BARRIER OPTIONS PRICING UNDER LOCAL VOLATILITY - DEVELOPER DOCUMENTATION

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1. Testing

1.1. **Antithetic Sampling for Variance Reduction.** Antithetic Sampling is used to reduce the variance in a model by introducing negatively corrolated samples.

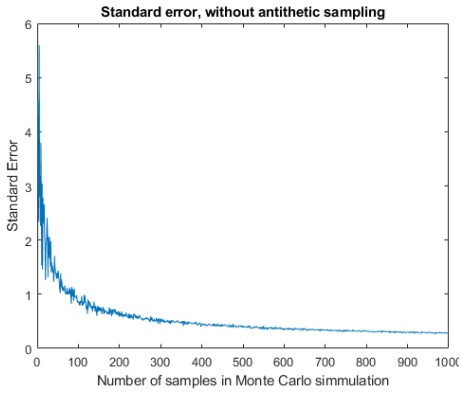

Figure 1. Standard Error without Antithetic Sampling

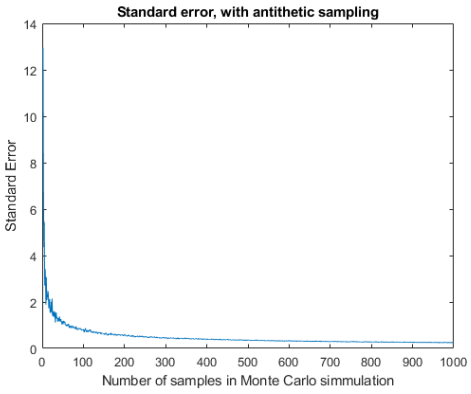

Figure 2. Standard Error with Antithetic Sampling

We can see from the standard error graphs that both errors tend to 0 as the number of simmulations increases, although we can see that the line in the antithetic sampling figure is much thinner, due to the overall reduction in variance.

1.2. **Performance.** Including antithetic sampling in the Monte-Carlo simmulation greatly increases. The below table shows how the time to run changes with increasing number of simmulations both using and not using antithetic sampling.

Nmc	Non-Antithetic Time (s)	Antithetic Time (s)	Improved Antithetic
100	0.0454	0.0691	0.0397
1000	0.3588	0.7000	0.3777
10000	3.6219	7.002	3.9213
100000	35.7083	71.5724	39.3678

We can see that although both increase exponentially, the version using antithetic sampling ends up roughly doubling the time taken by not using it. This is because we are calculating double the amount of samples, just with opposite coefficient on the drift term. So in order to increase performance, it was decided that instead of calculating $(r - \delta - \frac{\sigma^2}{2})(t_{i+1} - t_i)$ and $\sigma\sqrt{t_{i+1} - t_i}$ twice, we can calculate them at the start of the for-loop and call that value when it is needed. It can be seen in the final column of Table 1.2 that doing this cuts the time down by again around a half, so we get the reduced variance and increased performance.

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