Computatioanl Finance

Group Work Submission 1:

Price a European Up-and-out Call Option

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Abstract

This project provides examples on pricing European vanilla call options, European up-and-out barrier option, and European up-and-in barrier call option. Besides, we extend the analysis to Monte Carlo estimates of the Credit Valuation Adjustments. Finally, we discuss the difference between the default-free valuation and Credit Valuation Adjustment.

Keywords: Option Pricing, Credit Valuation Adjustment, Monte Carlo.

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1 General: 4 points

- What are the advantages and disadvantages of purchasing the up-and-out barrier call option, compared to the plain vanilla European call option? (2 pts)

  Answer:

  The most obvious advantage is that the cost of up-and-out barrier call options will be lower than ordinary European European call options. The biggest advantage of the so-called "knock-out options" is that they require a lower margin than the amount required for a vanilla option. A major drawback of "knock-out" options is the information requirement that the options trader has to get both the direction and magnitude of the likely move in the underlying asset right.Another one is that the barrier is not available to retail investors.

- Would you expect to find this option on an exchange, or Over-The-Counter? (1 pts)

  Answer:

  The exchange usually provides ordinary vanilla options, which are usually parameterized by the underlying (specific stock), type (call/put), several expiration dates (specific date), and several executions to establish an efficient market , And each product has trading volume (so market participants can meet other people to trade with). The barrier options are only available over-the-counter.

- Is there a closed-form, analytical solution for pricing an up-and-out barrier call option? (1 pts)

  Answer:

  According to previous courses, we know there are closed-form analytical solutions for ordinary European call options. Through some research, we found that the closed-end analysis solution was developed by Merton [1973] for continuous (relative to discrete barrier evaluation) European call options and was perfected by Reiner and Rubinstein [1991]. There does not seem to be a closed analytical solution for the assessment of discrete obstacle traversal (such as monthly or daily closures).

2 Pricing: 32 points

Please refer to the notebook in attachment.

3 Discussion: 9 points

Before the 2008 financial crisis, market participants considered large derivative counterparties as riskless and as a result, never considered their counterparty credit risk. The risk was often ignored due to the high credit rating of counterparties and the small size of derivative exposures. The assumption was that such counterparties could not default on their financial obligations like other parties.

Credit Valuation Adjustment (CVA) is the price that an investor would pay to hedge the counterparty credit risk of a derivative instrument. It reduces the mark to market value of an asset by the value of the CVA.

In other words, it represents the discount to the standard derivative value that a buyer would offer after taking into account the possibility of a counterparty's default.

However, during the 2008 financial crisis, the market experienced several corporate collapses, including large derivative counterparties. As a result, Credit Valuation Adjustment was introduced as a new requirement for fair value accounting.

Market participants started incorporating credit valuation adjustment when calculating the value of over-the-counter derivative instruments.

In a nutshell we could say, that CVA is type of hedge for a counterparty in an over the counter derivative agreement that makes the "default free" value of the option truly default free by discounting the default free value by its credit risk.

4 Conclusion

Having computed the option value of the up-and-out option for different sample sizes. It is possible to see that the width of the interval becomes approximately constant for sample sizes bigger than 30,000, suggesting that this may be an optimal value to use for simulation for this problem. This happens also for the CVA and, consequently, for the CVA-adjusted value.

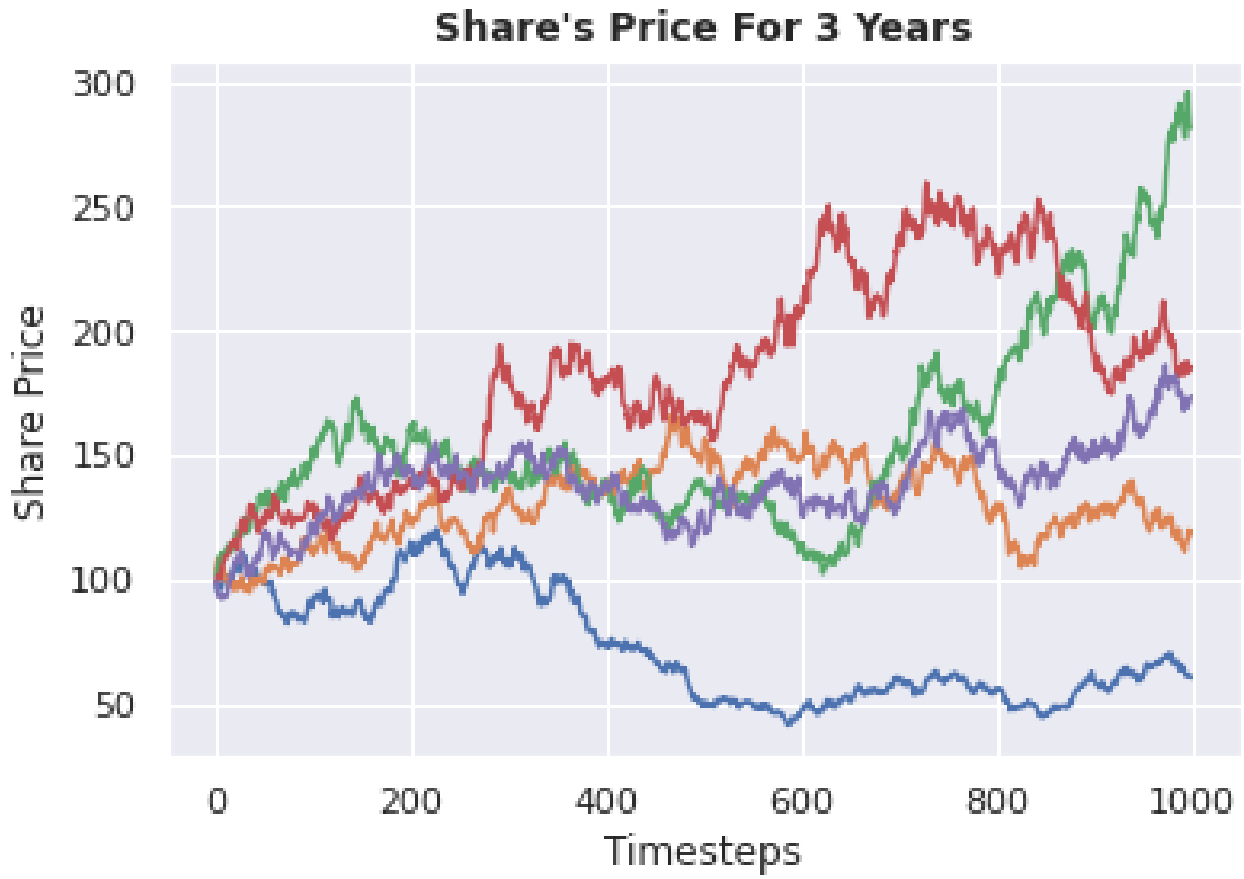

Figure 1: Share Data Simulation

Having computed the option value of the up-and-out. We deduce that the width of the interval relatively remaining unchanged or constant for sample size greater than 30,000, which can be assumed to be an optimal value to be used for simulating this problem. This also similar when simulating for the CVA and the CVA adjusted value.

References

https://www.investopedia.com/articles/active-trading/041414/use-knockout-options-lower-cost-hedging.asp

https://www.risk.net/definition/credit-valuation-adjustment-cva

Figure 2: Firm Data Simulation

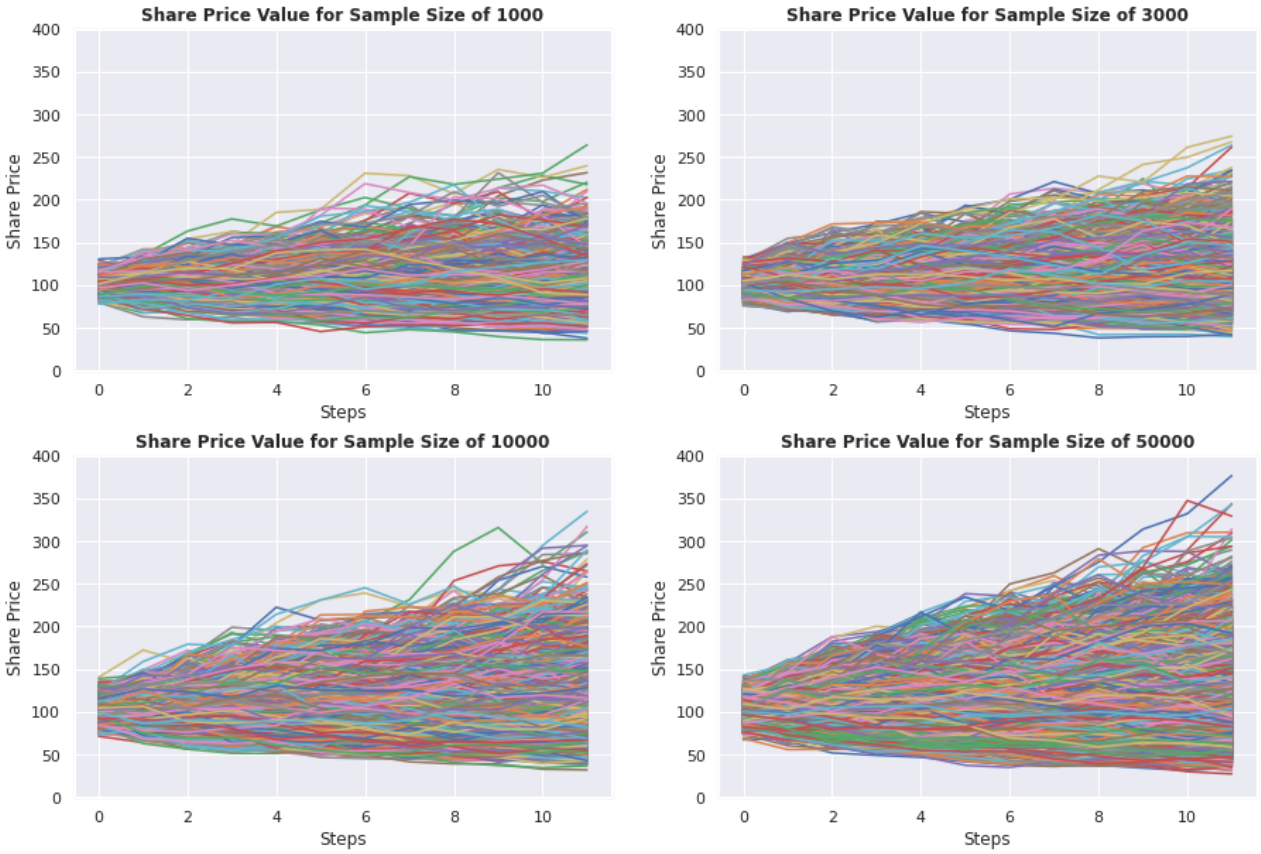

Figure 3: Share Price Value Simulation

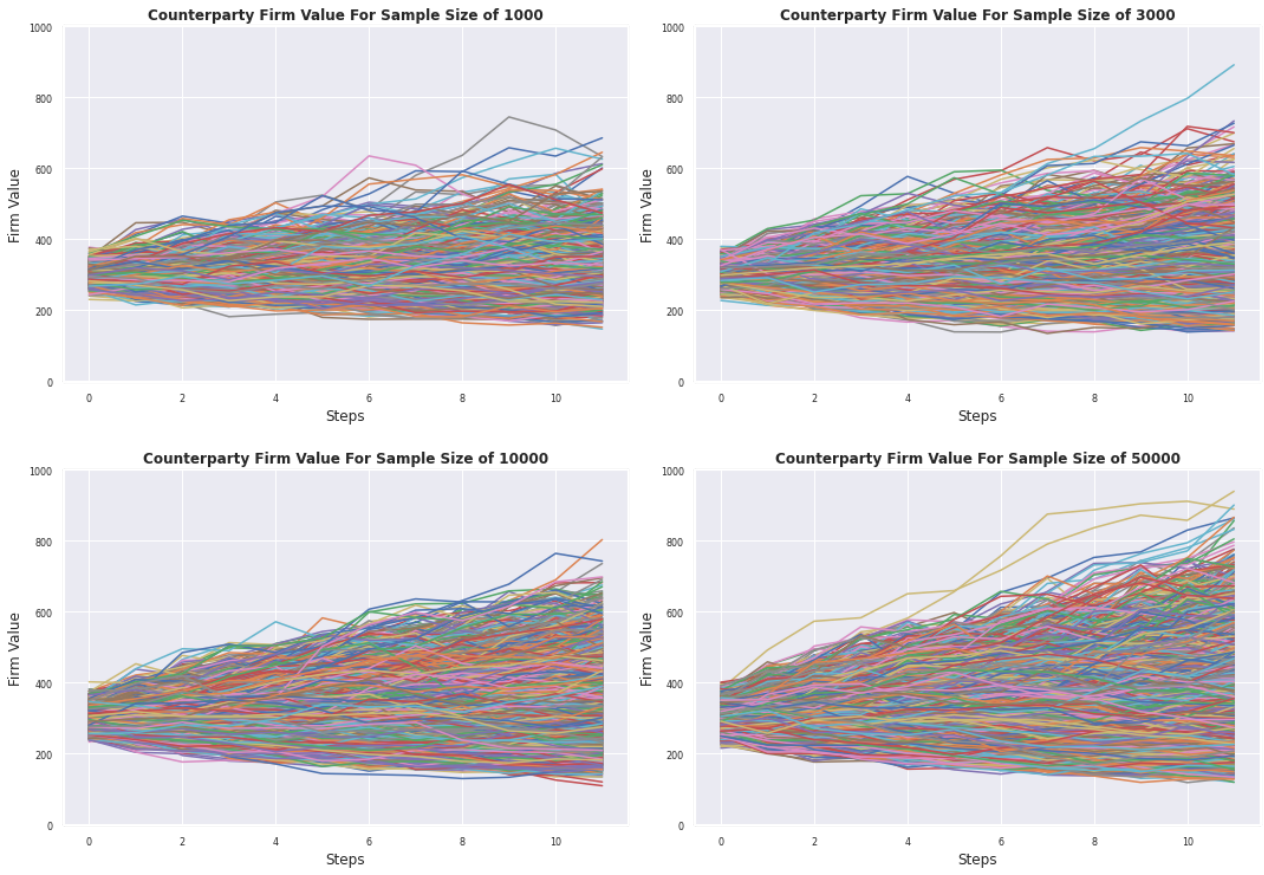

Figure 4: Firm Value Simulation

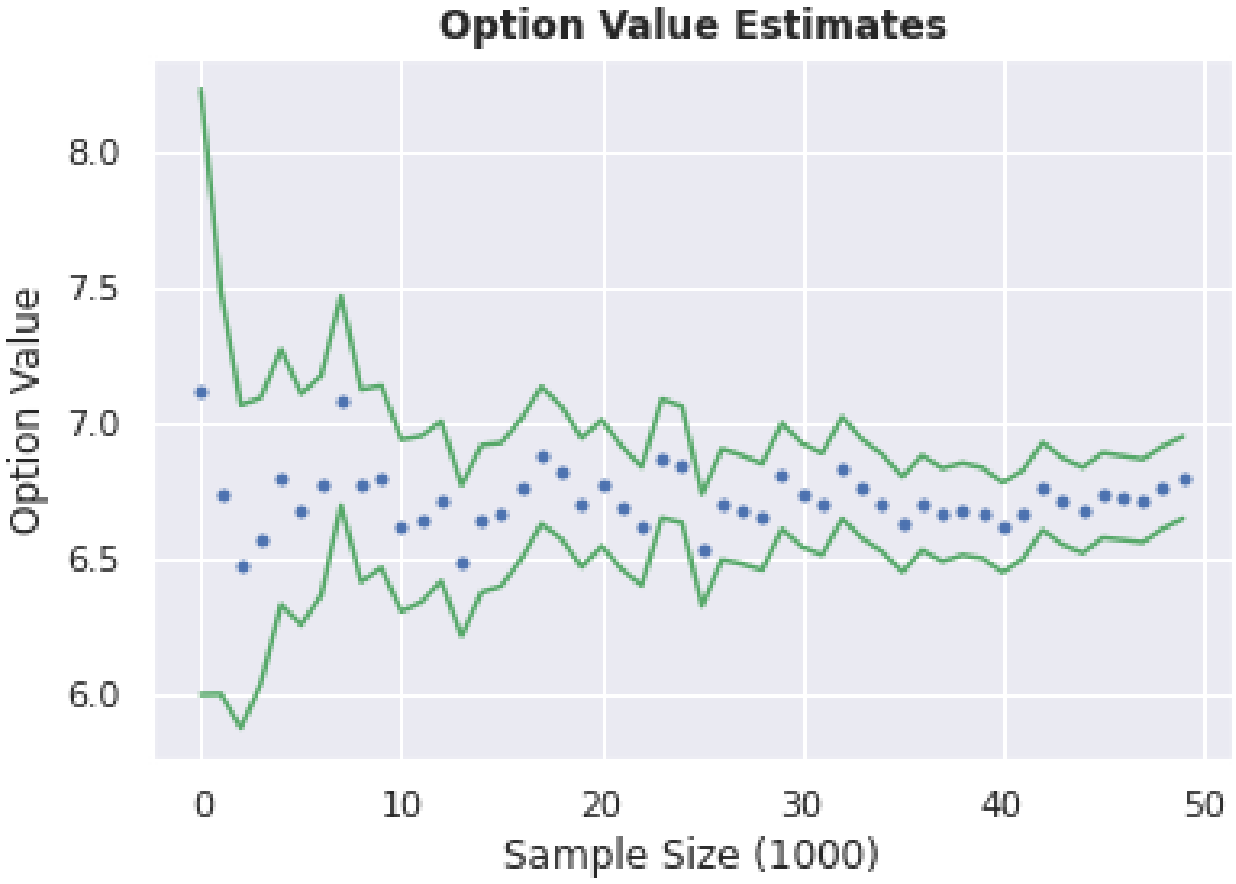

Figure 5: Option Value Simulation

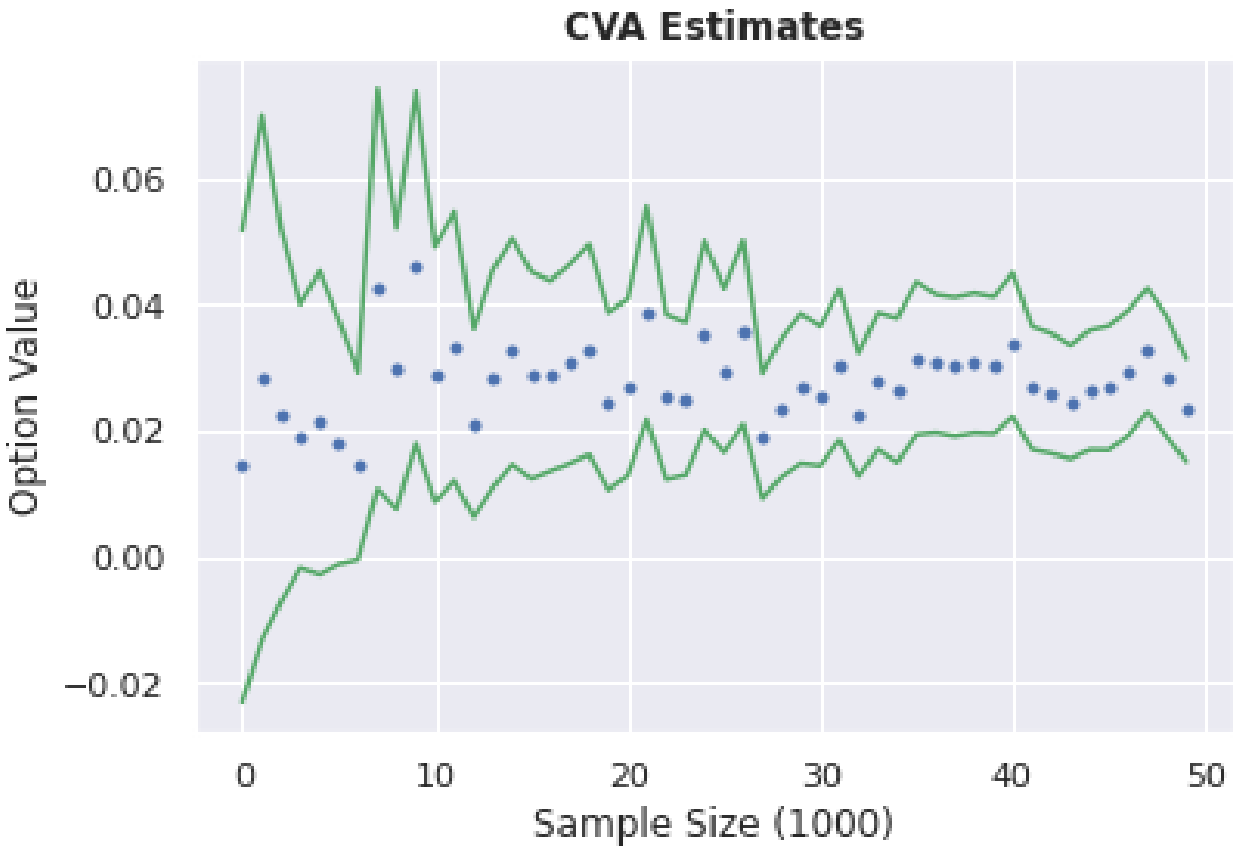

Figure 6: CVA Estiamtes

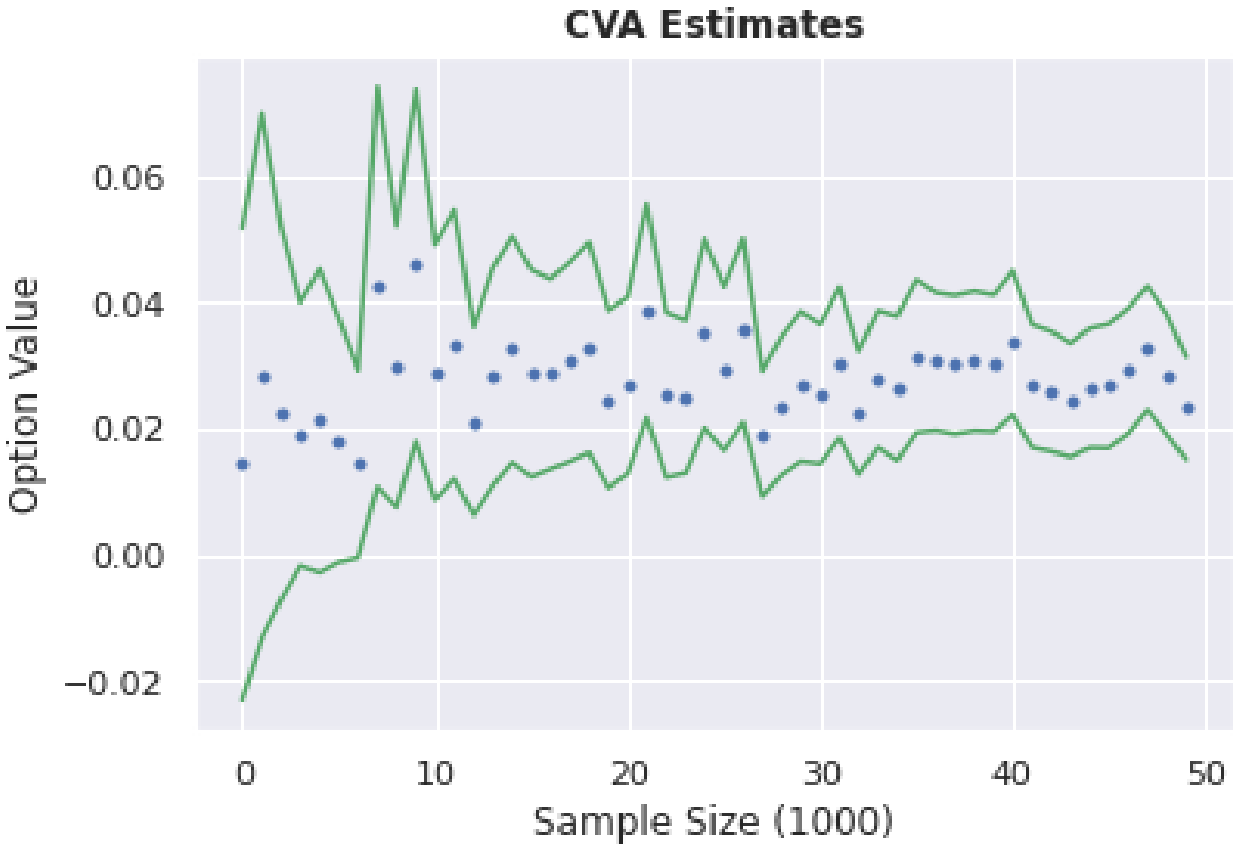

Figure 7: CVA-adjusted Option Prices Simulation