparation)

Optimal control in finance

New regression methods and convergence analysis for the optimal control problem:
\[
Y_r = \sup_{a \in A, r \in T_r} E^n \left[ \sum_{s=r}^{T-1} f_s(X_s, a_s) + g_r(X_T) \right]
\]

Industrial contracts

Future goals in financial optimization

Problems in illiquid markets, models with transaction costs, large investors etc.
- Optimal stopping and control for utility functionals (with E2)
- Dimension reduction, nonstationary time series analysis (with A3/F10)
- Dual methods for Lévy processes (with E9), multiple stopping, and energy options