We analyse the accuracy of numerical methods by means of a coupon bond option

Market data and model setup

Flat yield curve 3% (cont. compounding, Act/365), 100bp short rate volatility, mean reversion 5%.

Coupon bond option test instrument setup

- European call option, exercise in 10y at unit strike
- 3% coupons at $11y, \ldots, 20y$, unit notional payment in $20y$
- all dates and year fractions in model times

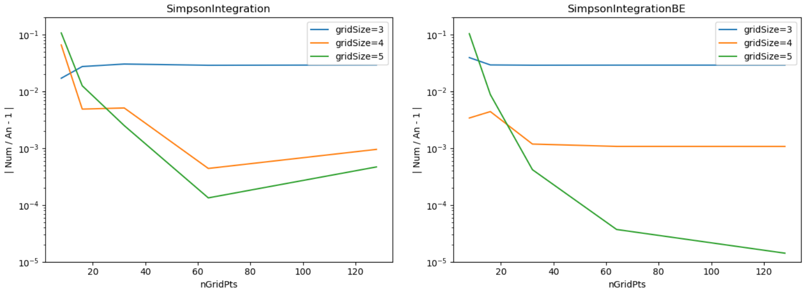
Testing approach

- Construct pseudo Bermudan option from European coupon bond option by adding zero strike exercises at $2y$ and $6y$
- compare numerical Bermudan option price versus analytical European option price

$$\text{RelErr} = \left| \frac{\text{BermudanPrice}}{\text{EuropeanPrice}} - 1 \right|$$

Density integration methods are compared for scenarios of grid size, # grid points and Hermite polynomial degree I

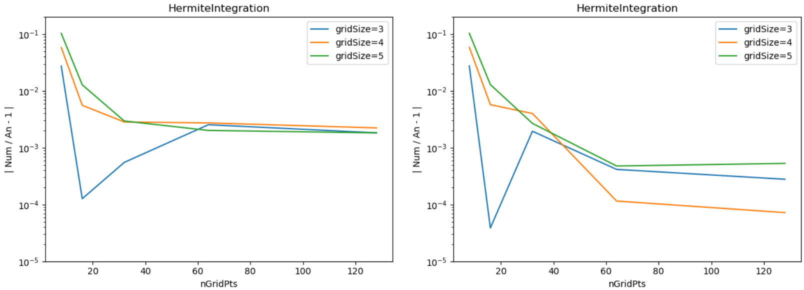
Simpson's rule - w/o (l) and w/ (r) break-even calculation



- accuracy is mainly limited by grid size
- break-even calculation required to achieve higher accuracy

Density integration methods are compared for scenarios of grid size, # grid points and Hermite polynomial degree II

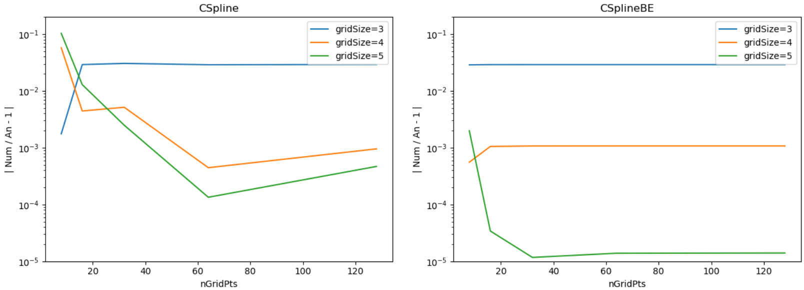
Hermite integration - degree $d = 5$ (l) and $d = 10$ (r)



- higher polynomial degree is required to mitigate non-smooth payoff impact
- too large grid size seems to deteriorate accuracy

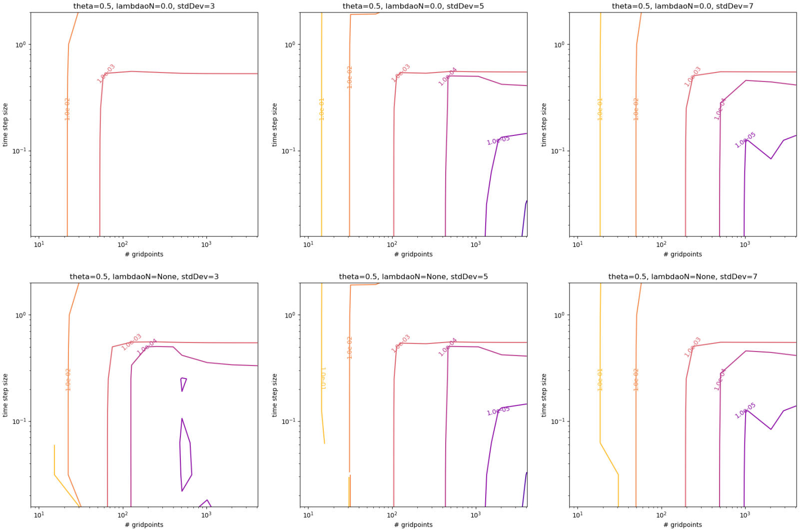
Density integration methods are compared for scenarios of grid size, # grid points and Hermite polynomial degree III

Cubic spline - w/o (l) and w/ (r) break-even calculation



- accuracy is mainly limited by grid size and break-even calculation
- CSpline with break-even clearly outperforms other methods for small number of grid points

We analyse PDE methods using contour plots of error estimate for # of grid points versus time step size I

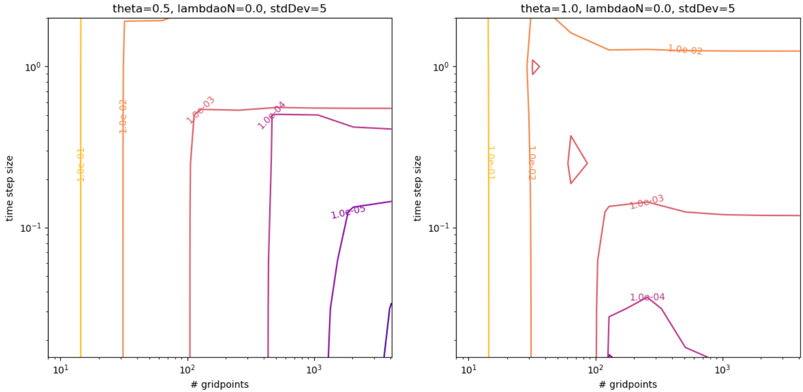


We analyse PDE methods using contour plots of error estimate for # of grid points versus time step size II

- # grid points need to be increased simultanously to reducing time step size to improve accuracy
- Again, accuracy is limited by grid size
- For small grid sizes approximation of boundary condition (via $\lambda_{0,N}$) improves accuracy

We analyse PDE methods using contour plots of error estimate for # of grid points versus time step size III

Compare $\theta = \frac{1}{2}$ (l) versus $\theta = 1$, i.e. Implicit Euler (r)



- Implicit Euler requires smaller step size to achive same accuracy as for $\theta = \frac{1}{2}$ (i.e. Cranck-Nicolson)