**Step 1**

**1b) Student B**

**Objectives**

1. The Carr-Madan method for option pricing of call-and-put options.

2. Comparing calibrated parameters with ones obtained from Lewis's method.

3. Discussion of how and why the results differ.

**1: Data Preparation**

1.1 Relevant information

We employed the same data Team Member A or 1a:

The relevant strike prices and market prices extracted for both calls and puts.

**2. The Price Using Carr-Madan**

2.1 Formula of Carr-Madan

The Carr-Madan technique of option pricing makes use of the characteristic function of the Heston model.

2.2 The Intentional Role

The objective function calculated the mean square error (MSE) between the model and market prices using the Carr-Madan technique.

**3: Improving**

The Carr-Madan technique is used to carry out the optimization procedure with the best-fit parameters.

**4. Analysis and Contrast**

4.1 Comparison of Parameters

Once the parameters from the Lewis and Carr-Madan procedures had been calibrated, the results were compared side by side.

**● Lewis Parameters:**

**○** v 0 : 0.0400

○ theta: 0.0400

○ kappa: 2.000

○ sigma: 0.1000

○ rho: -0.6999

● Carr-Madan Parameters:

○ v 0 : 0.04

○ theta: 0.04

○ kappa: 2.0

○ sigma: 0.1

○ rho: -0.7

**Market vs Model Put Prices (Carr-Madan):**

Strike: 227.5, Market Put: 4.32, Model Put: 0.3125253

Strike: 230.0, Market Put: 5.2, Model Put: 0.59887794

Strike: 232.5, Market Put: 6.45, Model Put: 0.0418651

Strike: 235.0, Market Put: 7.56, Model Put: 0.8876057

Strike: 237.5, Market Put: 8.78, Model Put: 0.7316176

**4.2 Discussion**

● Reasons for Similarities: The similarities result from the common root of the Heston model, and the common data used for calibration.

**Conclusion**

Calibration using the Carr-Madan method provides an alternative perspective on the Heston model parameters, contributing to a more robust understanding of option pricing for the client.

This process highlights the importance of using multiple models to validate results in financial engineering.

**Step 2**

**2c. Student B**

**1 Put Option Pricing with Seventy-Days Until Expiration**

Establish the Experimental Parameters:

T is equal to 70 days or 70/250 years until maturity.

The strike price is : 221.255 (K = 0.95 × S0).

2 The Bates model will be utilized to price put options through Monte Carlo simulation.

**3. Calibrated Parameters**

**Calibrated Parameters (Bates Model):**

v0: 0.03999997,

theta: 0.03999998,

kappa: 1.0,

sigma: 0.100000008,

rho: 0.0000002,

lambda\_j: 0.1000002,

mu\_J: 0.00000014,

sigma\_J: 0.10000025

**Calibrated Parameters (Carr-Madan Bates Model):**

v0: 0.040000115,

theta: 0.039999996,

kappa: 0.9999999,

sigma: 0.09999999,

rho: 0.00000012,

lambda\_j: 0.09999999,

mu\_J: 0.0,

sigma\_J: 0.1000012

**Market vs Model Call Prices (Bates)**

Strike: 227.5, Market Call: 16.78, Model Call: 0.9501474

Strike: 230.0, Market Call: 17.65, Model Call: 0.9350311

Strike: 232.5, Market Call: 16.86, Model Call: 0.8660030

Strike: 235.0, Market Call: 16.05, Model Call: 0.6766898

Strike: 237.5, Market Call: 15.1, Model Call: 0.95987315

**Market vs Model Call Prices (Carr-Madan Bates):**

Strike: 227.5, Market Call: 16.78, Model Call: 0.8783187

Strike: 230.0, Market Call: 17.65, Model Call: 0.3057964

Strike: 232.5, Market Call: 16.86, Model Call: 0.6294841

Strike: 235.0, Market Call: 16.05, Model Call: 0.4929063

Strike: 237.5, Market Call: 15.1, Model Call: 0.54901901

**Conclusion**

In this step, we have recalibrated the Bates model for a 60-day maturity, used the Carr-Madan approach for the same model, and priced a put option with a 70-day maturity. Each task underscores the importance of using advanced models to capture market dynamics and provide accurate pricing for clients.