

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/Bermudan call option, exercise in 10y (11y, ..., 19y) at unit strike
- ▶ 3% coupons at 11y, ..., 20y, unit notional payment in 20y
- ▶ all dates and year fractions in model times

Testing approach

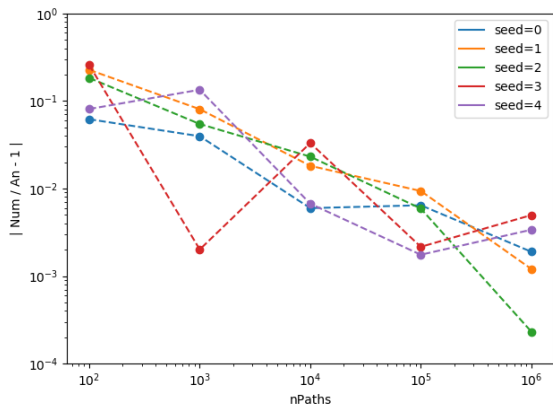
- ▶ Construct pseudo Bermudan option from European coupon bond option by adding zero strike exercises at 2y and 6y
- ▶ compare numerical Bermudan option price versus analytical European option price

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

- ▶ Compare MC Bermudan price versus density integration reference price

MC methods are compared for scenarios of seed, # paths, as well as model and option parameters I

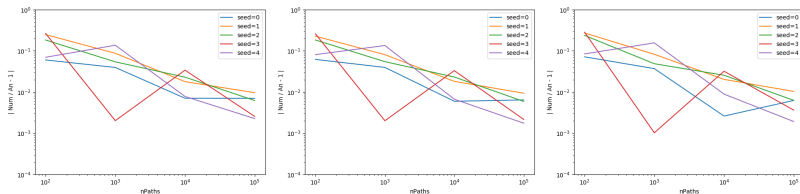
Base scenario, ATM European option



► MC estimate is a random number - dependency on seed illustrates this aspect

MC methods are compared for scenarios of seed, # paths, as well as model and option parameters II

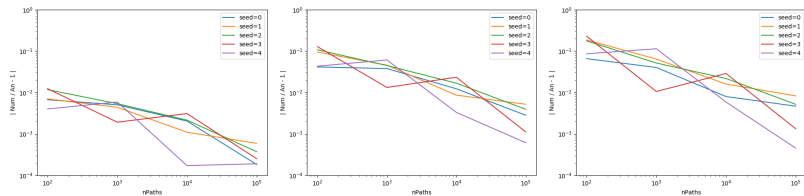
ATM European option - low volatility ($10bp$, left) and negative mean reversion (-3% , right) scenarios



- ▶ Relative (!) error more or less invariant to model parameters.
- ▶ Note that ATM option value is roughly proportional to variance (driven by volatility and mean reversion)

MC methods are compared for scenarios of seed, # paths, as well as model and option parameters III

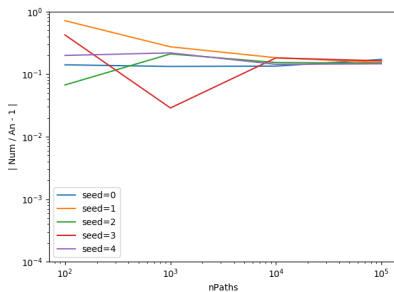
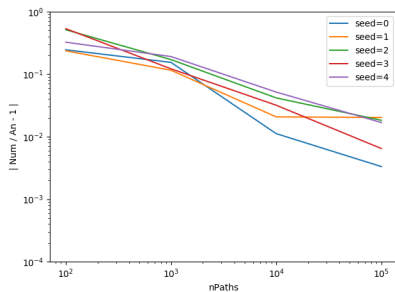
ITM European option - low volatility (10bp, left) and negative mean reversion (-3% , right) scenarios



- ▶ Relative error decreases for low model variance and increases for high model variance
- ▶ Note that ITM option converges to positive intrinsic value if variance decreases

AMC methods are compared for scenarios of seed, # paths, as well as AMC regression properties I

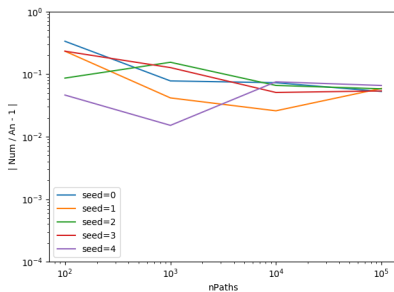
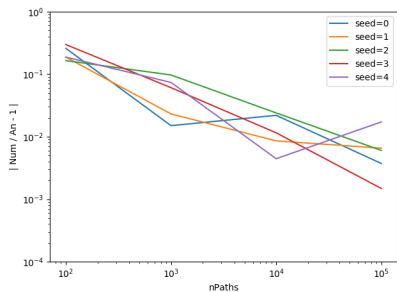
Pseudo-Bermudan option with hold value regression (left) vs. exercise decision only regression (right)



- ▶ Regression on exercise decision only does not work in this case.

AMC methods are compared for scenarios of seed, # paths, as well as AMC regression properties II

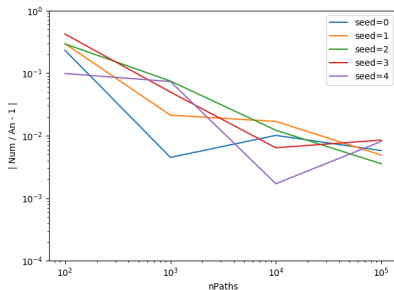
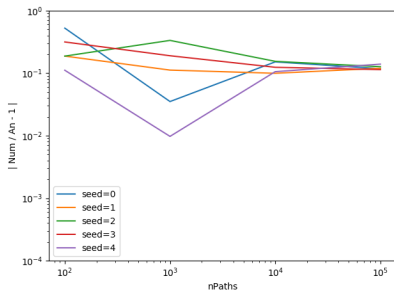
Bermudan option with hold value regression (left) vs. exercise decision only regression (right)



- ▶ Regression on exercise decision only does not work in this case.

AMC methods are compared for scenarios of seed, # paths, as well as AMC regression properties III

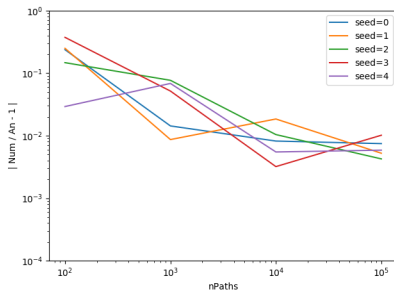
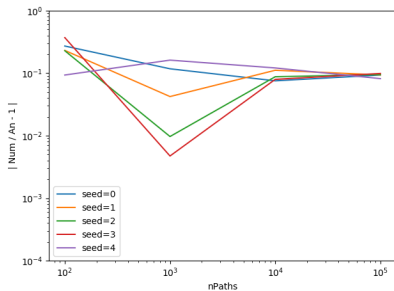
Bermudan option with max. polynomial degree 1 (left) vs. 6 (right) - default is 3



- ▶ Too small polynomial degree prevents convergence.
- ▶ Very high polynomial degree does not improve accuracy.

AMC methods are compared for scenarios of seed, # paths, as well as AMC regression properties IV

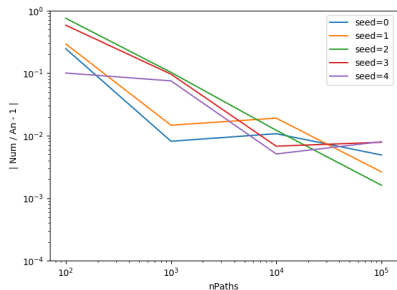
Bermudan option with co-terminal swap rate basis and max. polynomial degree 1 (left) vs. 3 (right)



- ▶ Too small polynomial degree prevents convergence.

AMC methods are compared for scenarios of seed, # paths, as well as AMC regression properties V

Bermudan option with co-terminal swap rate and Libor rate basis (max. polynomial degree 3)



- ▶ Similar result as for other basis functions.

AMC methods are compared for scenarios of seed, #
paths, as well as AMC regression properties VI

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