Project I - SF2975 Financial Derivatives

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Fall 2023

Project I: Local volatility estimation

Introduction

The goal of this project is to estimate the local volatility surface from call option data. First of all read the text "The local volatility surface", which can be found on the Canvas page of the course.

Assignments

(a) Describe the stochastic model for the stock price in a local volatility model and then explicitly derive the Dupire formula by going through the steps I-III as outlined in the document "The local volatility surface".

(b) In your programming platform of choice, import the two csv-files containing call option prices. Each row in the csv-files consists of data on the form

`Time to maturity, Strike price, Call option price.`

(I) Reformat the imported lists of prices to an appropriate two-dimensional matrix form. Then plot the two surfaces $c(t, K)$.

(II) Set $r = 0$ and approximate the required derivatives in the Dupire formula using finite differences. Then compute and plot the two local volatility surfaces. Tip: use vectorized operations and try to avoid loops where possible.

(c) The method used in (b) can be numerically unstable. Describe any problems you might have had. Check the robustness of the approach by varying the prices and study how the local volatility surface changes.

(d) Discuss alternative approaches to finding the local volatility surface from Dupire's formula when there is only a finite set of call options prices. Implement one of your alternatives, still with $r = 0$, and compare the surfaces you get with the one you got from using finite differences.

(e) (Optional) Describe the usefulness of the volatility surface.