Fredholm, Martingale and Gram-Charlier methods in fixed income derivative pricing

This thesis deals with three issues of fixed income derivative pricing. We start with bond pricing in mean-reverting CIR model, which is linked to quadratic functionals of Brownian motion. By the bivariate Laplace transform of quadratic functionals, classical and new bond pricing formulas in the CIR model are obtained as particular cases.

Secondly, we study bond pricing and spot forward rate models under the normal martingale setting, which has the chaotic representation property and satisfies the specified structure equation. We extend the Wiener chaos-based framework to normal martingale chaos-based framework and derive the variance representation of price density $V_t$, which depends on the square-integrable random variable $X_\infty$. We obtain the spot forward rate chaos models by the chaos expansion of $X_\infty$. Calibration of spot forward rates are included.

Furthermore, we deal with synthetic Collateralized Debt Obligation (CDO) pricing, which amounts to the computation of the expected tranche losses. We compute the tranche losses of CDOs with random recovery rates by Gram-Charlier expansion on the conditional density function of the loss. We then compare the conditional density functions of the loss approximated by Gram-Charlier expansion with Monte Carlo simulation.

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