Citi Markets Quant Internship – Task 2: Pricing Coffee Futures & Options

Pricing a Coffee Futures Contract Using the Cost of Carry Model:

Given:

- Current spot price (StSt): $1.20 per pound
- Risk-free rate (rr): 2% per annum
- Storage cost (dd): 1% per annum
- Time to maturity (TT): 6 months (0.5 years)

$F_t=1.20\cdot e^{(0.02+0.01).0.5}=1.20\cdot e^{0.015}\approx 1.20\cdot 1.015=1.218$

So, the fair price of the coffee futures contract is approximately $1.218 per pound.

Using Python for Analysis:

To apply these models and run simulations, Python can be a powerful tool. Here's how you could approach each part of the analysis using Python:

1. Cost of Carry Model:

```
python
Copy code
import numpy as np

# Given values
S_t = 1.20  # Spot price in dollars
r = 0.02  # Risk-free rate (2%)
d = 0.01  # Storage cost (1%)
T = 0.5  # Time to maturity in years

# Calculating futures price
F_t = S_t * np.exp((r + d) * T)
print(f"The fair price of the coffee futures contract is ${F_t:.3f} per
pound.")
```

2. Black-Scholes Model:

```
python
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from scipy.stats import norm
import numpy as np

# Given values
S_0 = 1.20  # Spot price in dollars
X = 1.25  # Strike price in dollars
r = 0.02  # Risk-free rate (2%)
T = 0.5  # Time to maturity in years
sigma = 0.25  # Volatility (25%)
```

```
# Calculating d1 and d2
d1 = (np.log(S_0 / X) + (r + 0.5 * sigma ** 2) * T) / (sigma * np.sqrt(T))
d2 = d1 - sigma * np.sqrt(T)

# Calculating call option price using Black-Scholes formula
C = S_0 * norm.cdf(d1) - X * np.exp(-r * T) * norm.cdf(d2)
print(f"The price of the call option is ${C:.3f}.")
```

3. Monte Carlo Simulation:

```
python
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import numpy as np

# Simulation parameters
S_0 = 1.20  # Spot price in dollars
r = 0.02  # Risk-free rate (2%)
sigma = 0.25  # Volatility (25%)
T = 0.5  # Time to maturity in years
num_simulations = 10000

# Running Monte Carlo simulation
np.random.seed(42)  # For reproducibility
simulated_prices = S_0 * np.exp((r - 0.5 * sigma ** 2) * T + sigma *
np.sqrt(T) * np.random.randn(num_simulations))

# Calculating the average simulated price
average_simulated_price = np.mean(simulated_prices)
print(f"The average simulated price of the coffee futures contract is
${average_simulated_price:.3f}.")
```

By thoroughly understanding and applying these quantitative techniques, you will be well-equipped to price coffee futures contracts accurately, structure securities effectively, and manage the associated risks.