

Assignment 1

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Roll Number – 190123066

Question 1

Given Data –

$S(0)$ = Initial stock price = 100

K = Strike price = 100

T = Time to maturity = 1 year

r = Risk free rate = 8%

σ = Volatility of the stock = 20%

At each time step prices of the stock can go up by a factor of u or go down by a factor of d .

Formula used for u and d –

Set 1-

$$u = e^{\sigma\sqrt{\Delta t} + (r - \frac{\sigma^2}{2})\Delta t}$$

$$d = e^{-\sigma\sqrt{\Delta t} + (r - \frac{\sigma^2}{2})\Delta t}$$

Set 2 –

$$u = e^{\sigma\sqrt{\Delta t}}$$

$$d = e^{-\sigma\sqrt{\Delta t}}$$

where $\Delta t = T/M$ with M being the number of subintervals in the time interval $[0, T]$.

For sensitivity analysis of option price with $S(0), K, M, r, \sigma$ various plots by varying one and two parameters are made.

Question 2

The path dependent derivative I chose is Asian Options.

For this question I have taken M as 10 because Algorithm for calculating price is $O(2^M)$. For $M = 100$, this analysis would be computationally infeasible.

Price of the option can be calculated as –

$$\frac{1}{e^{rT}} \sum_{\text{over all paths}} q^{\text{count of ups}} (1 - q)^{M - \text{count of ups}} f(S_{\text{avg}})$$

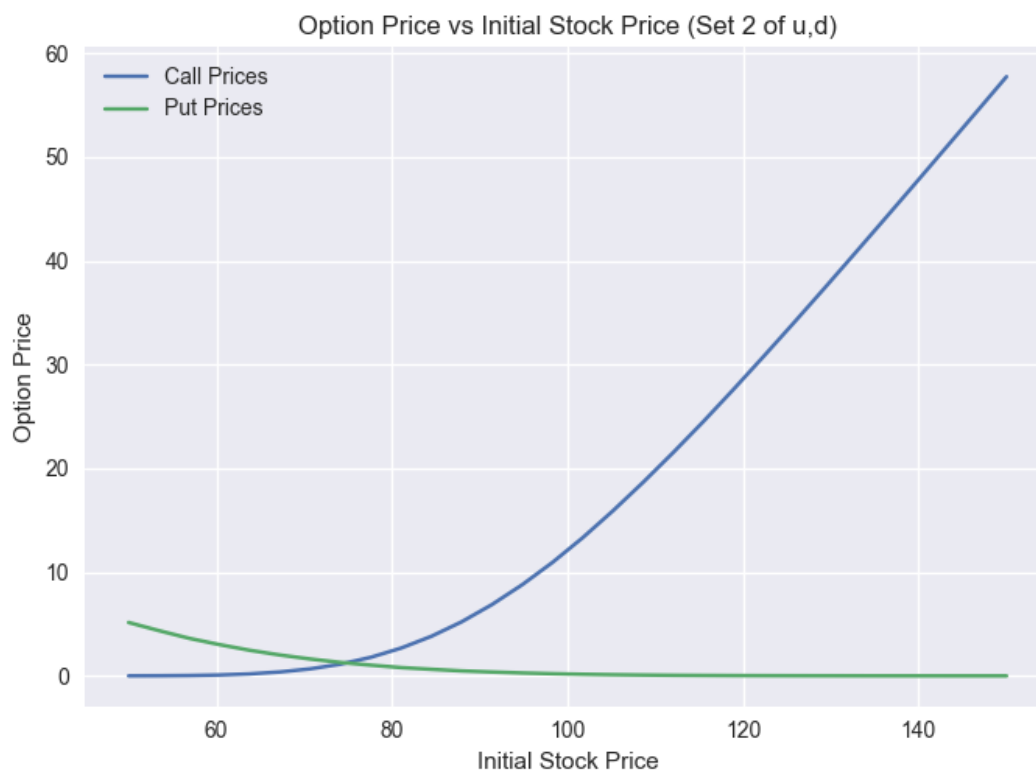
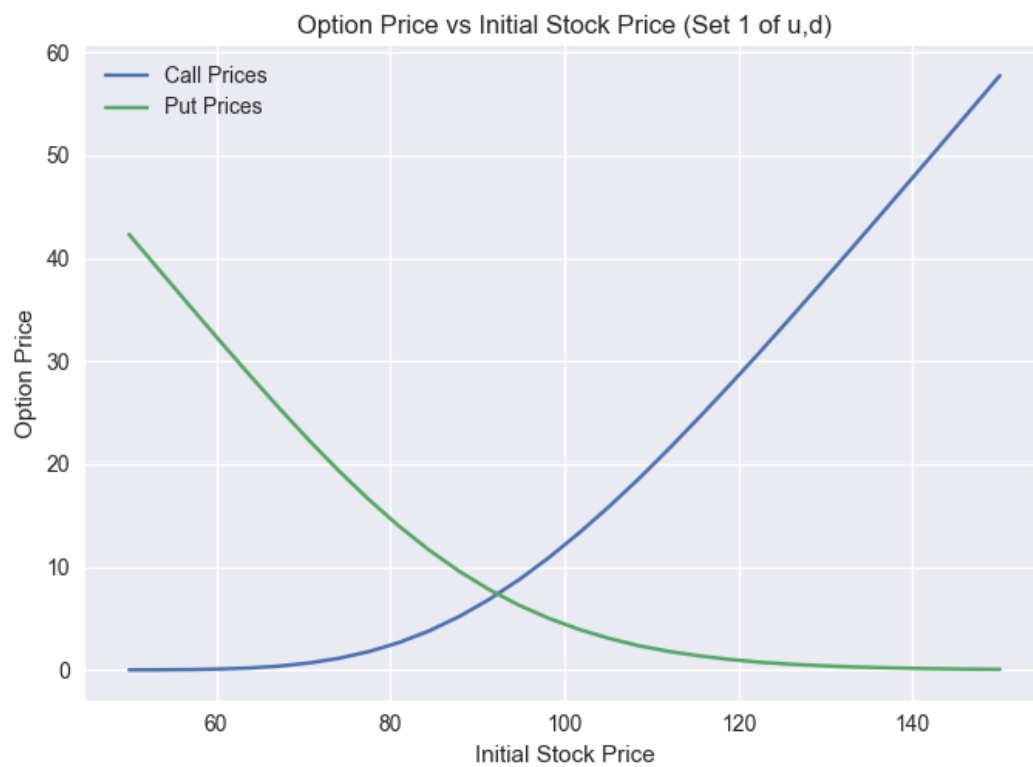
where $f(S_{\text{avg}})$ is the final payoff calculated using following formula –

for call option – $\max(S_{\text{avg}}(T) - K, 0)$

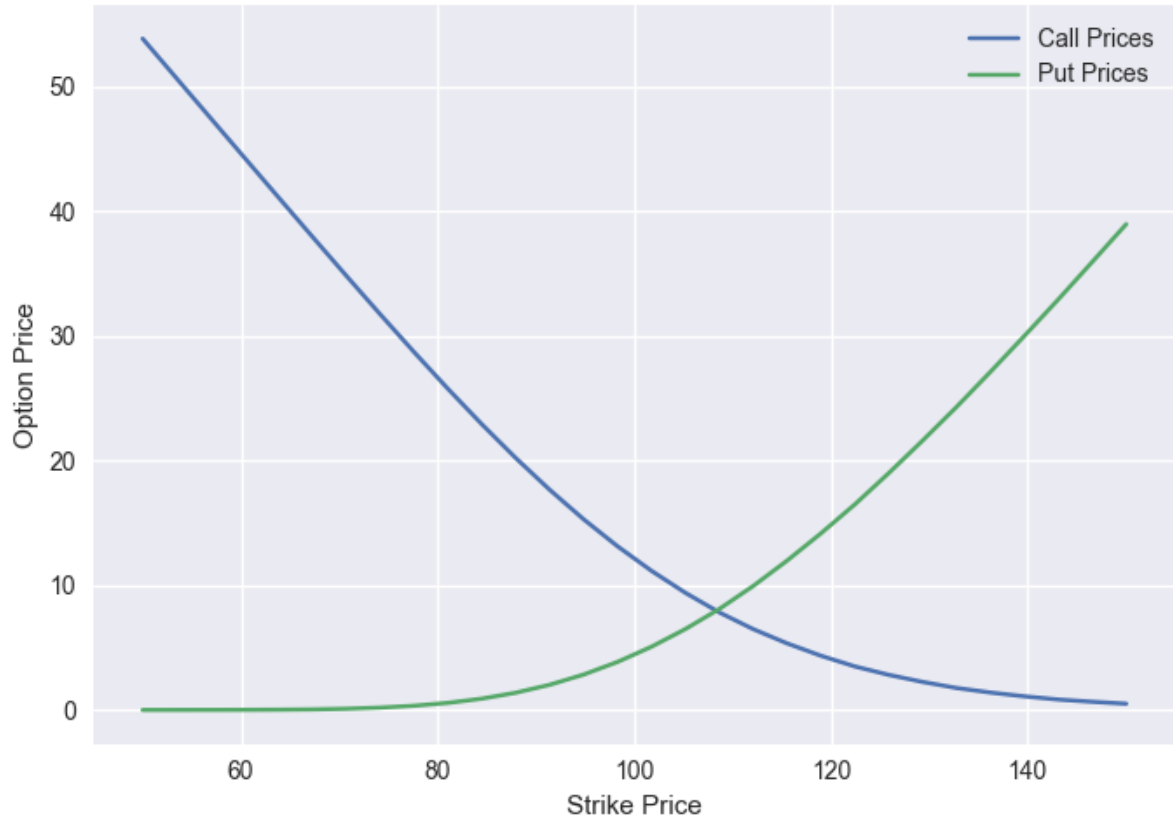
for put option – $\max(K - S_{\text{avg}}(T), 0)$

S_{avg} is the average stock price along any particular path.

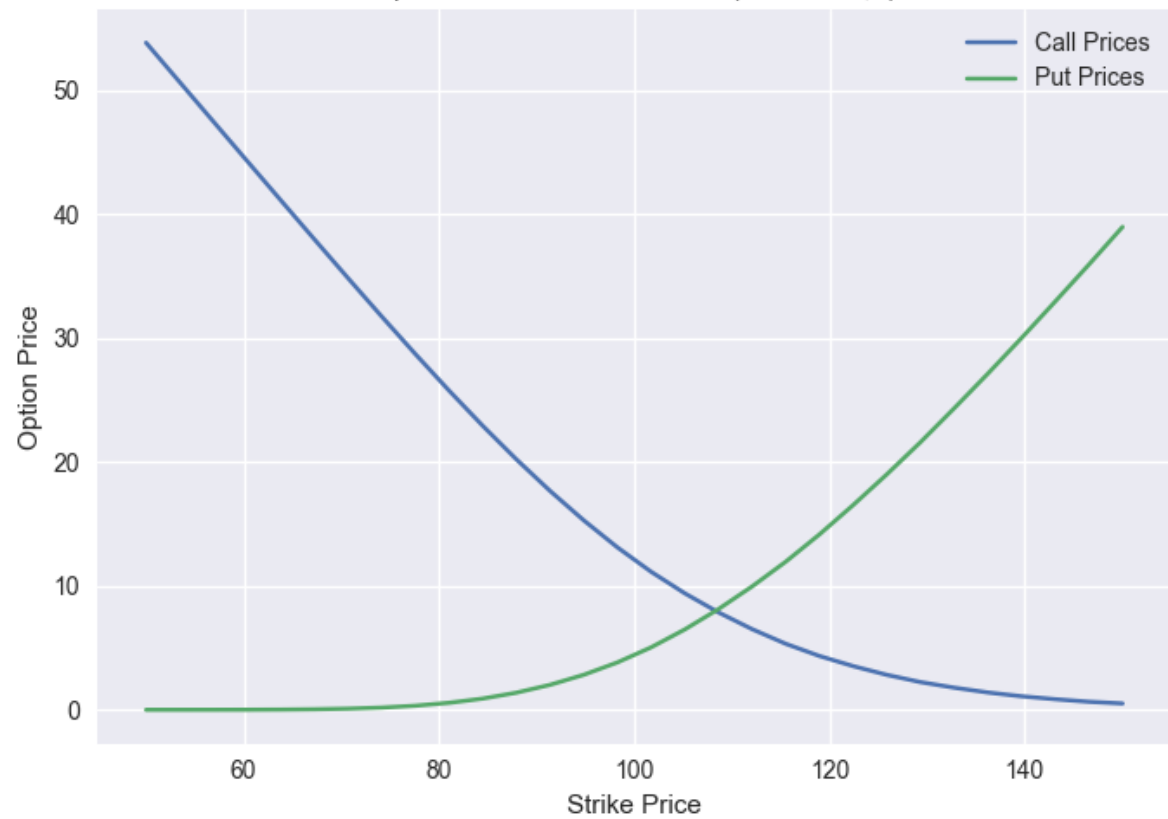
Question 1 Plots

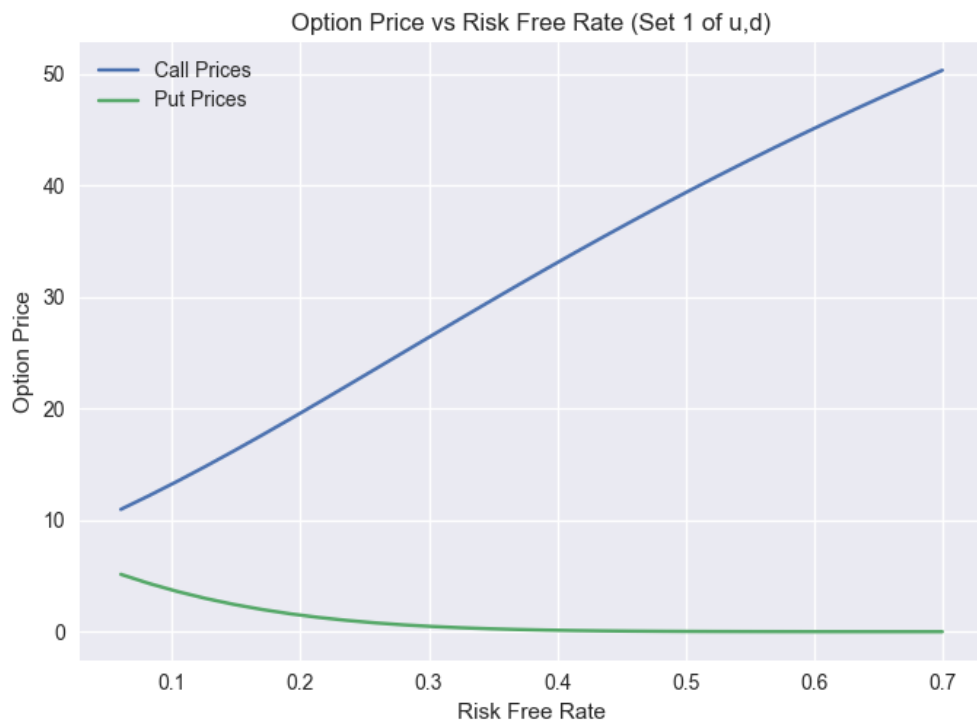


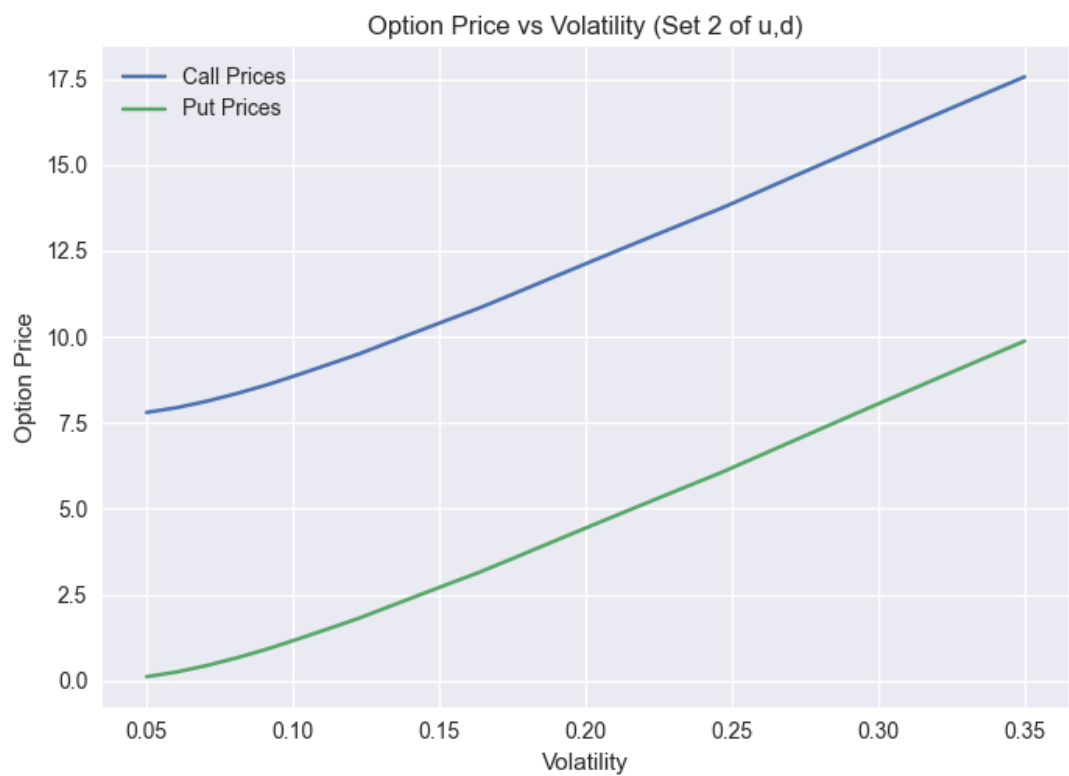
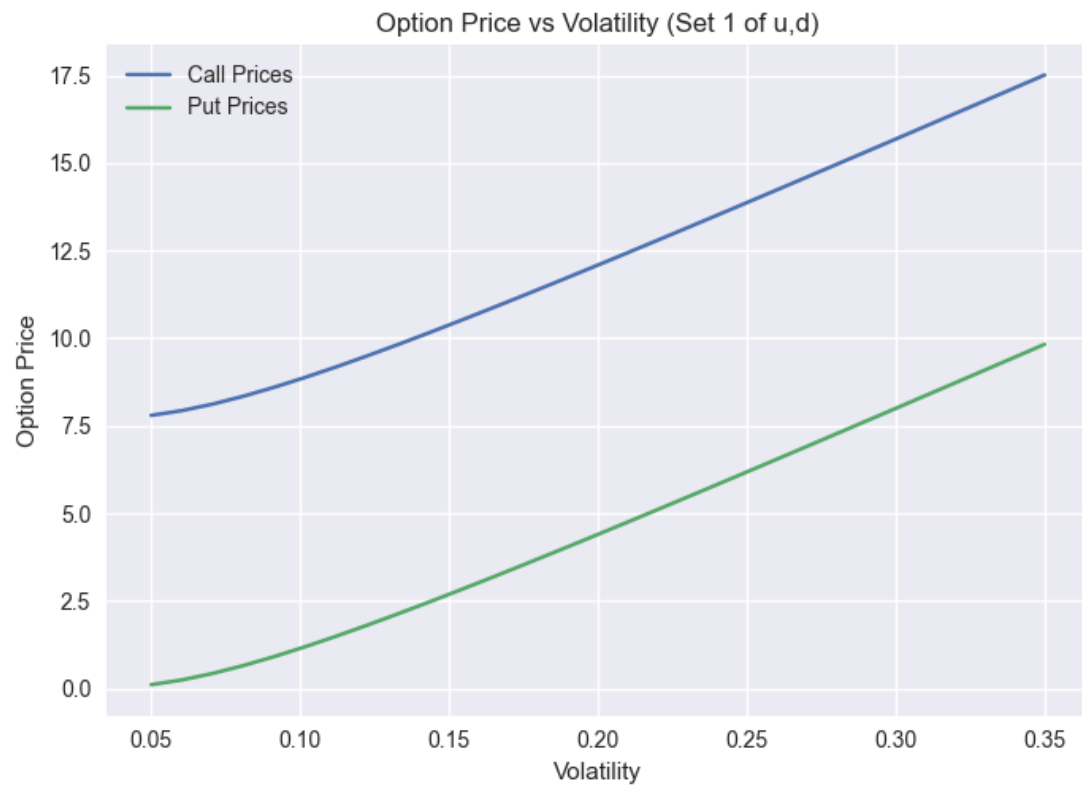
Option Price vs Strike Price (Set 1 of u,d)



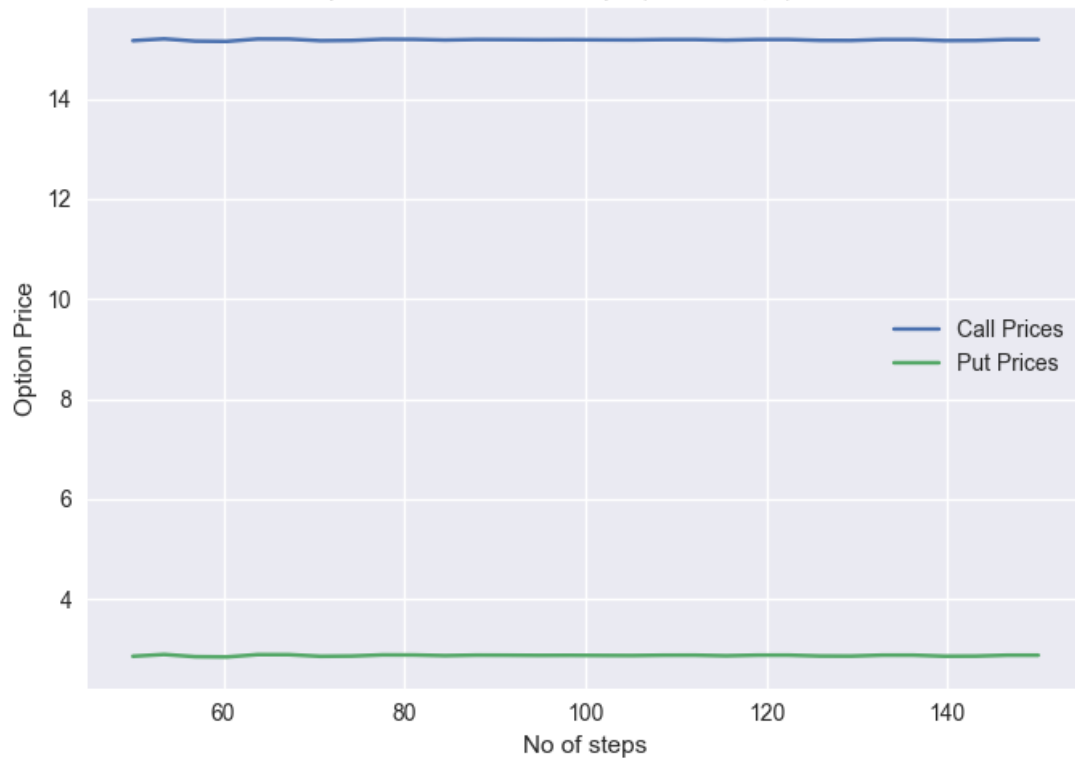
Option Price vs Strike Price (Set 2 of u,d)



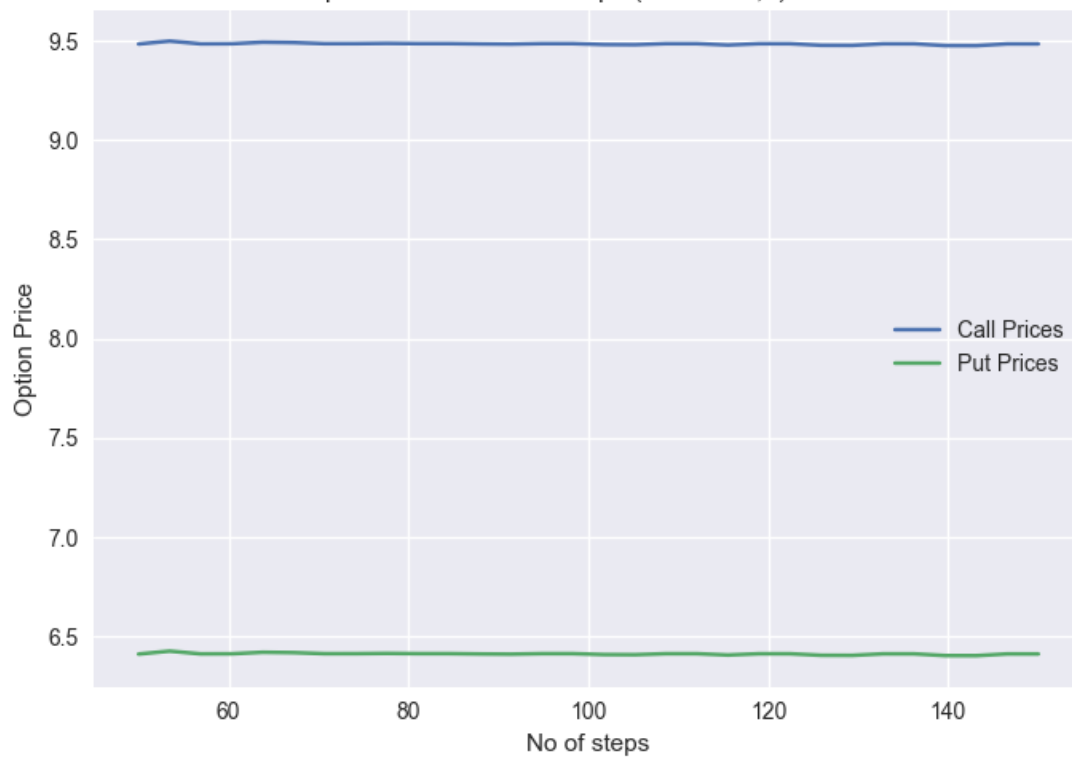




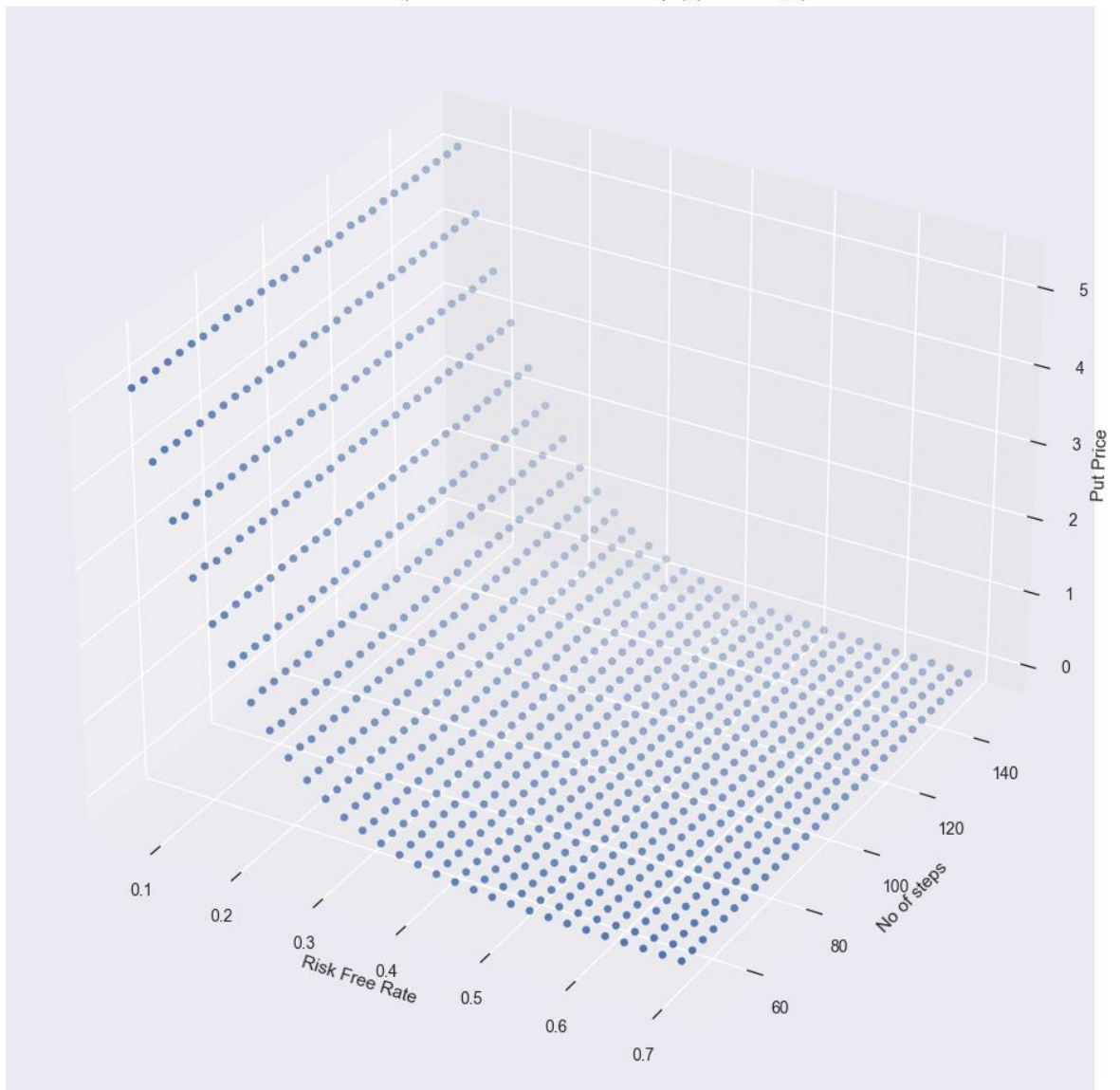
Option Price vs No of steps (Set 1 of u,d) K=95



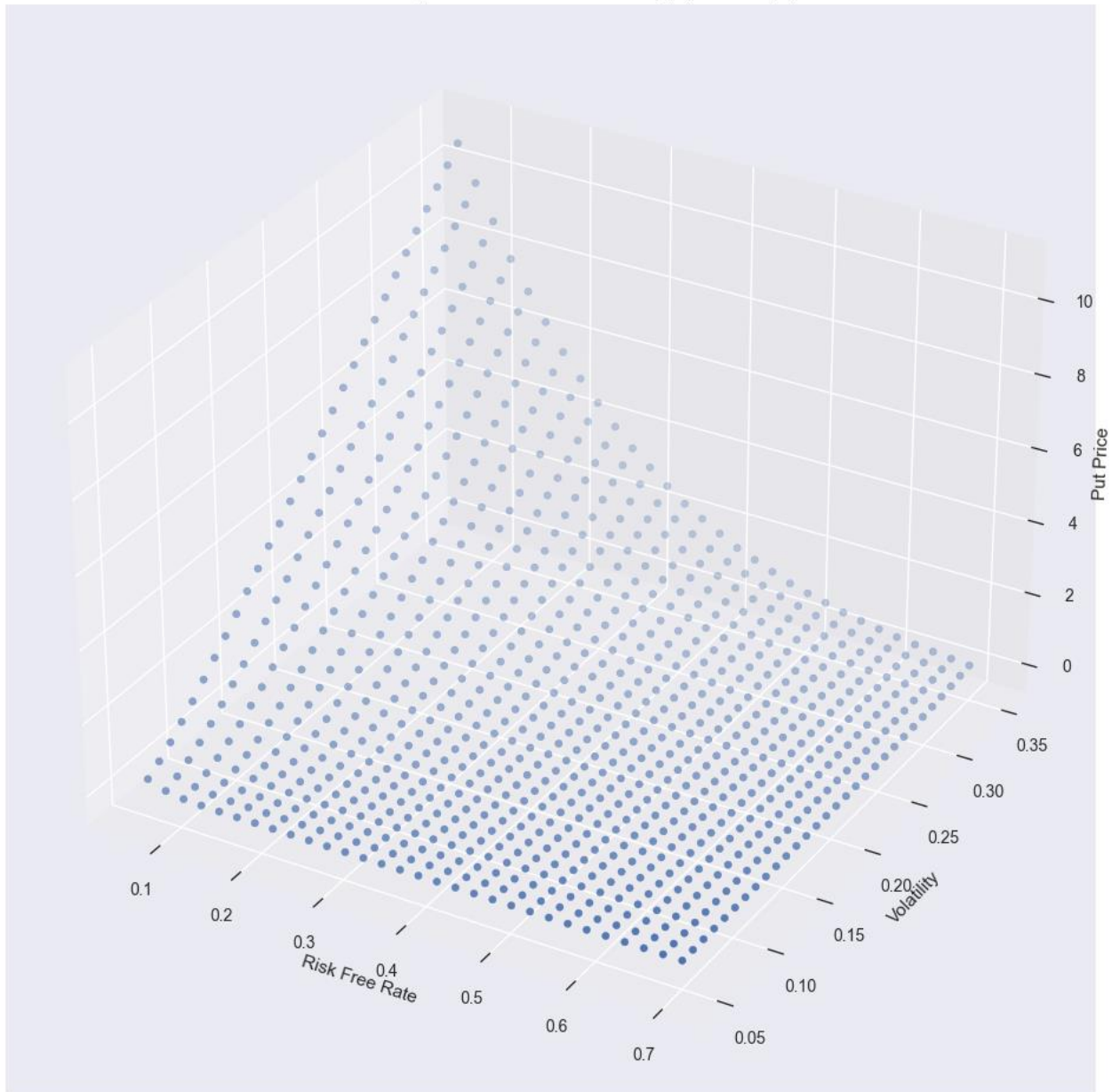
Option Price vs No of steps (Set 2 of u,d) K=105



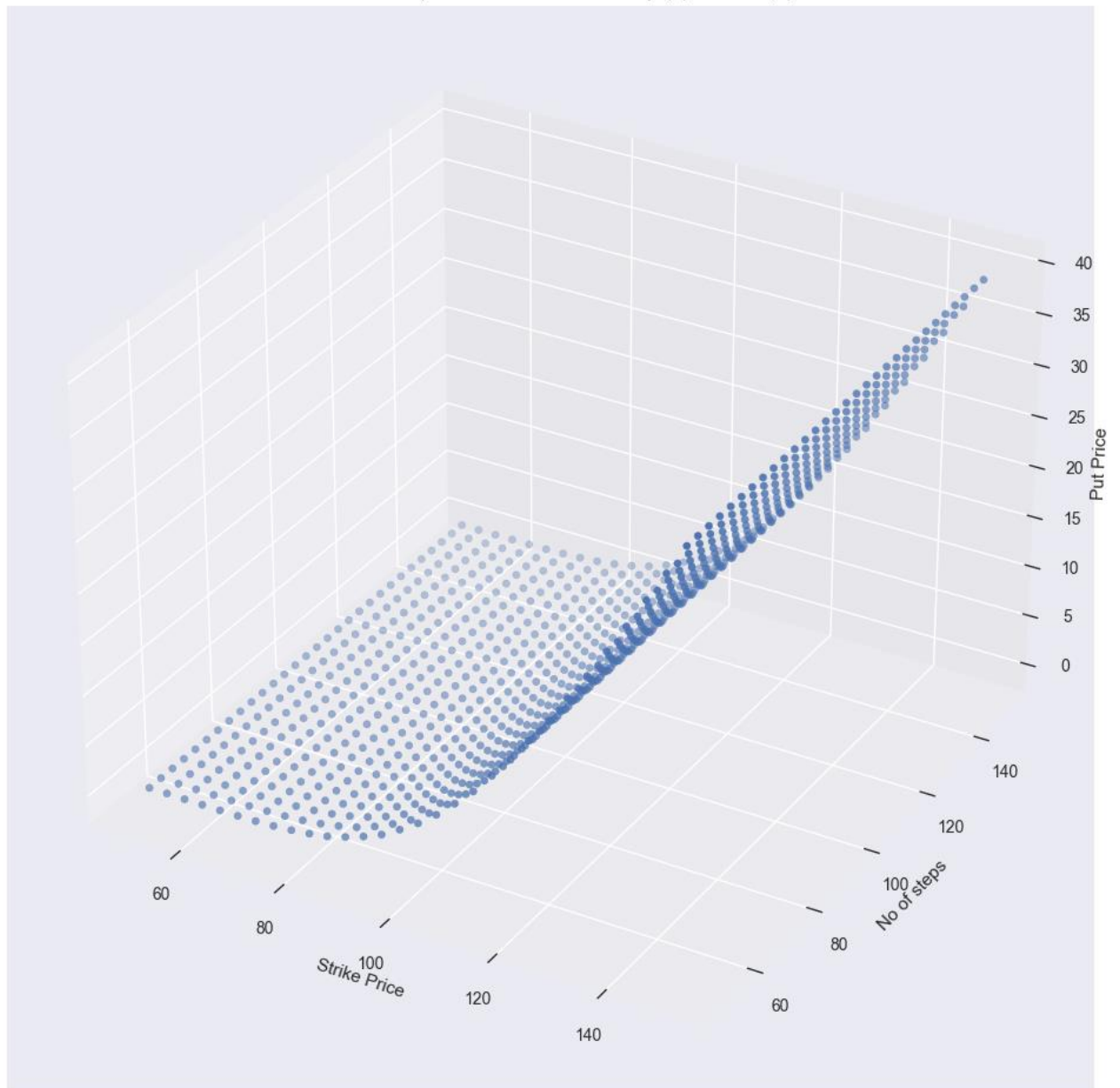
Put Price vs (Risk Free Rate and No of steps) (Set 2 of u,d)



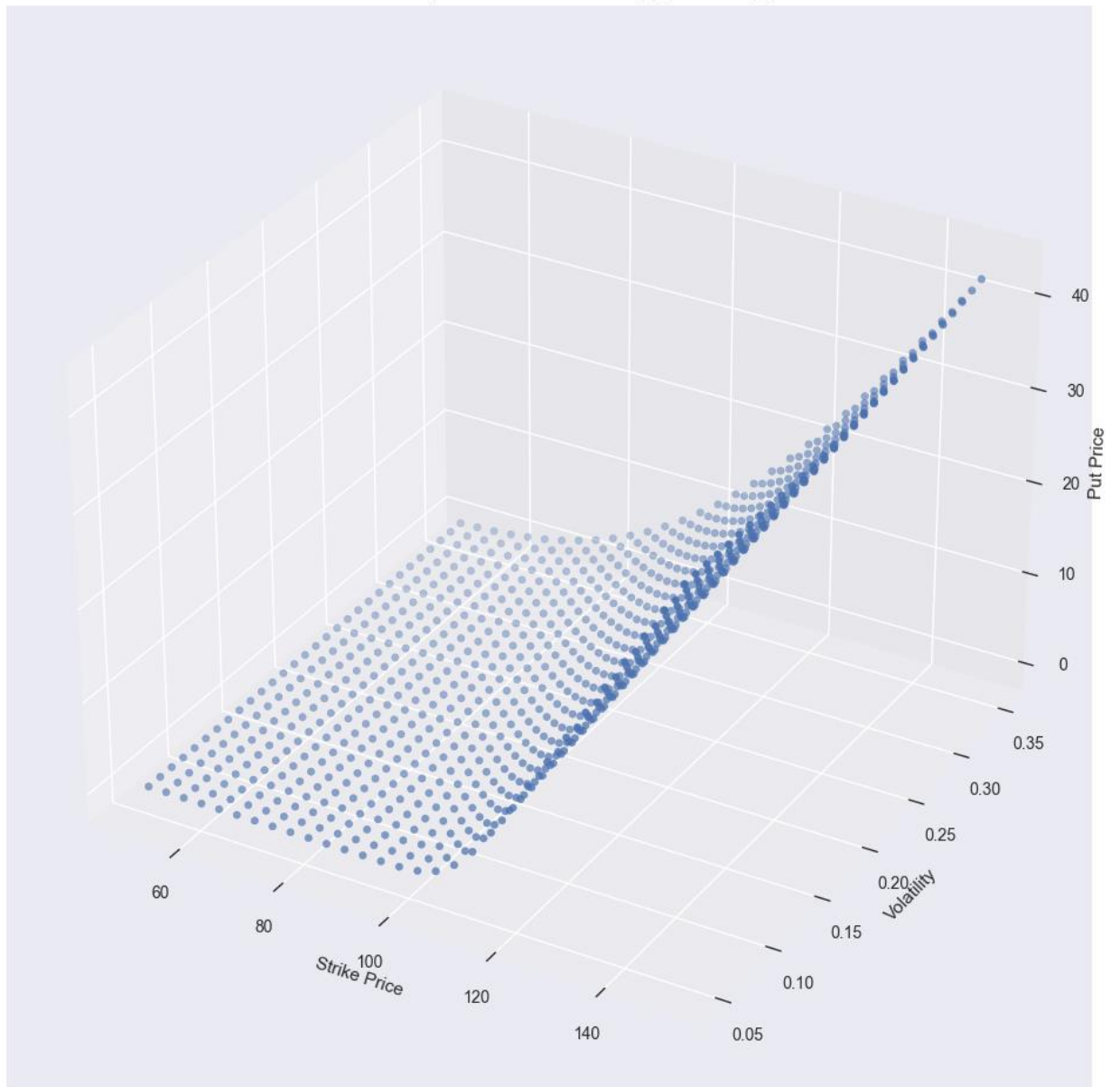
Put Price vs (Risk Free Rate and Volatility) (Set 2 of u,d)



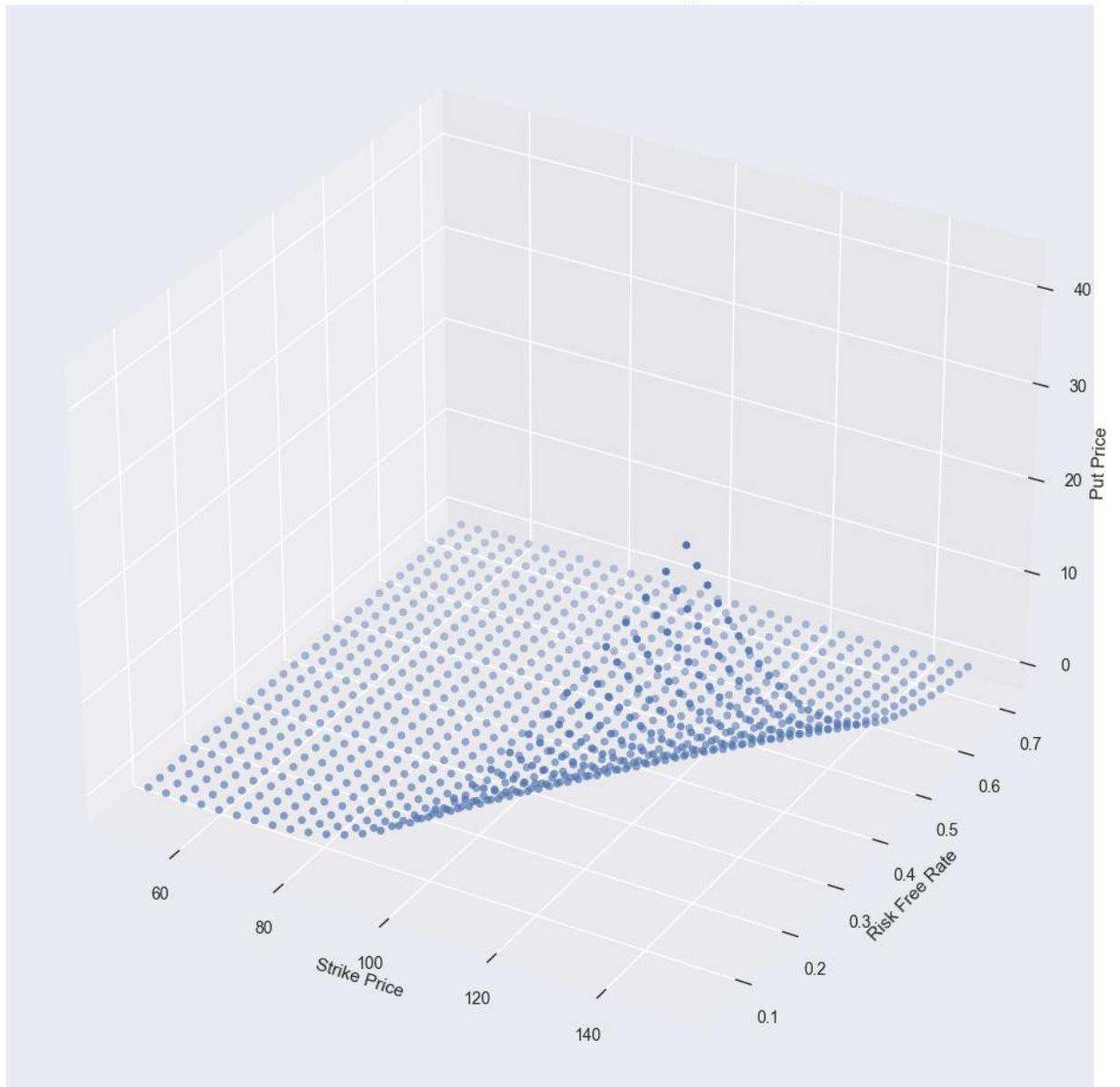
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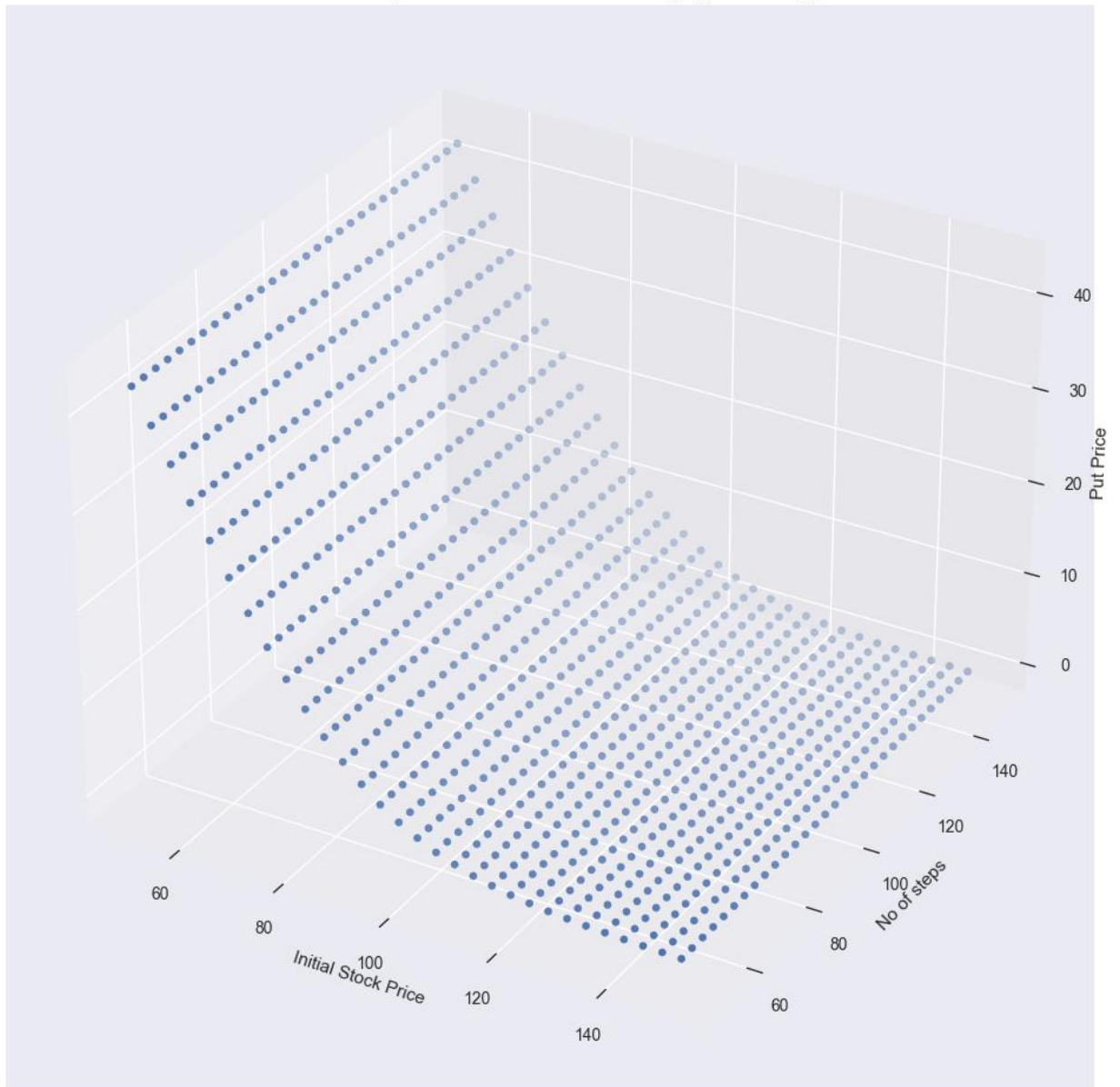
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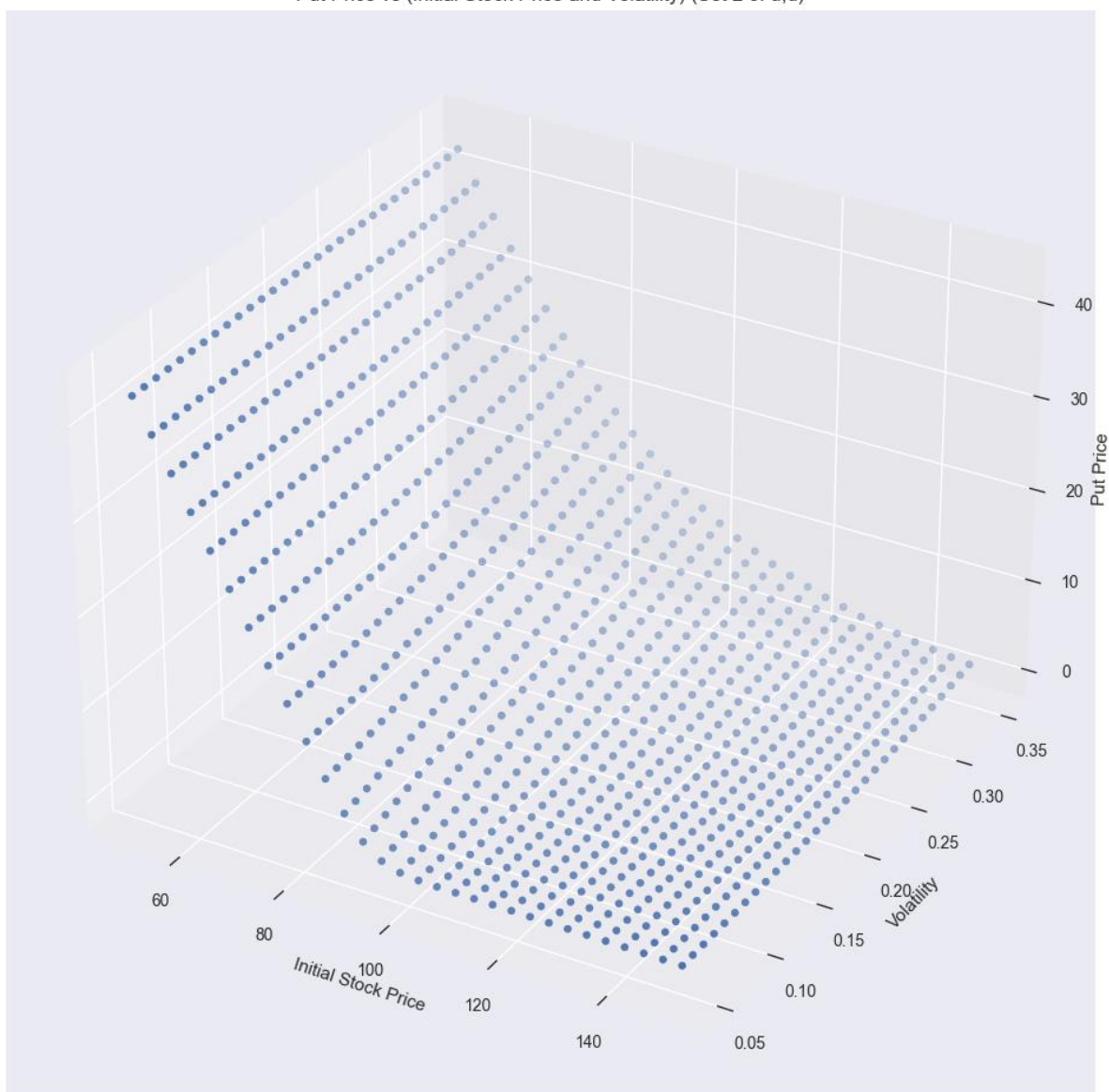
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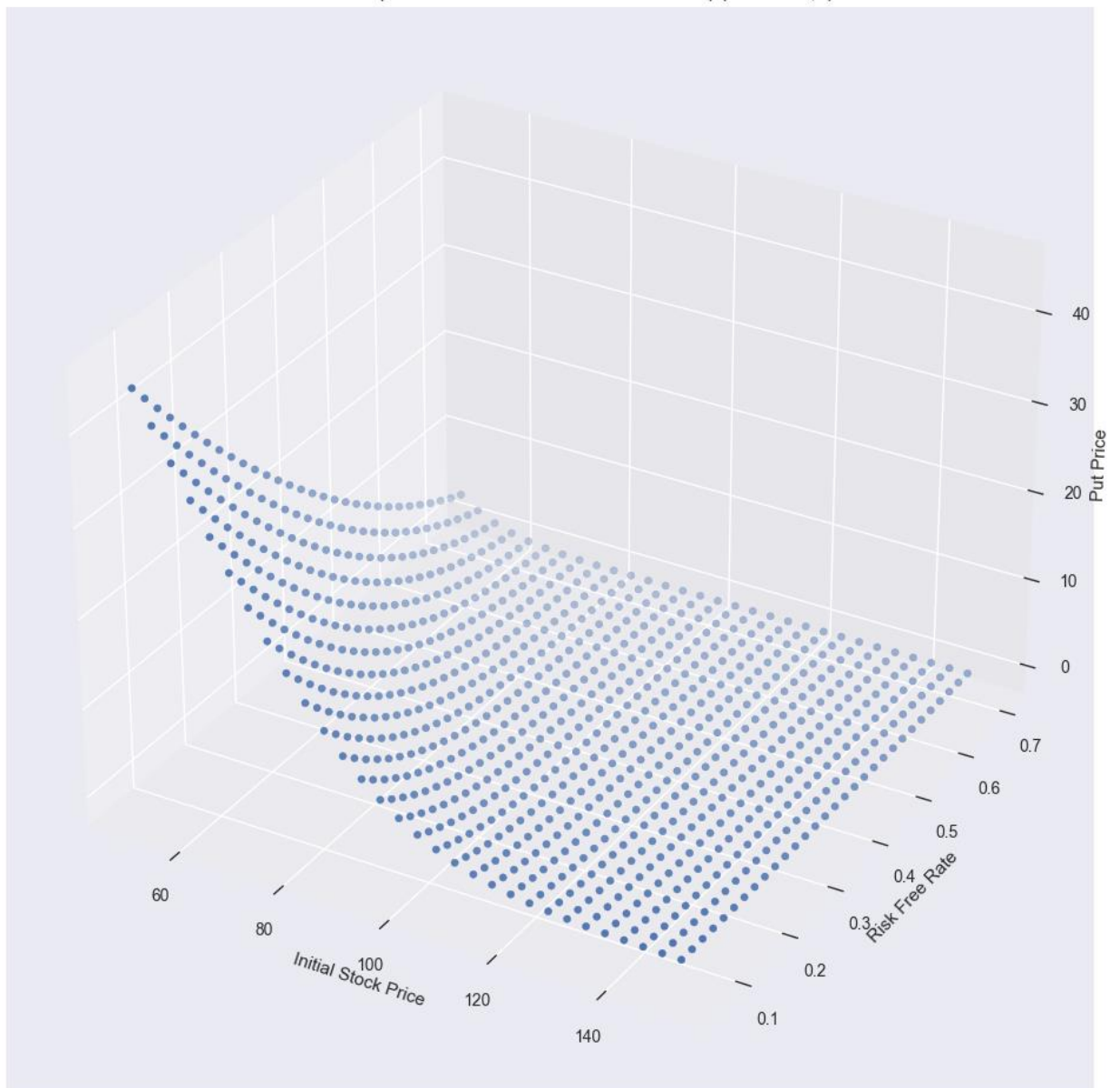
Put Price vs (Initial Stock Price and No of steps) (Set 2 of u,d)



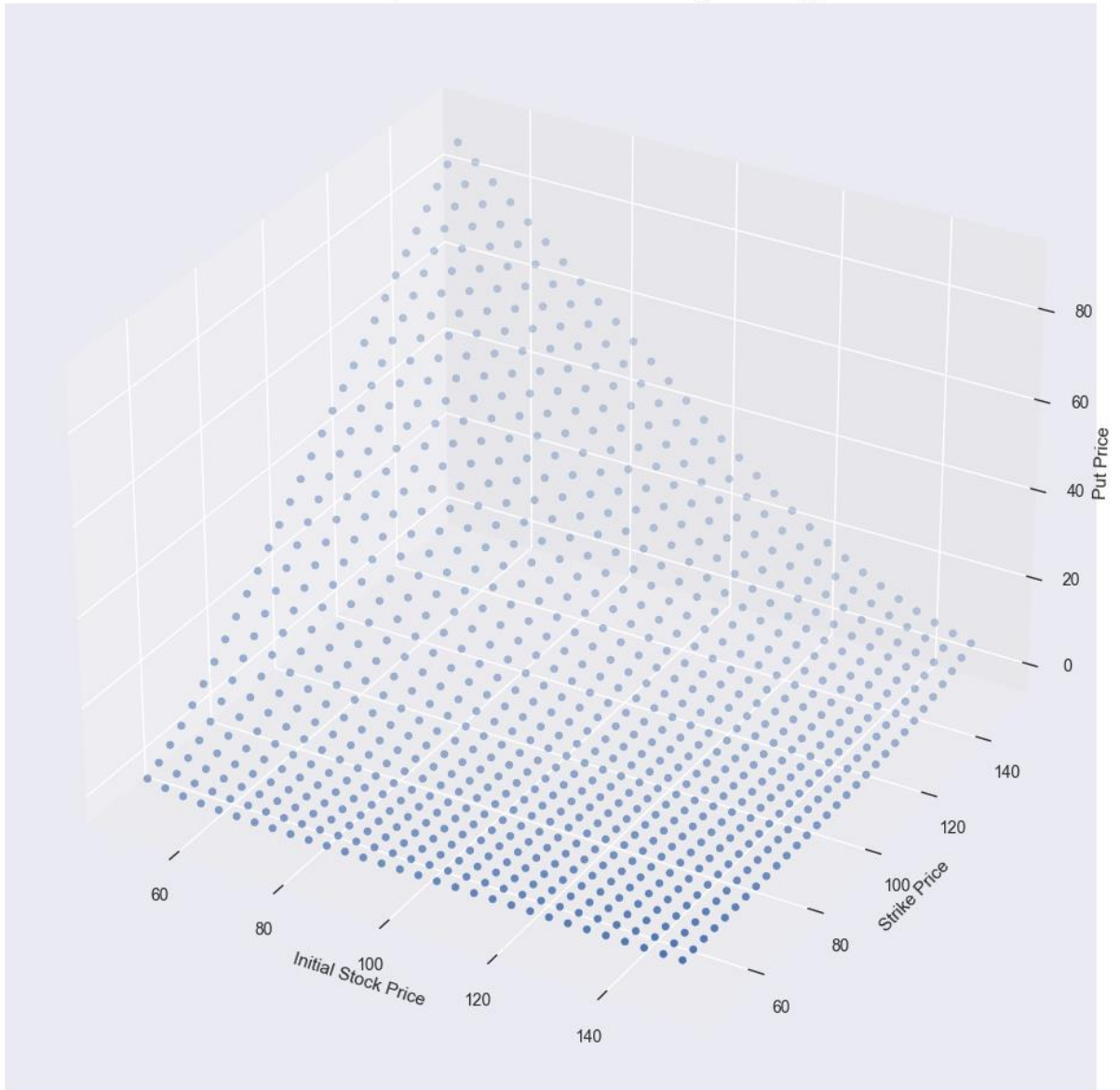
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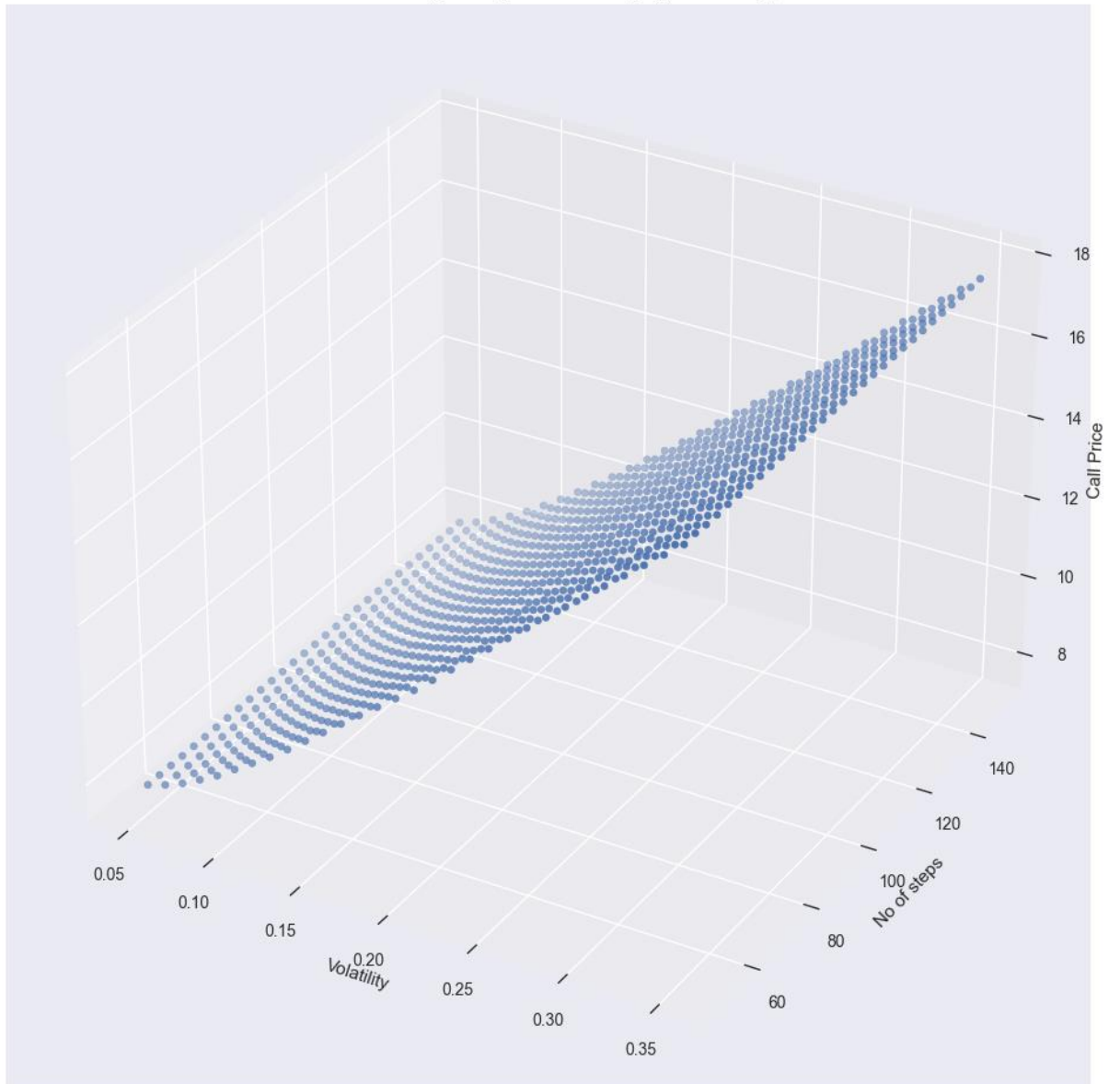
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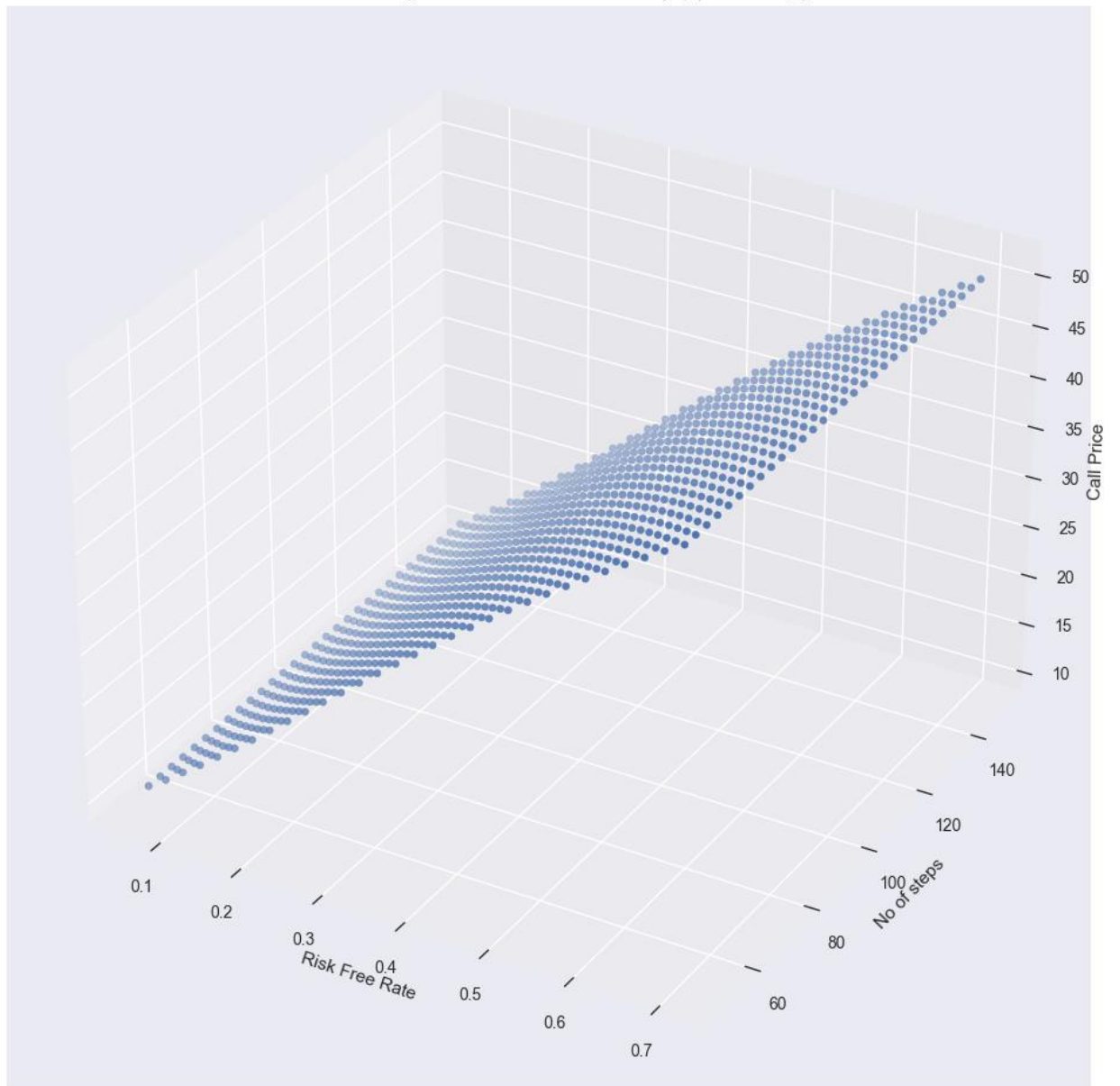
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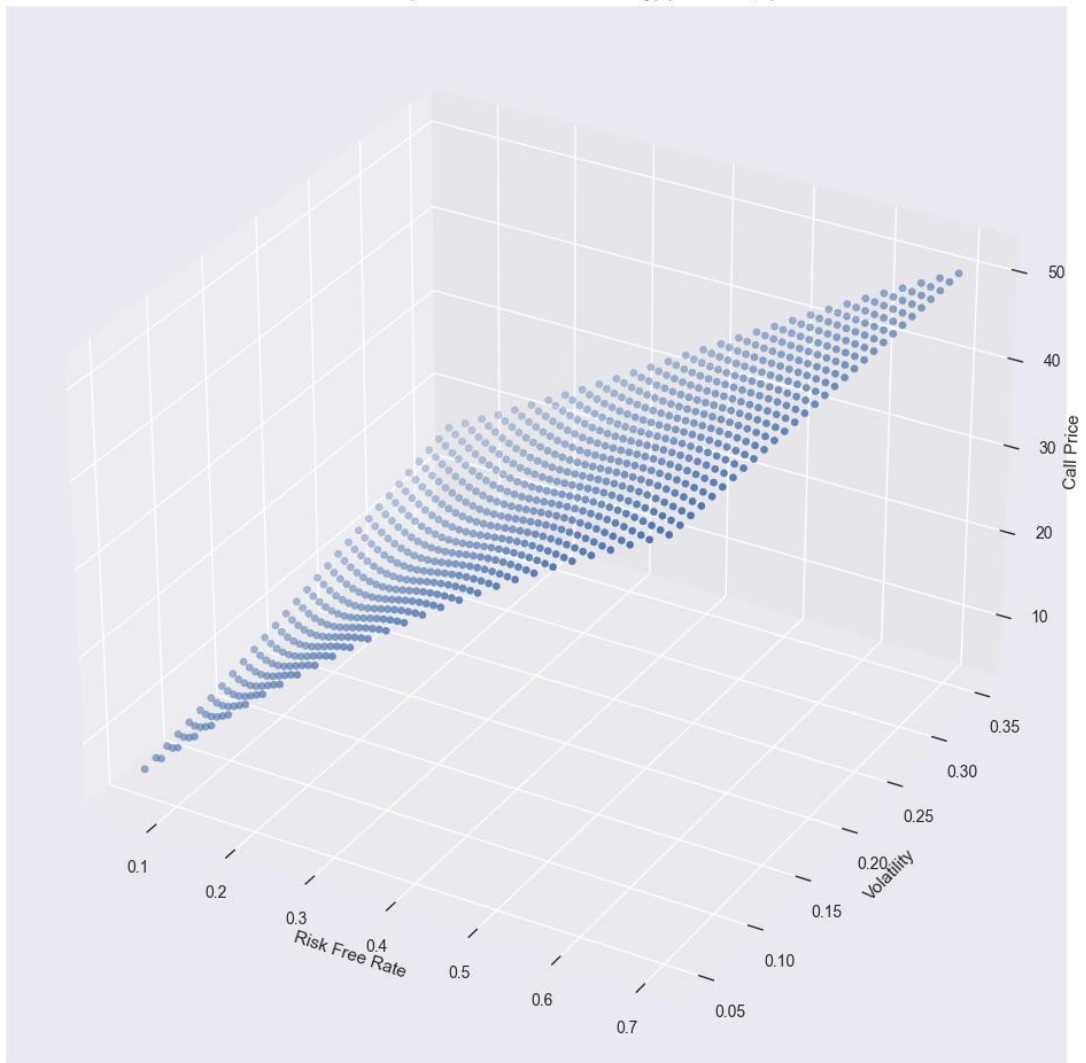
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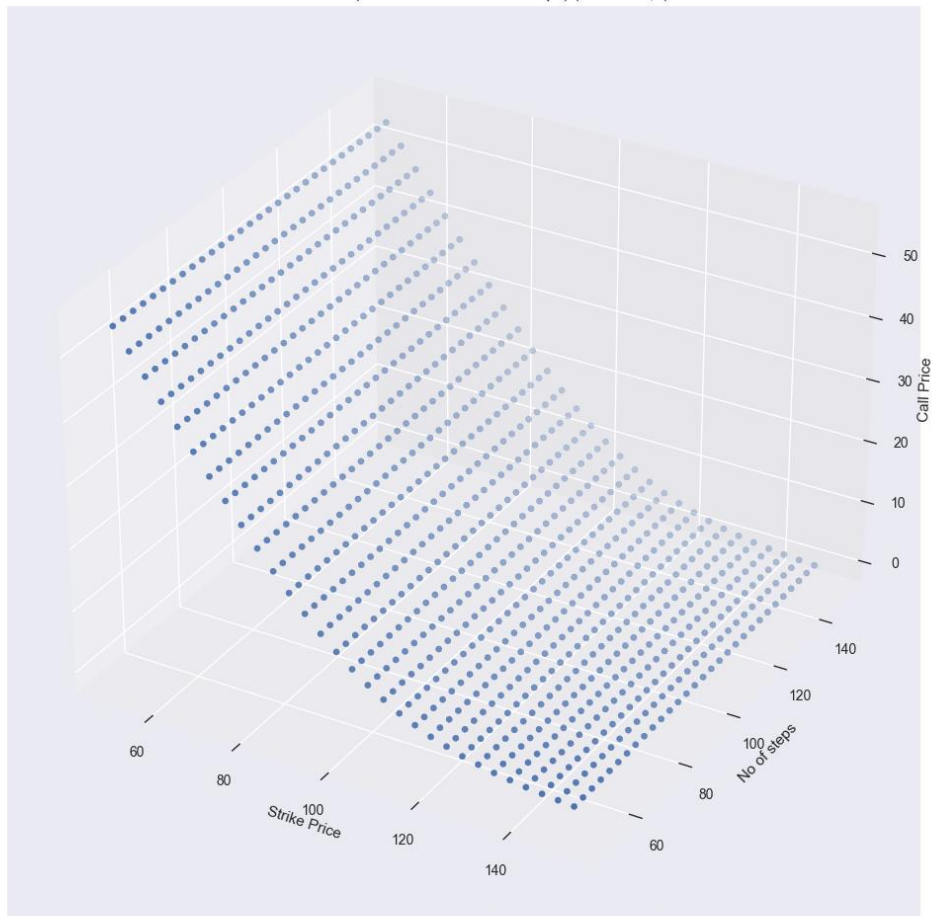
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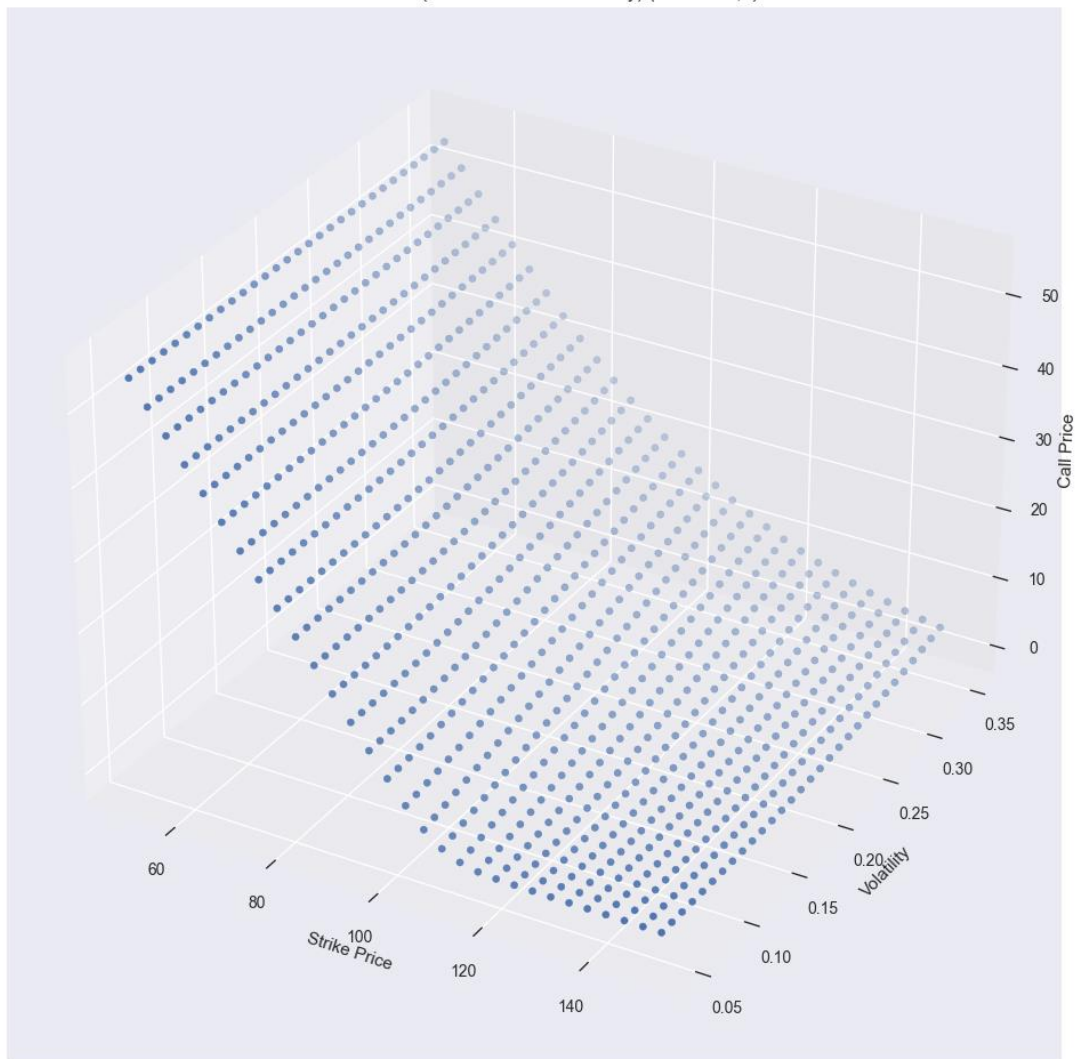
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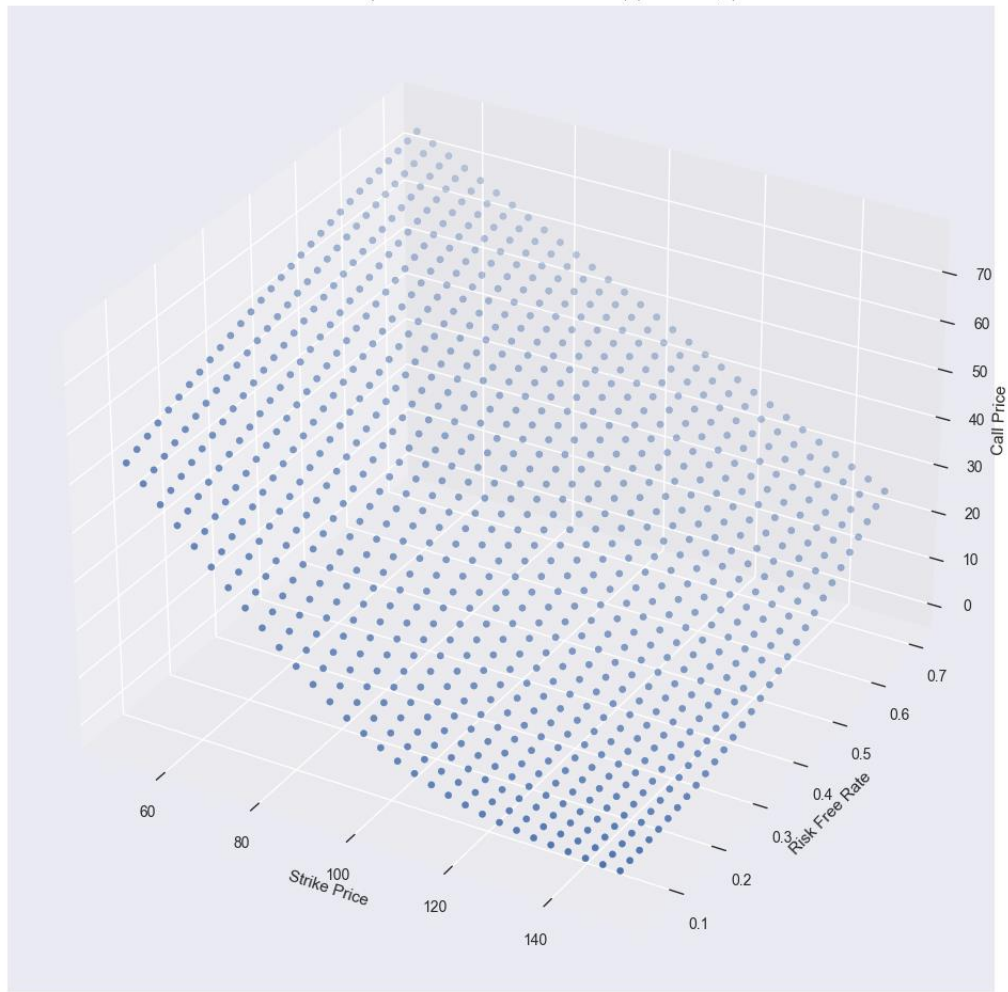
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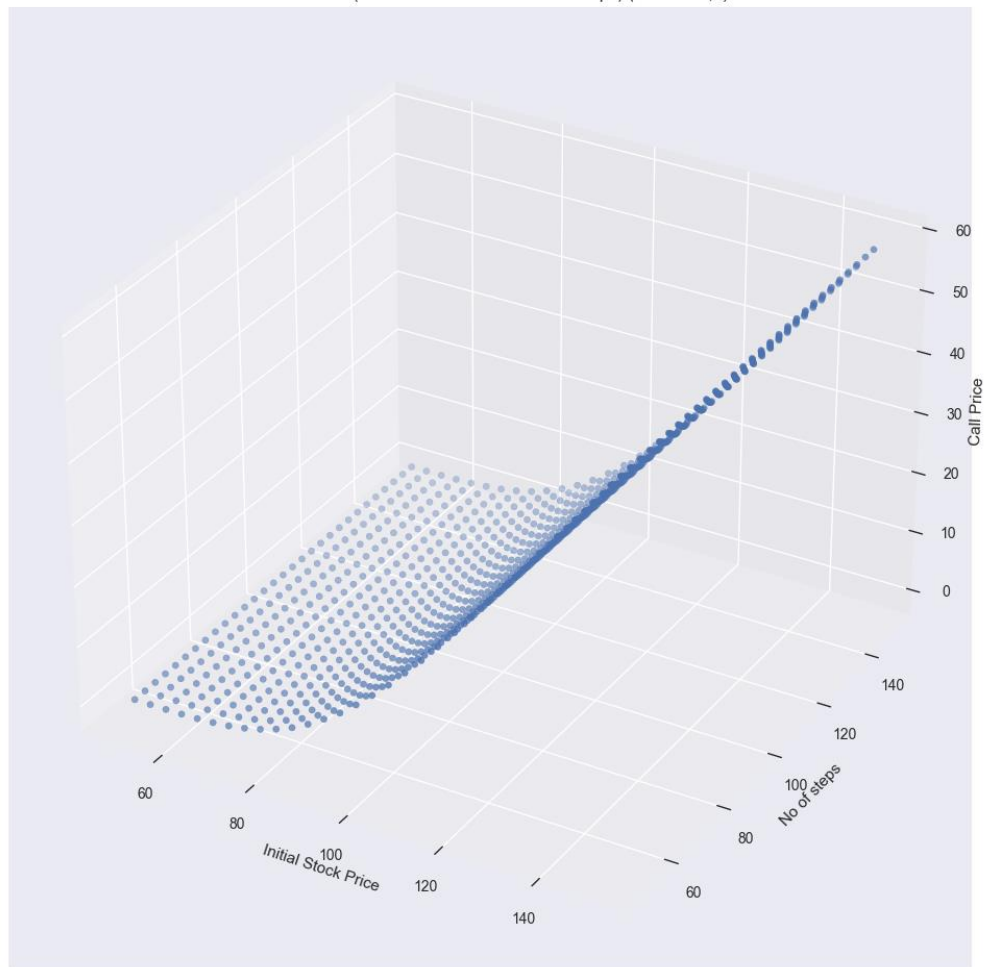
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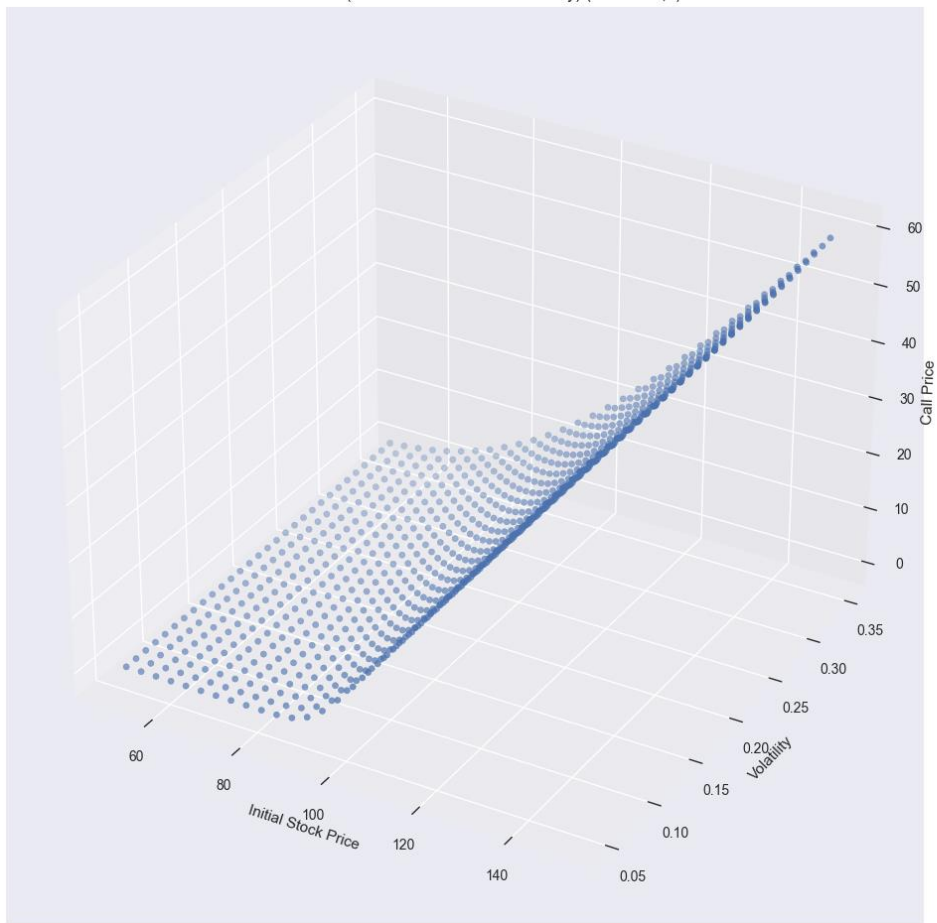
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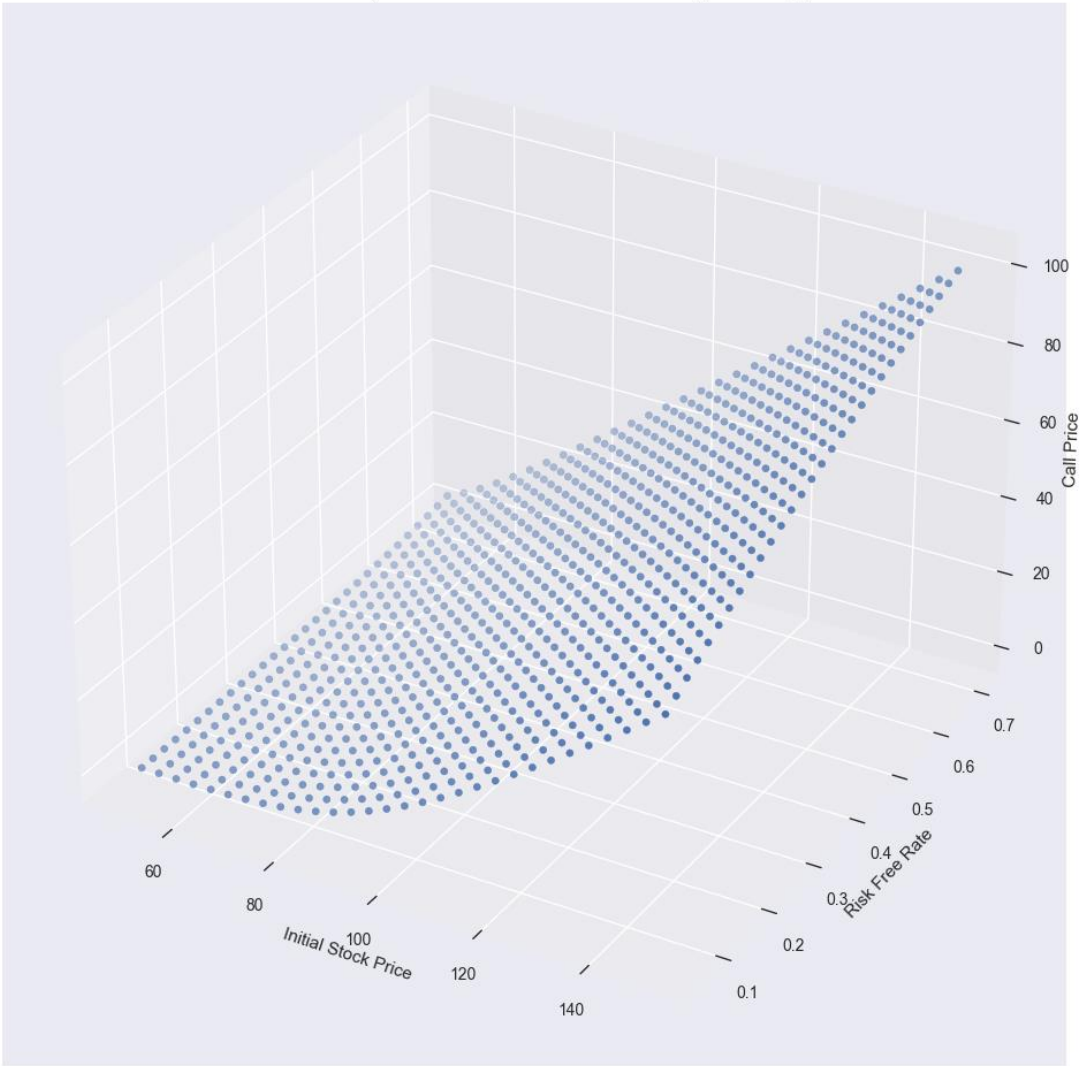
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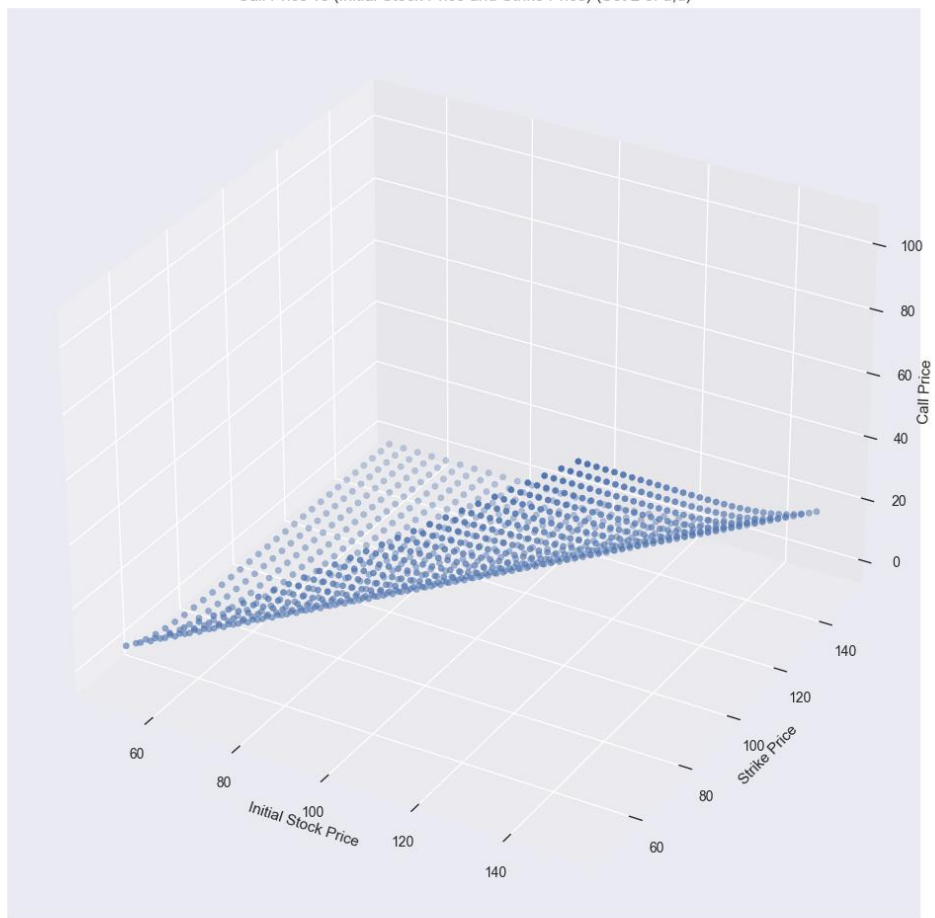
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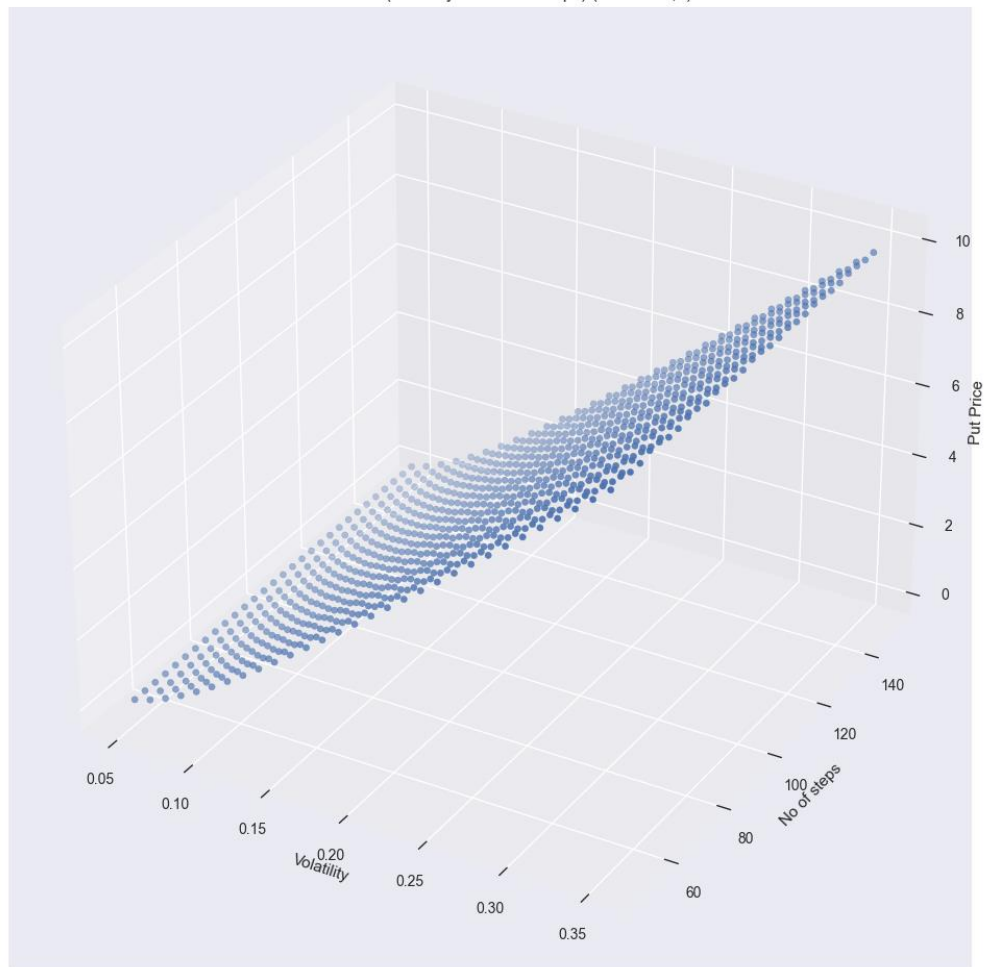
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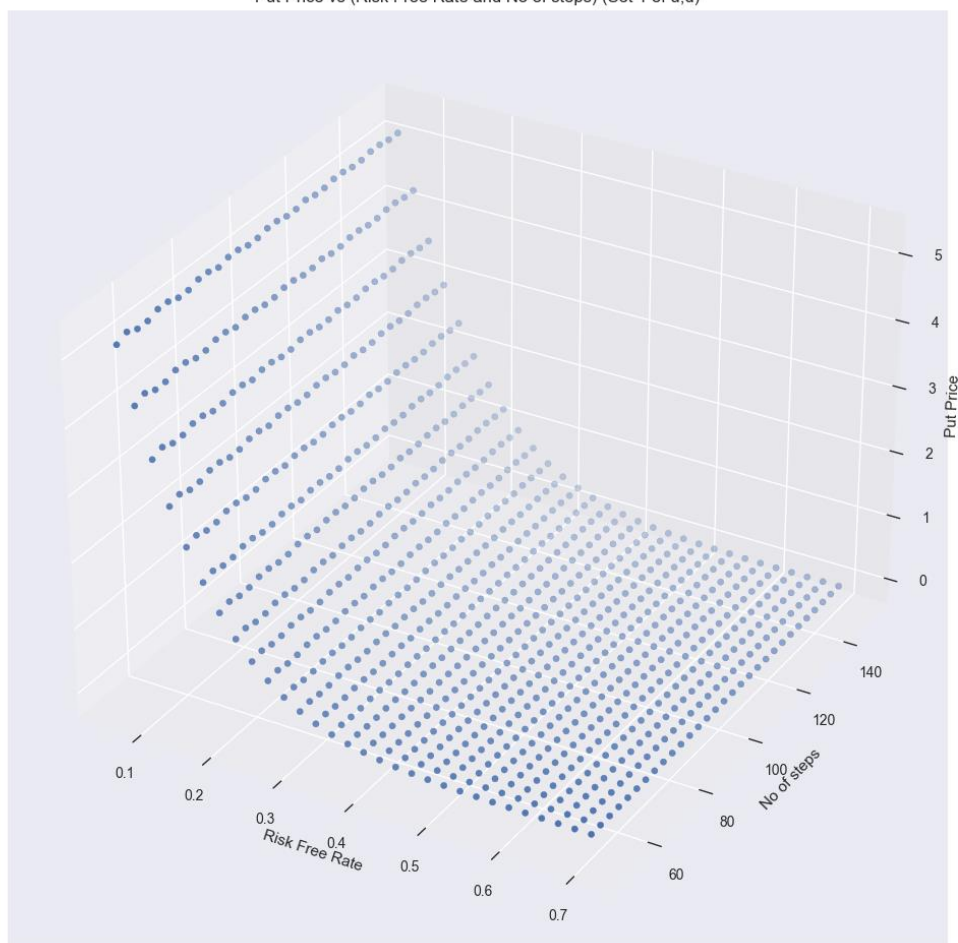
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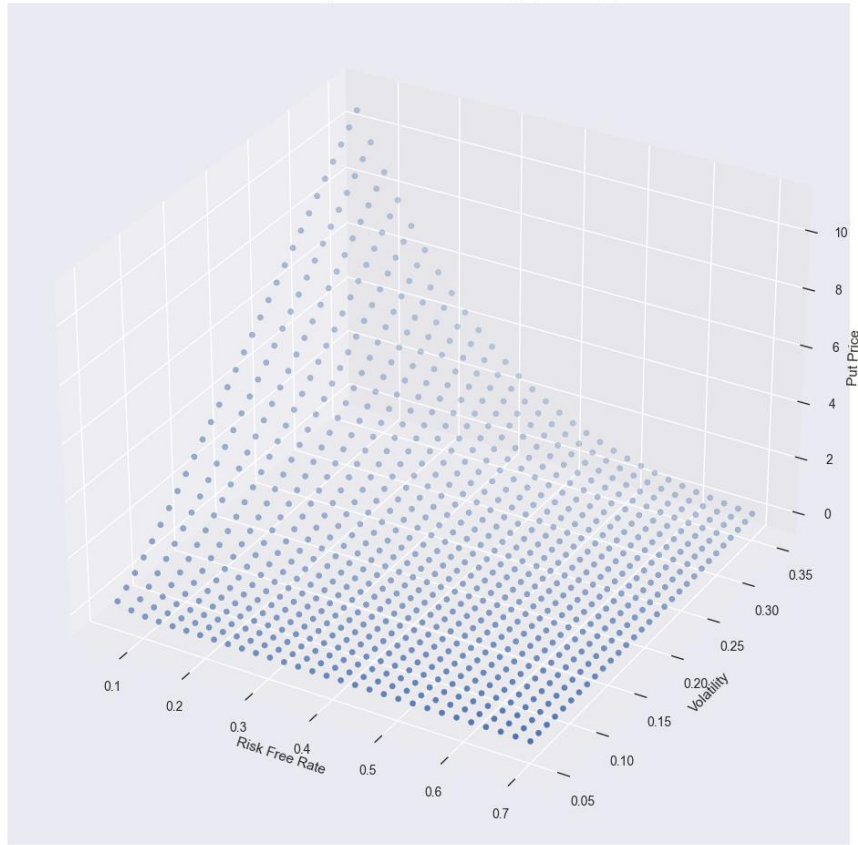
Put Price vs (Volatility and No of steps) (Set 1 of u,d)



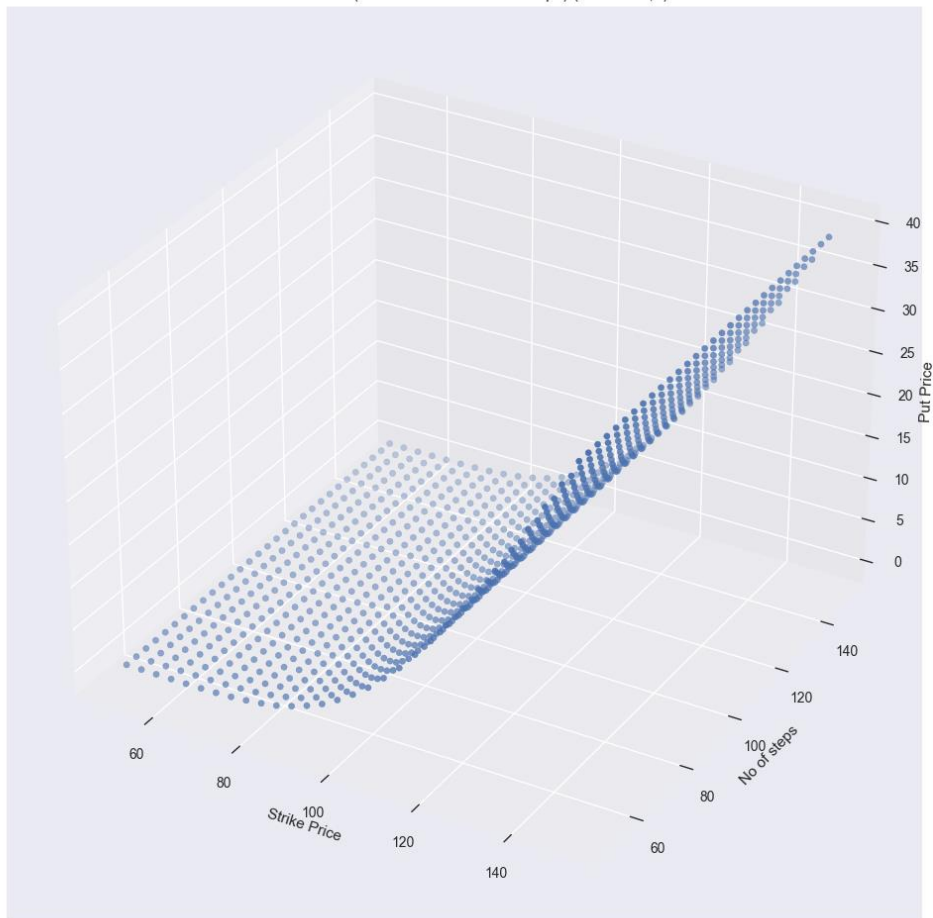
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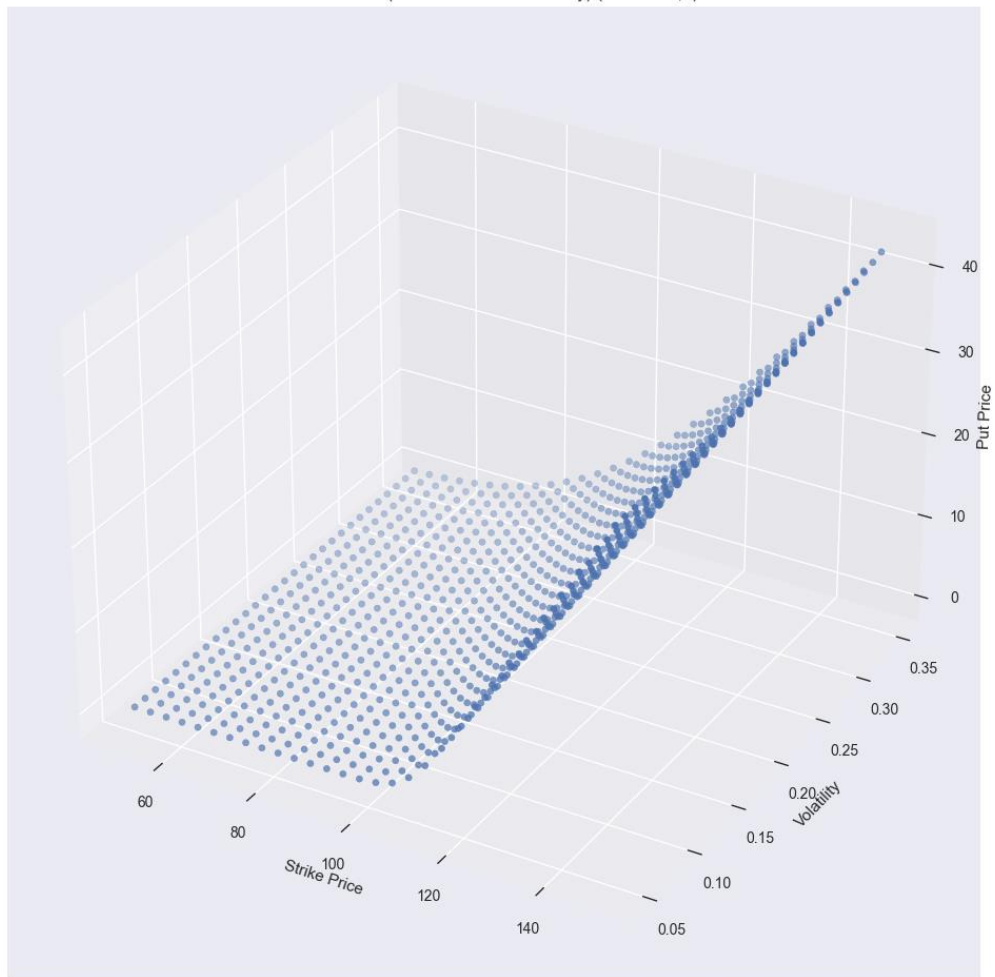
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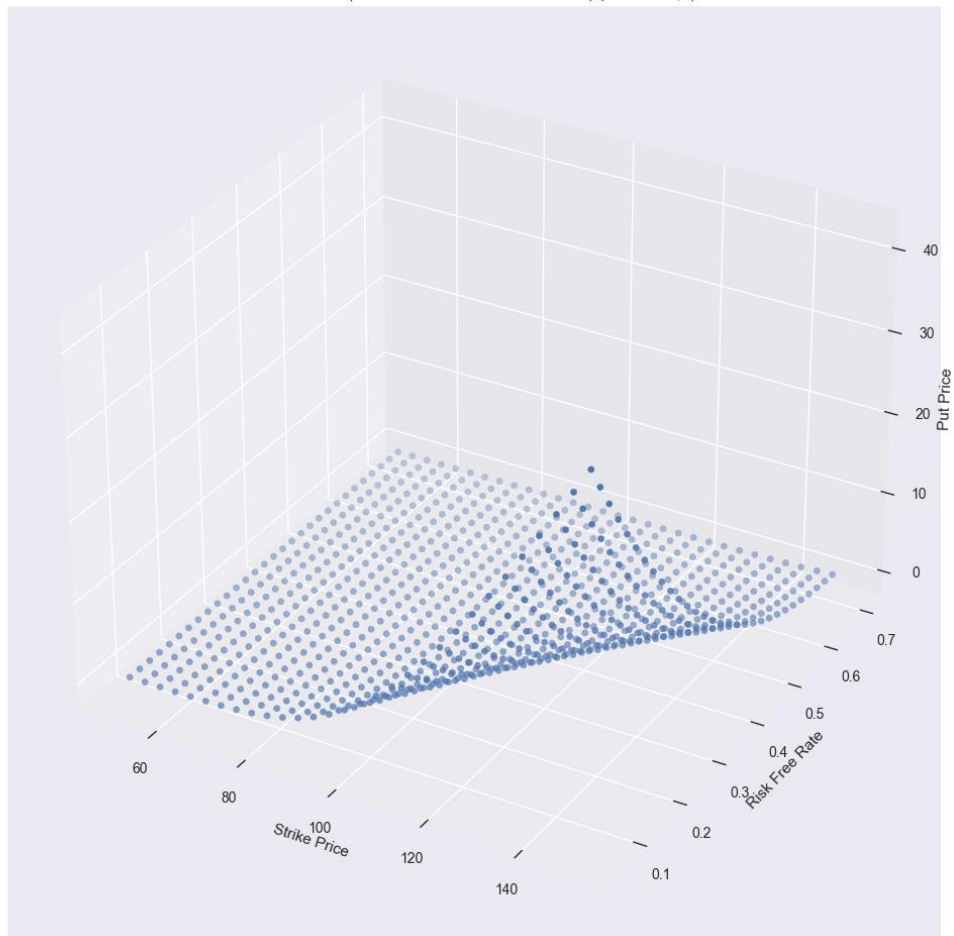
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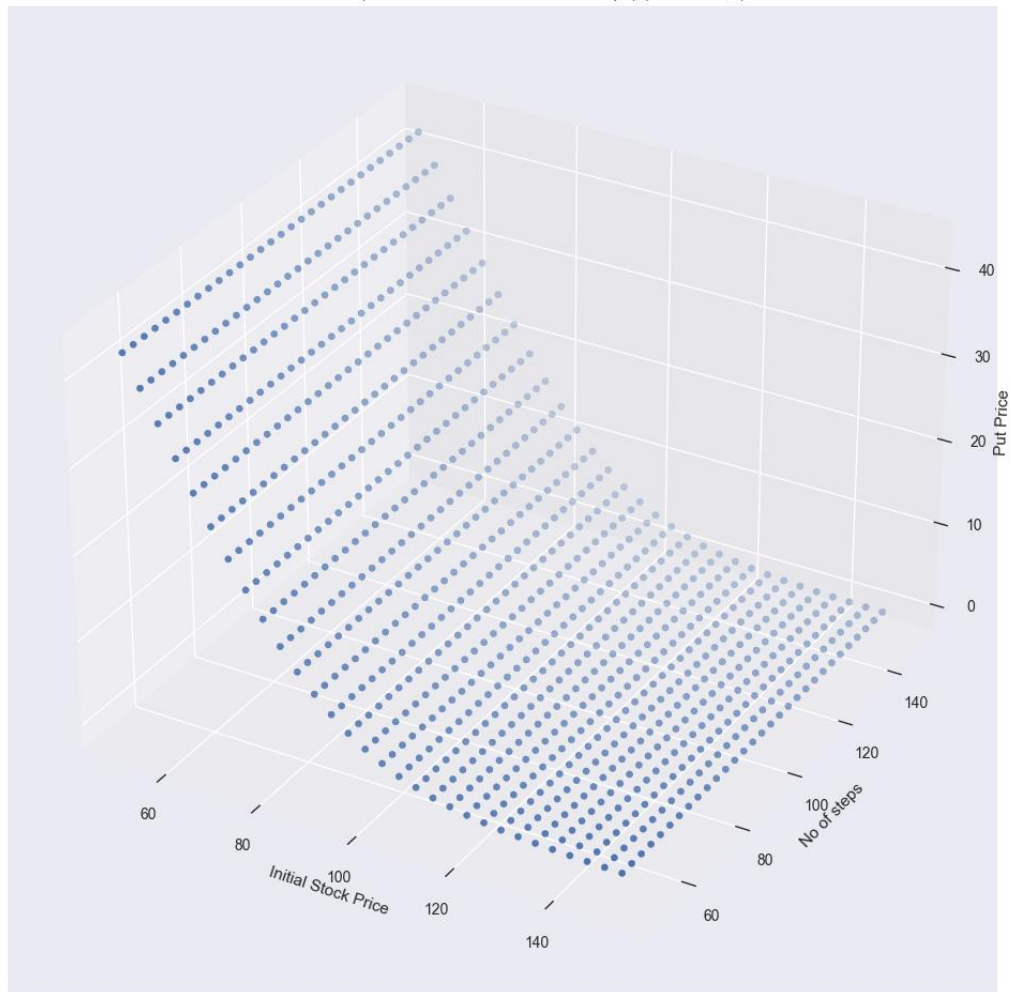
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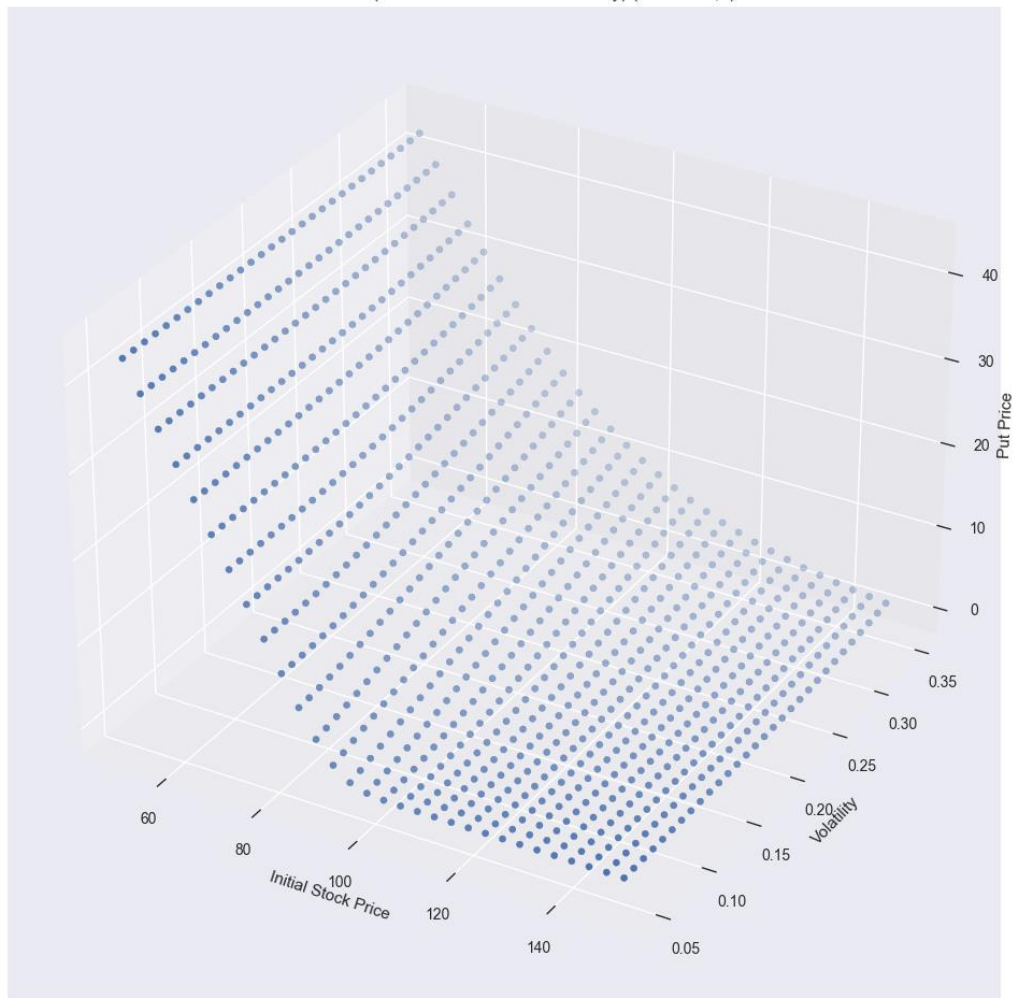
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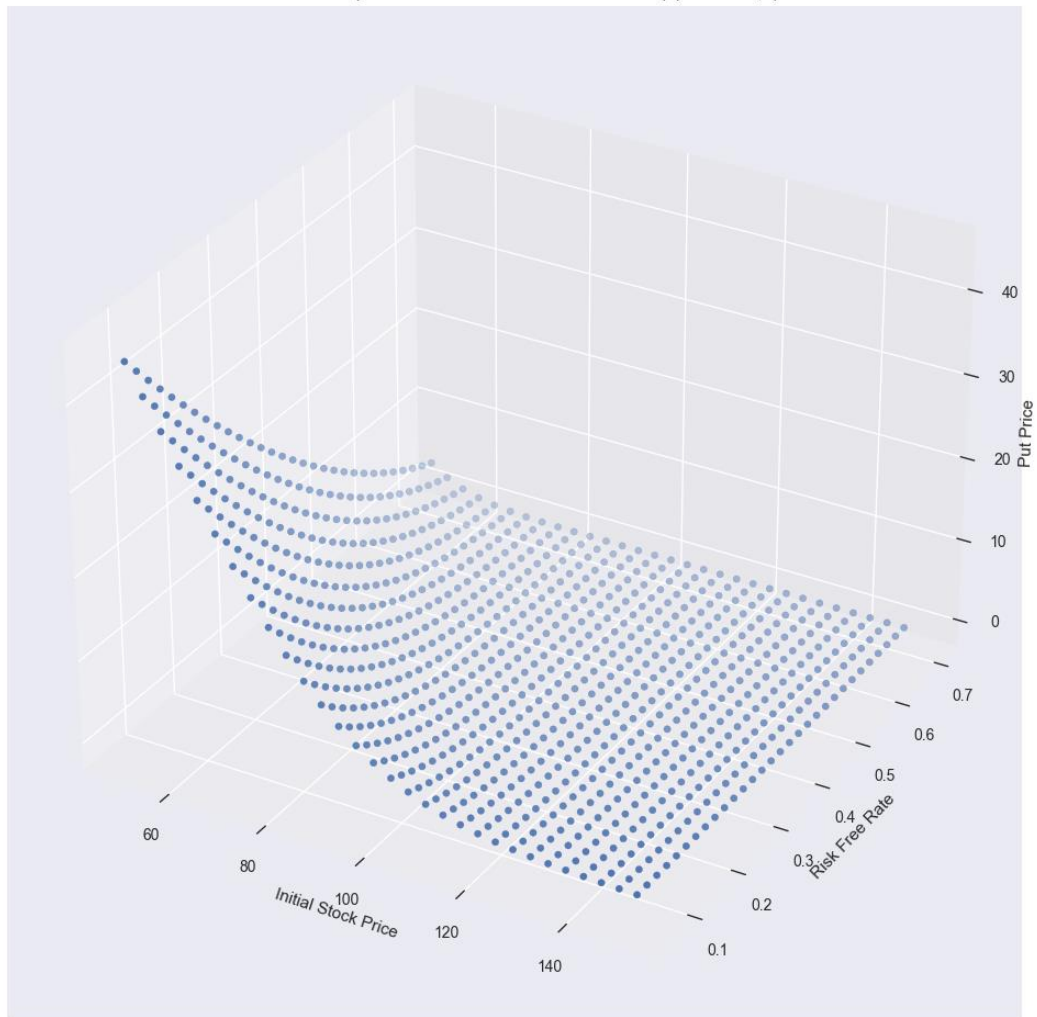
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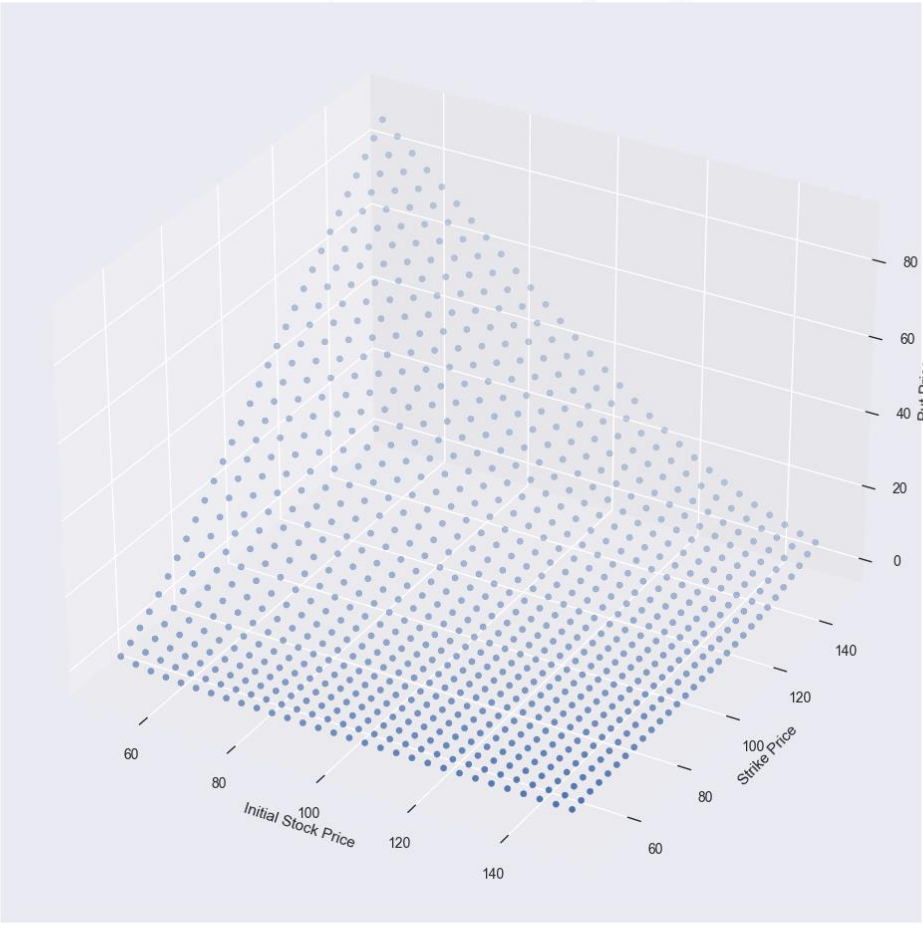
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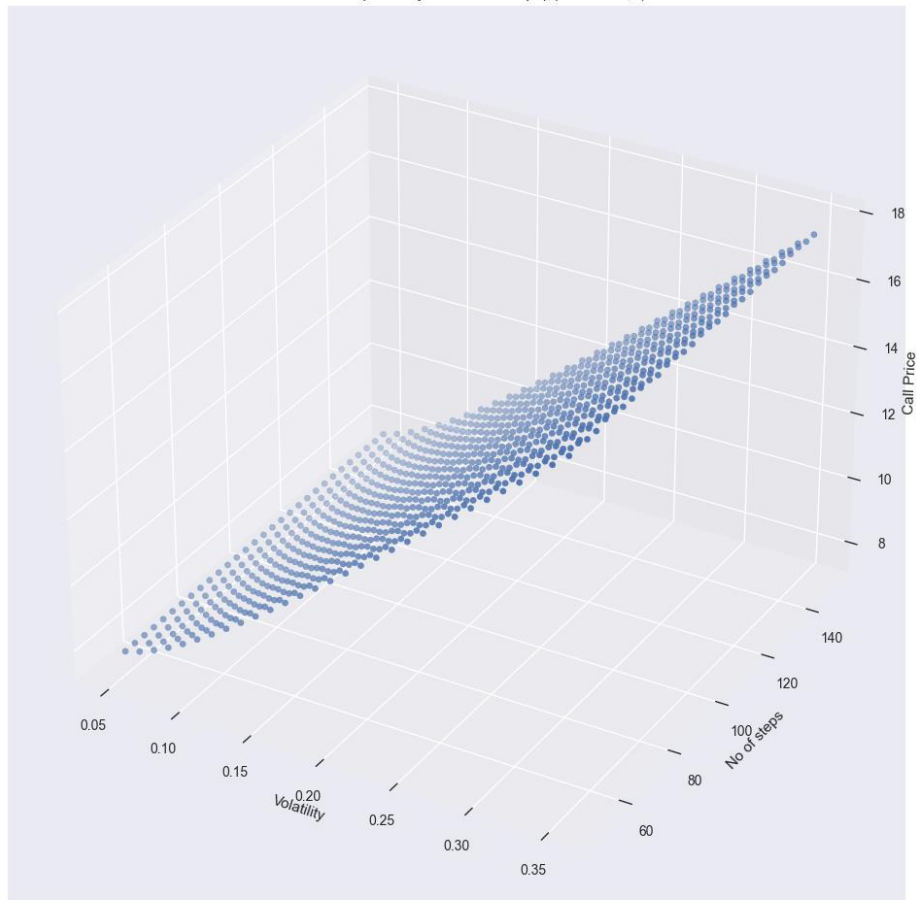
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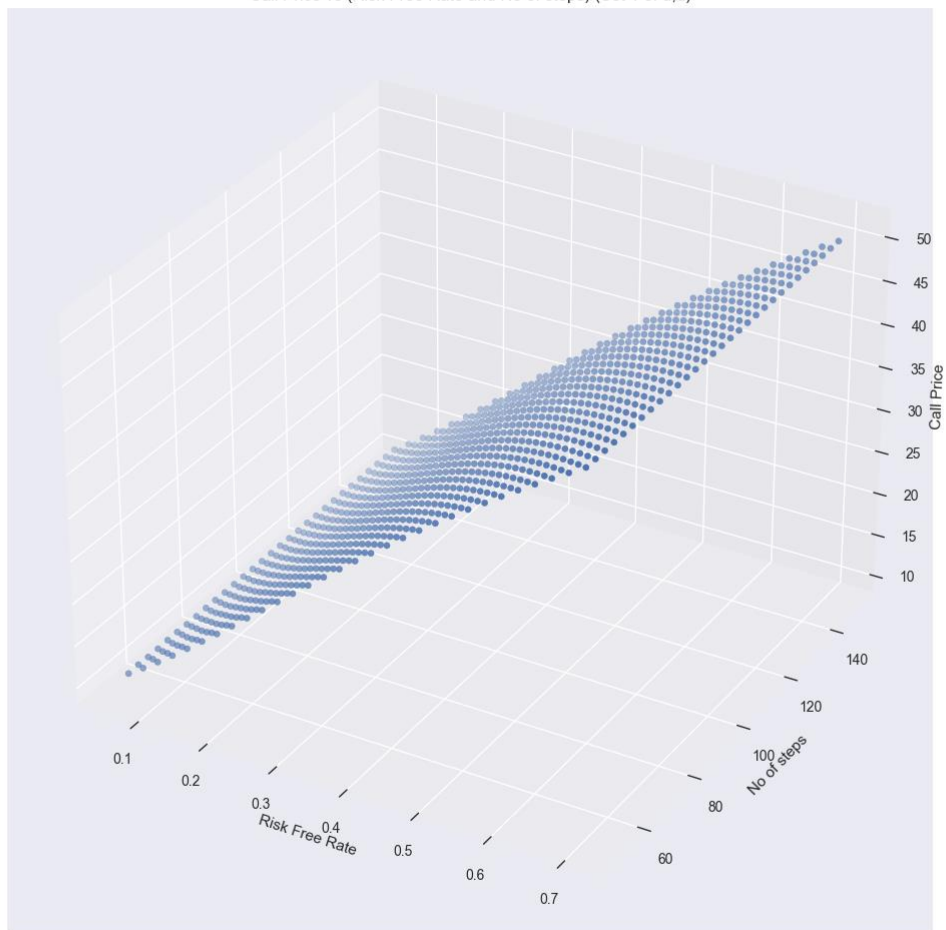
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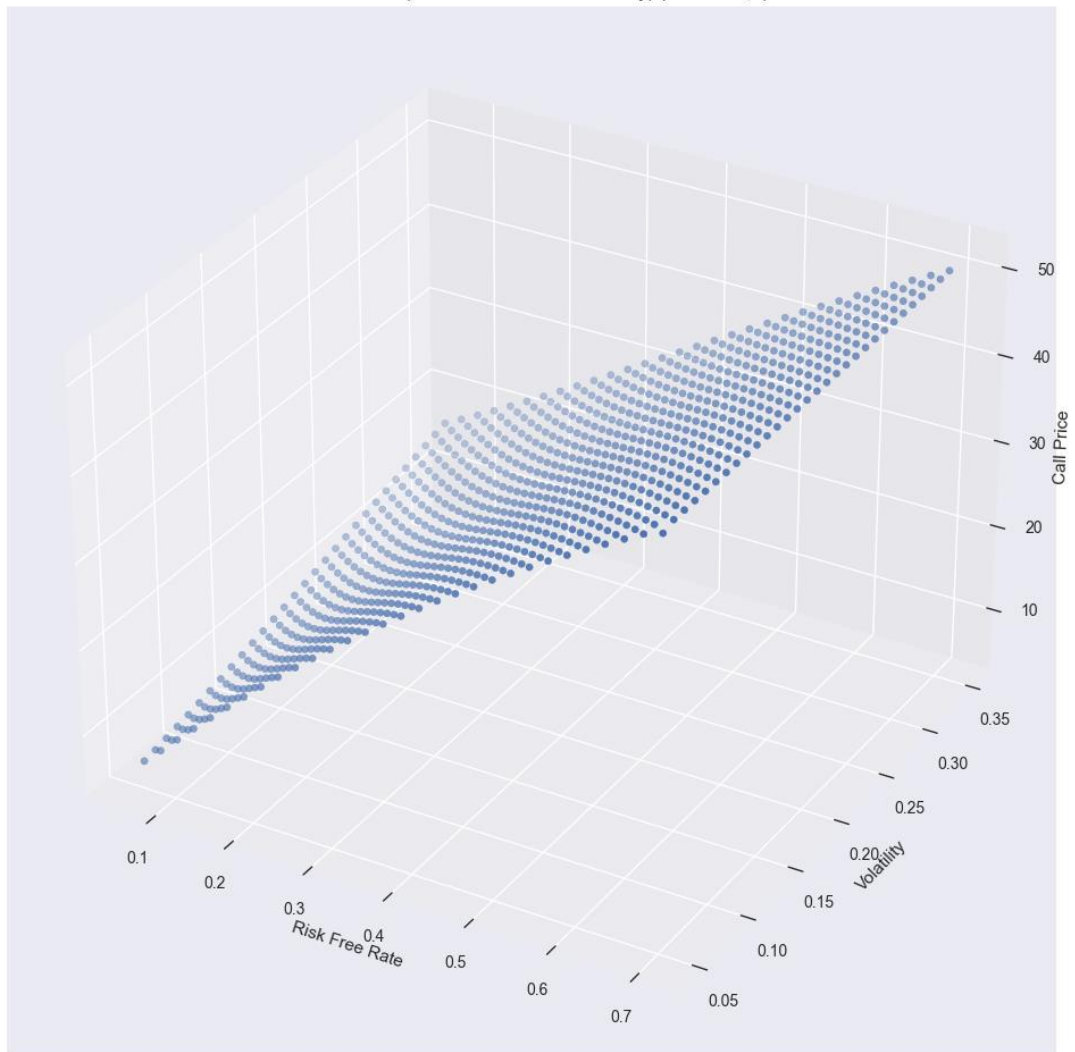
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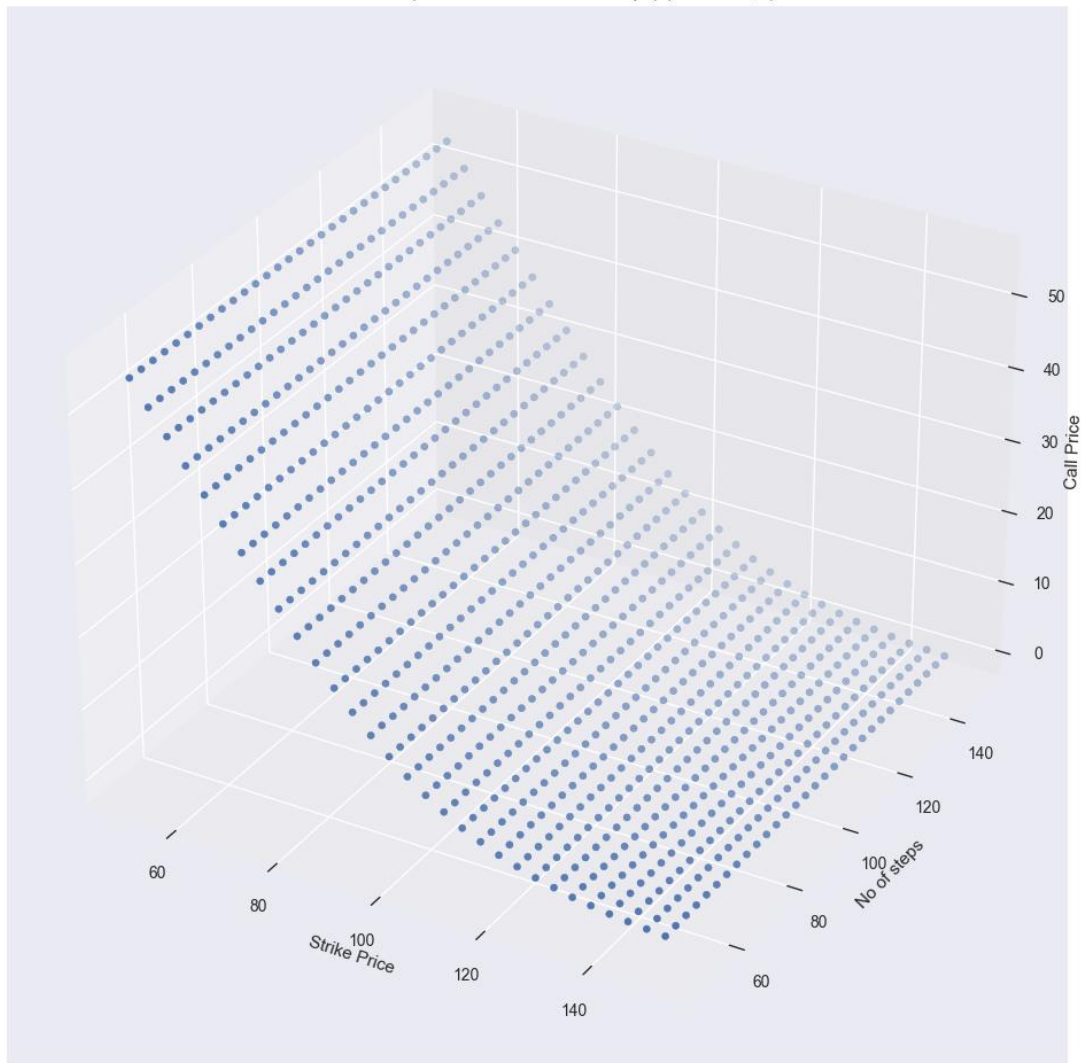
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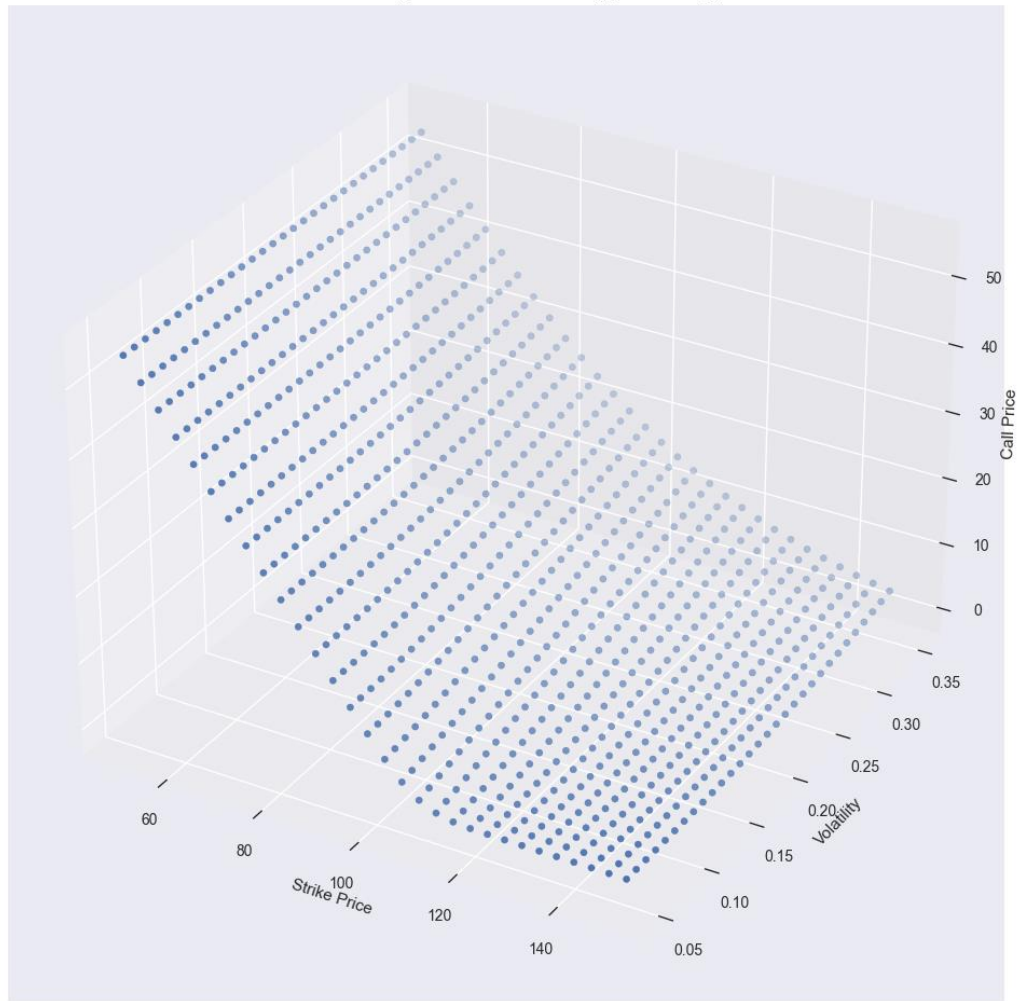
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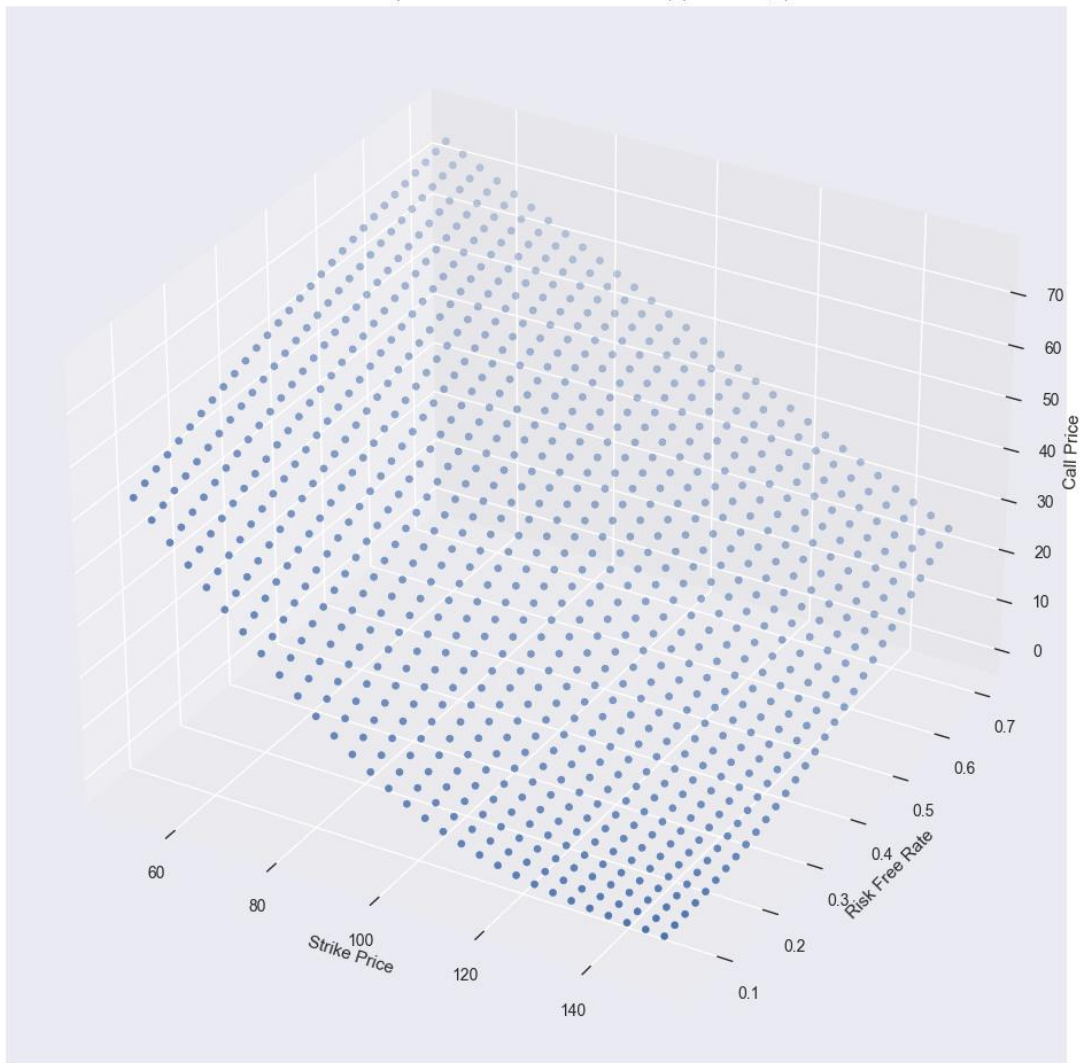
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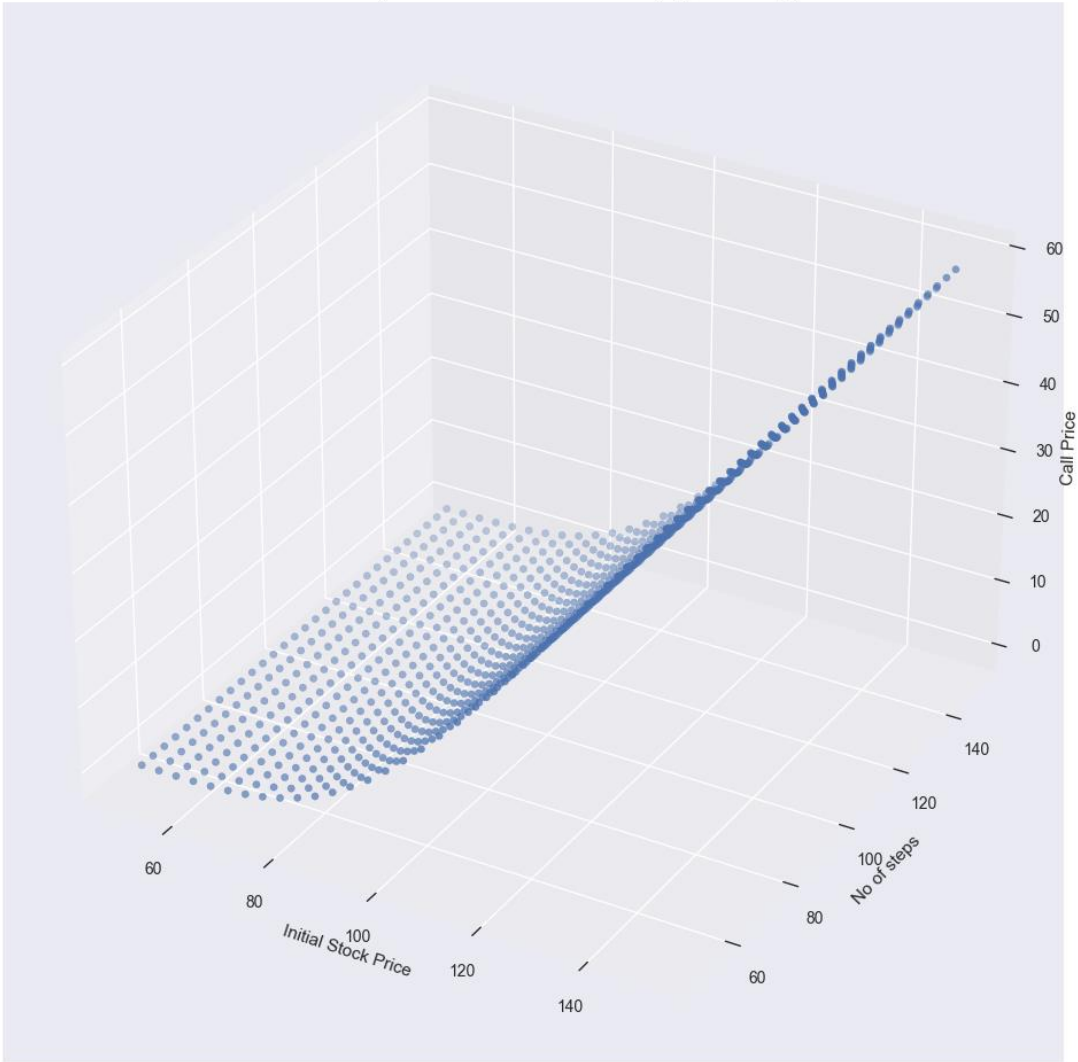
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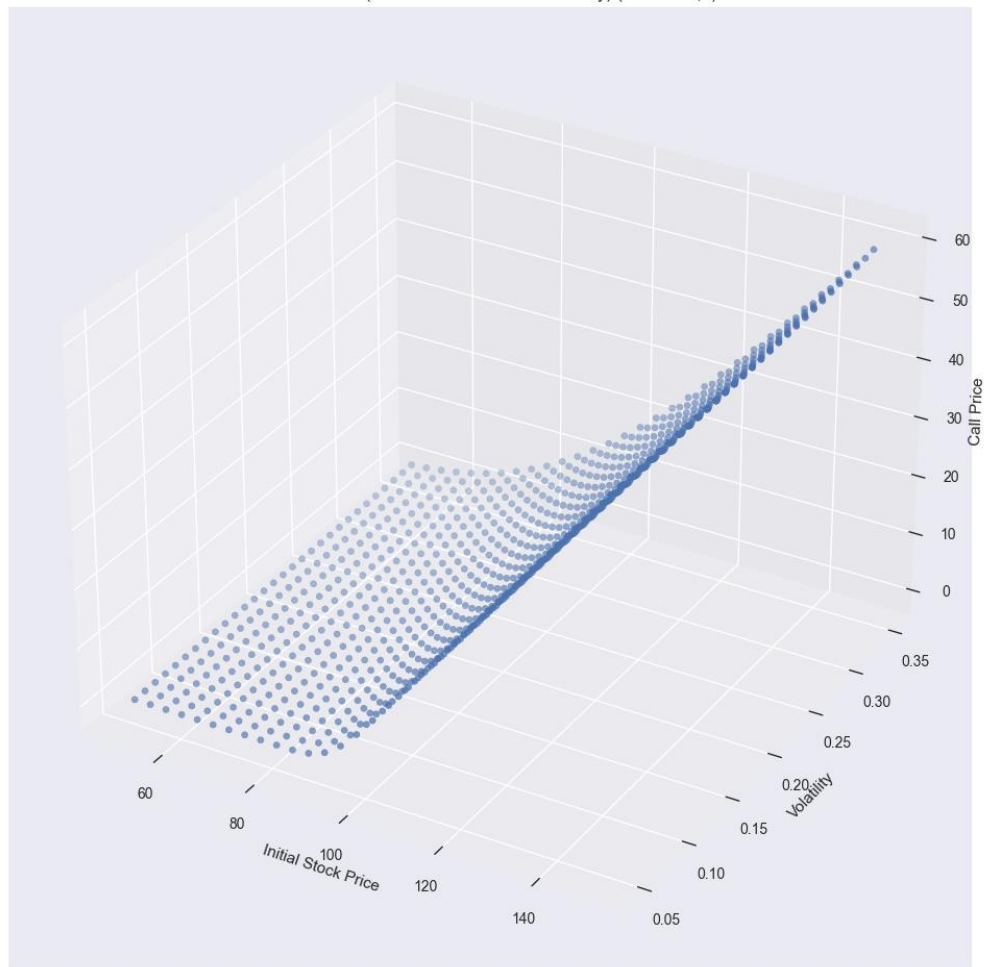
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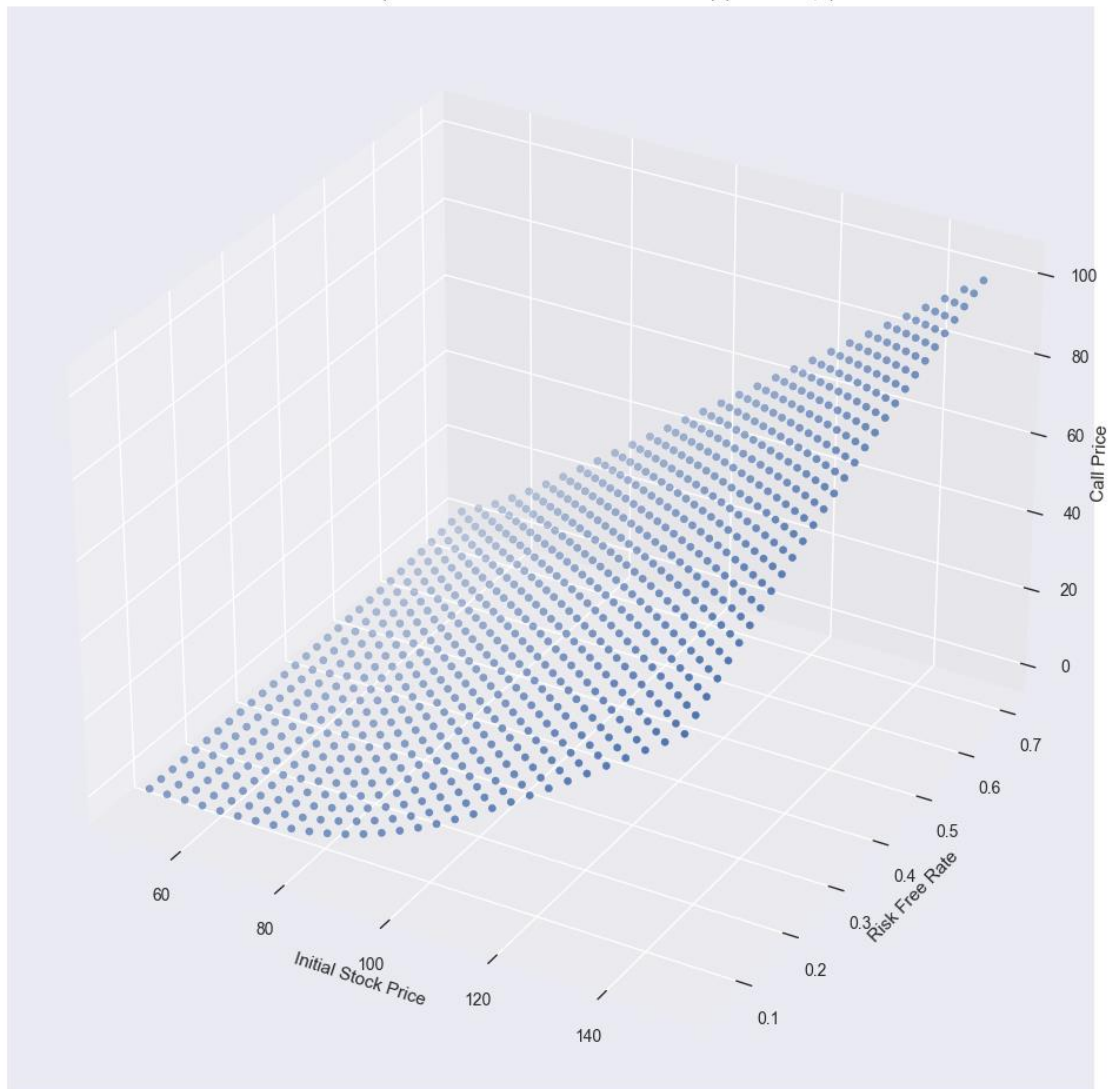
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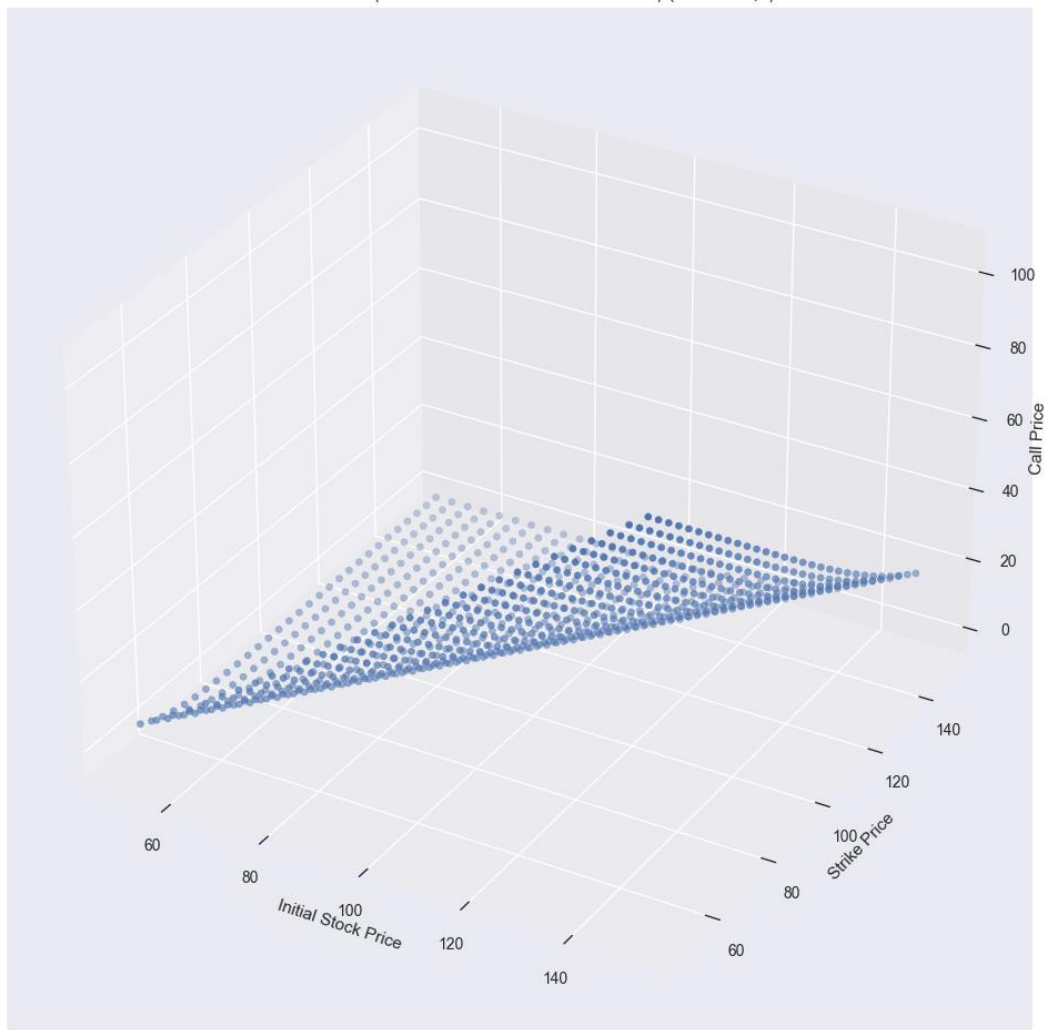
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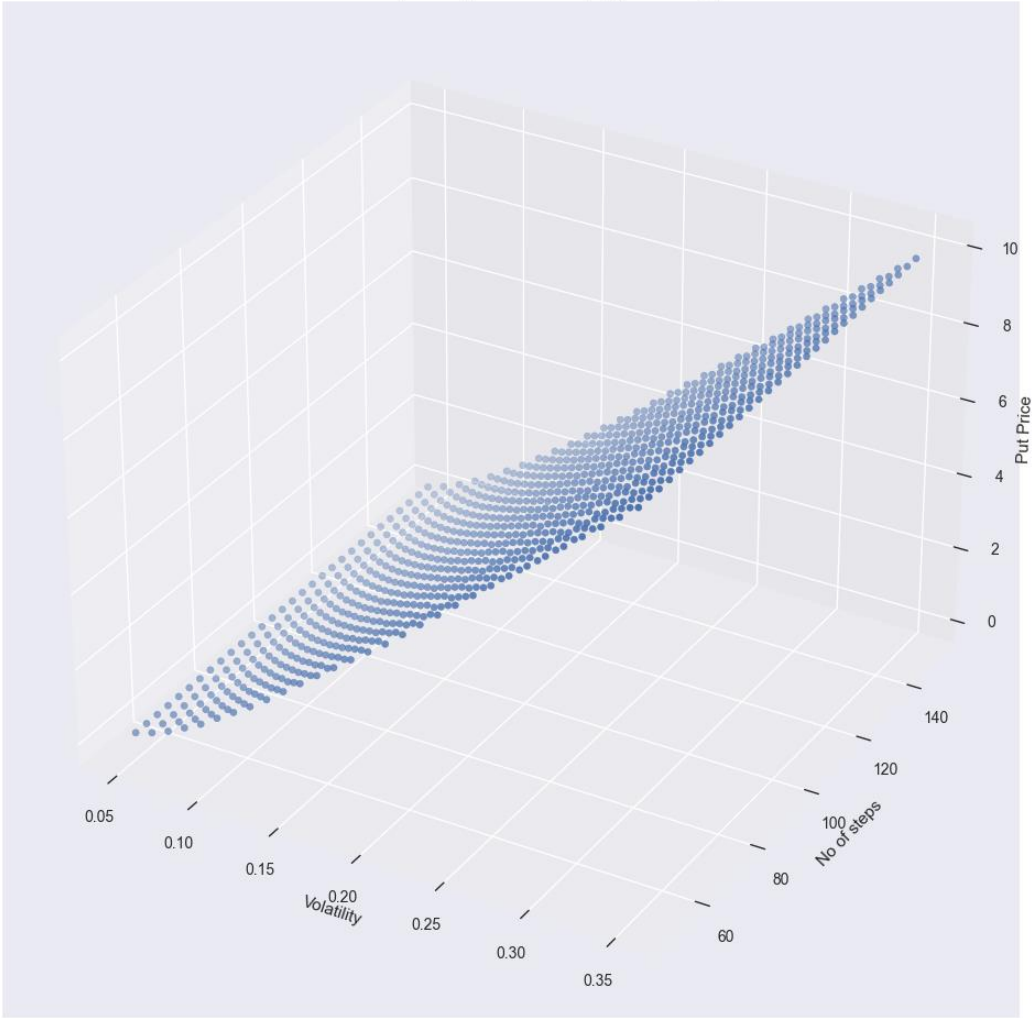
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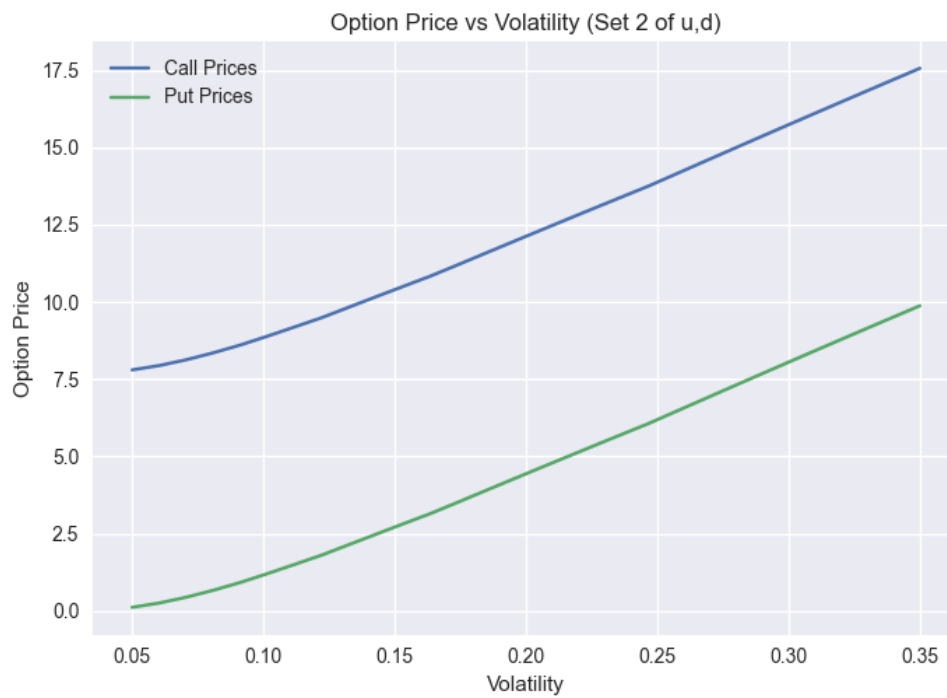
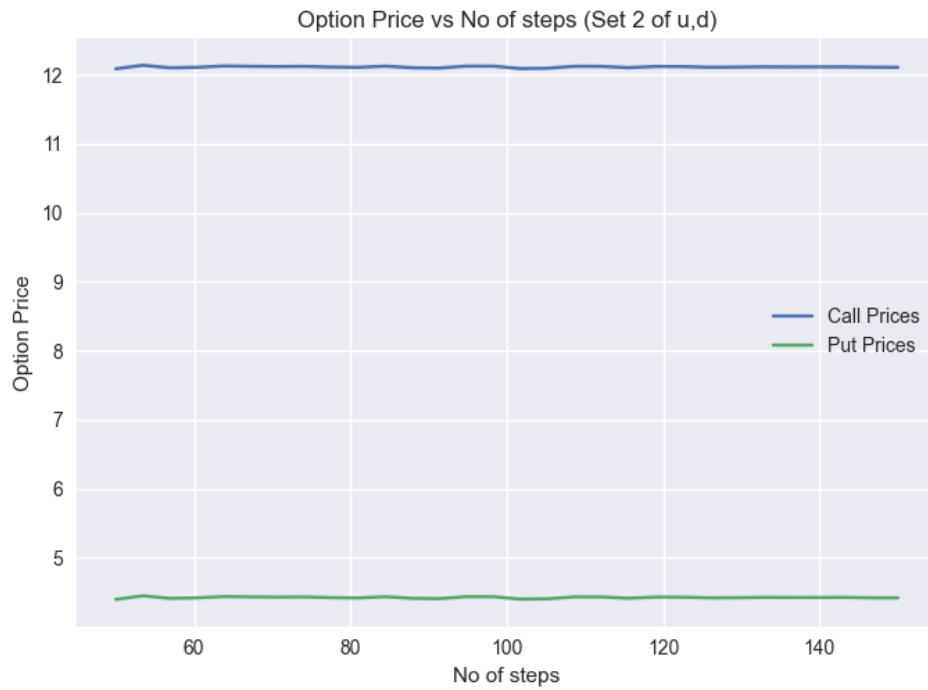
Call Price vs (Initial Stock Price and Strike Price) (Set 1 of u,d)



Put Price vs (Volatility and No of steps) (Set 2 of u,d)

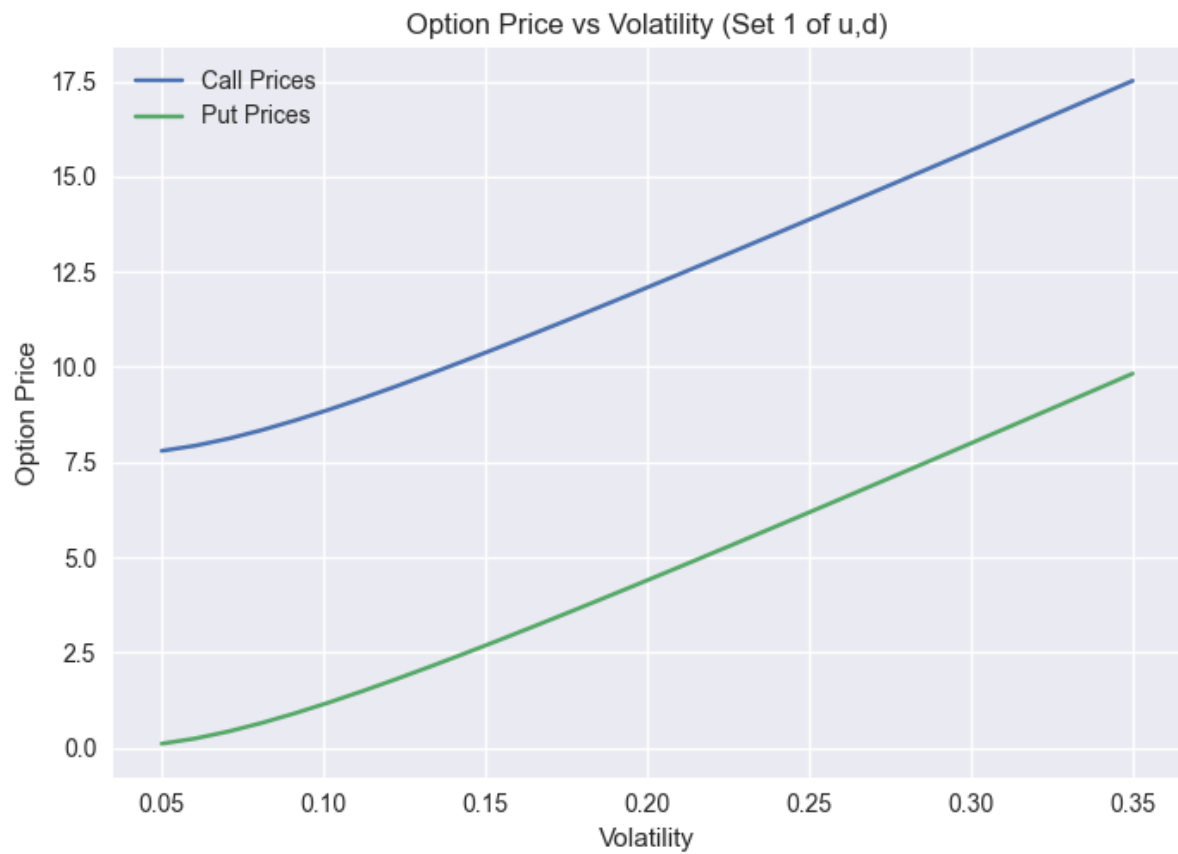
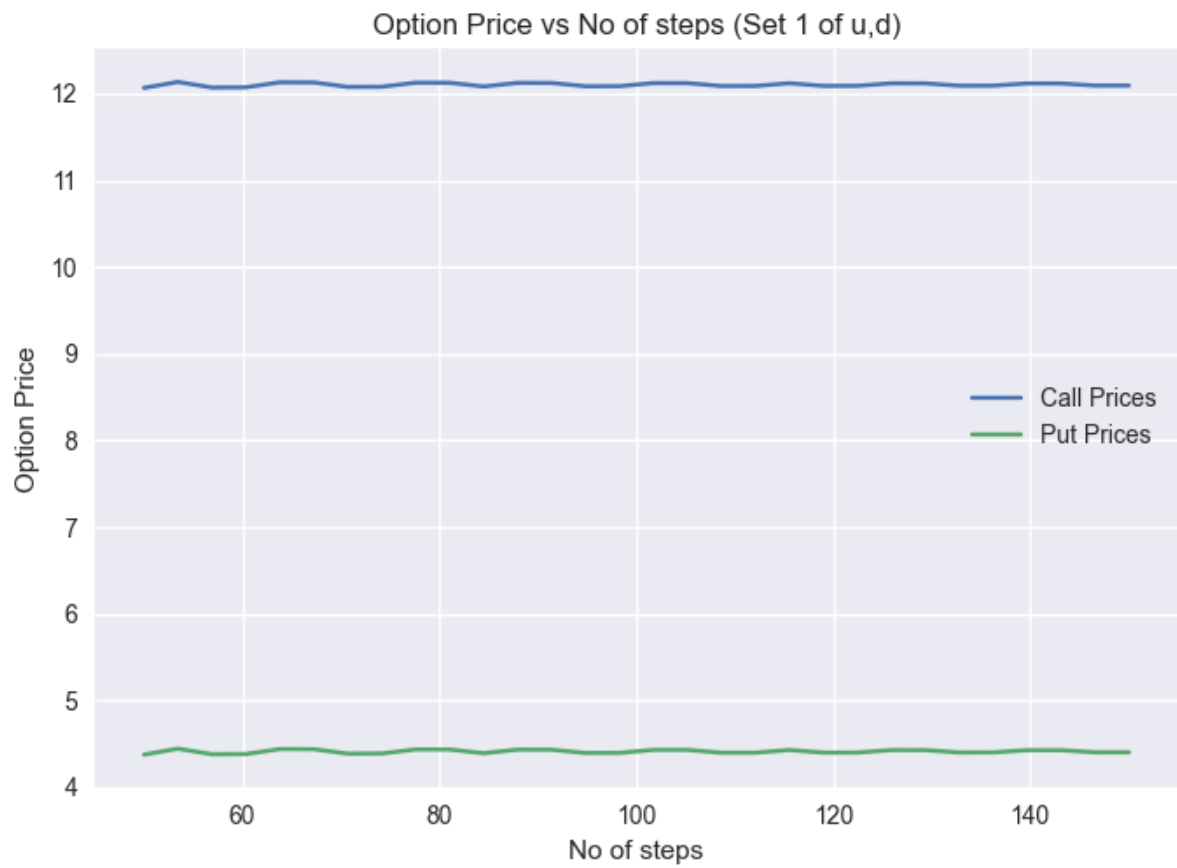


Question 2 Plots

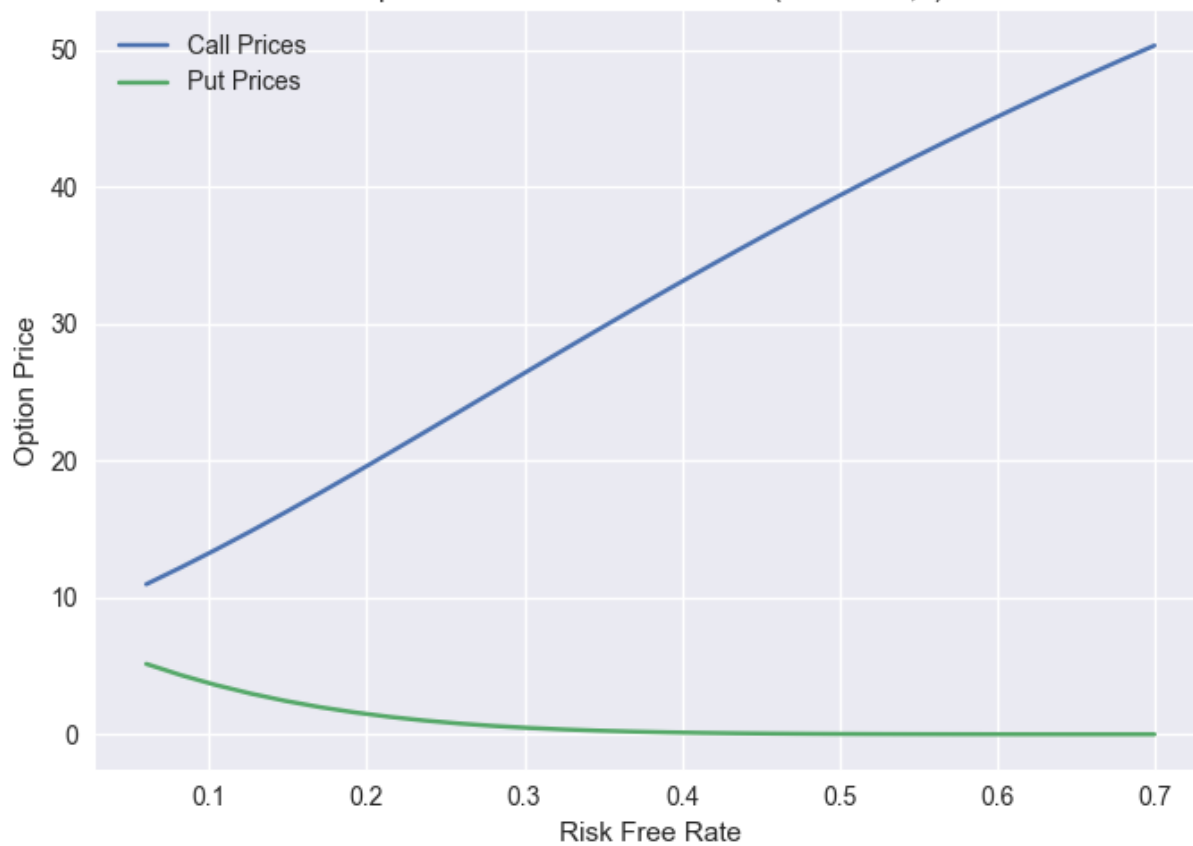




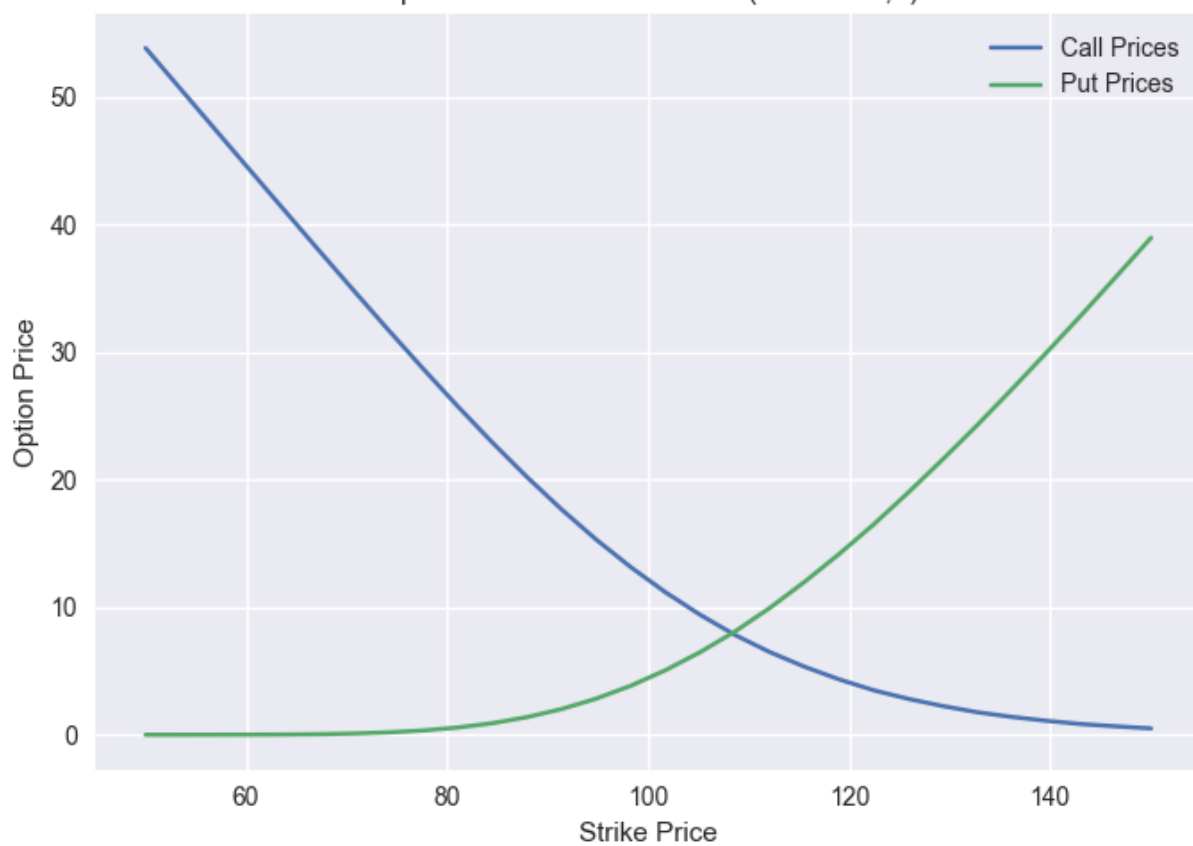


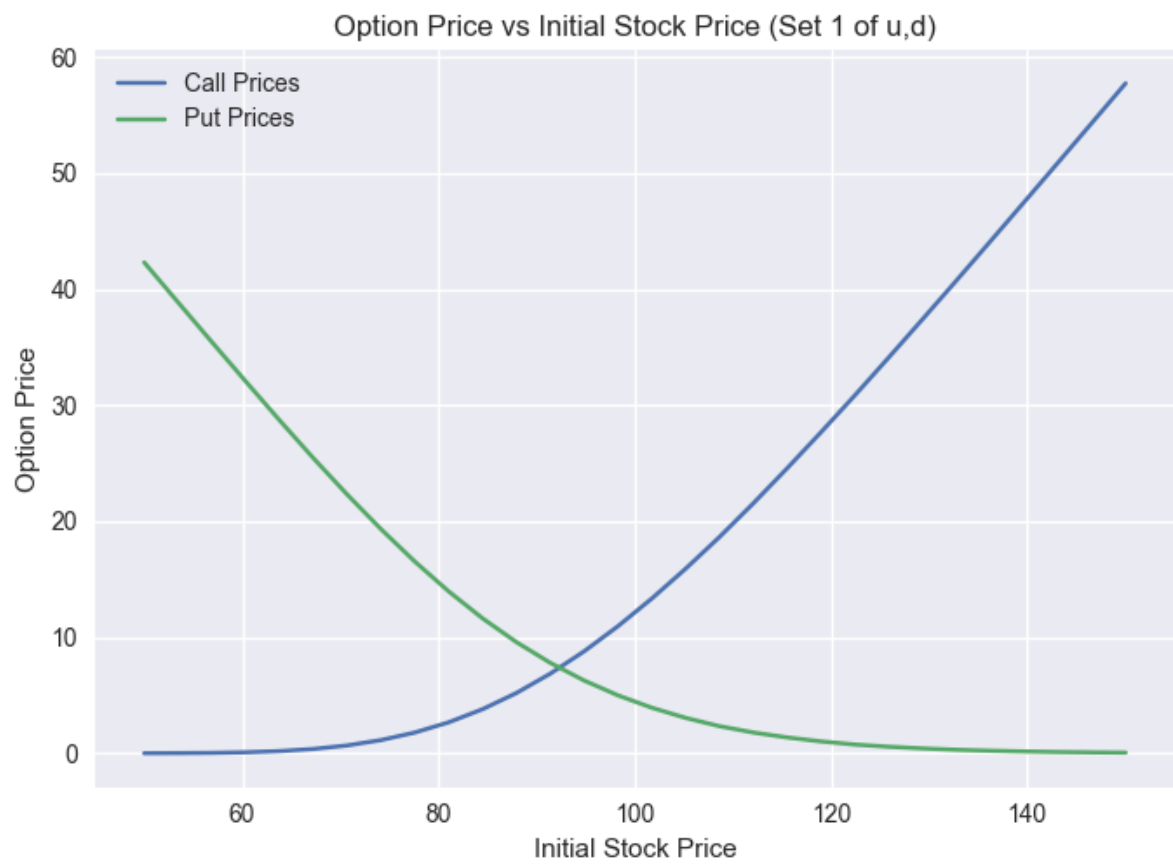


Option Price vs Risk Free Rate (Set 1 of u,d)



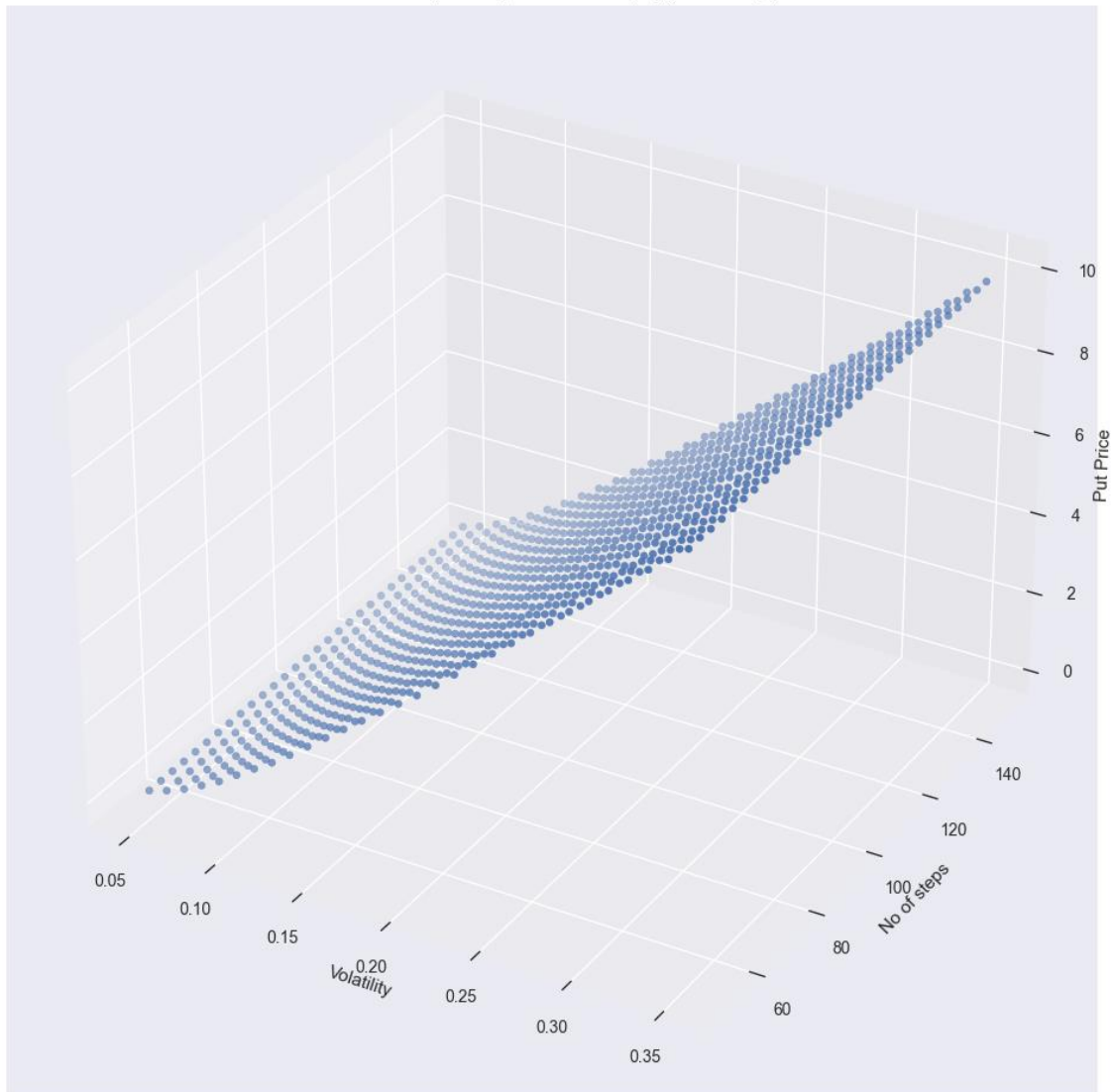
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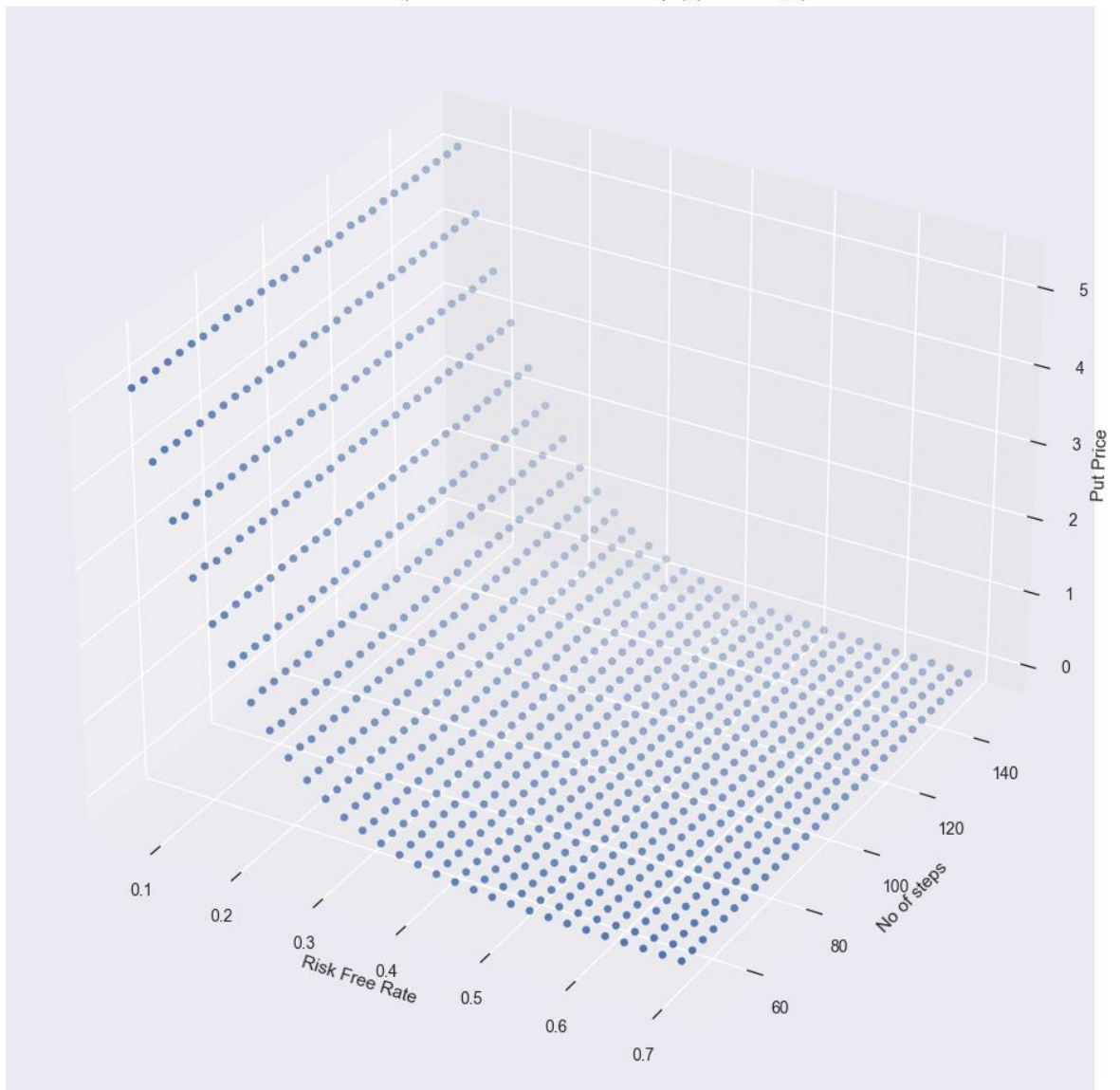


3D Plots

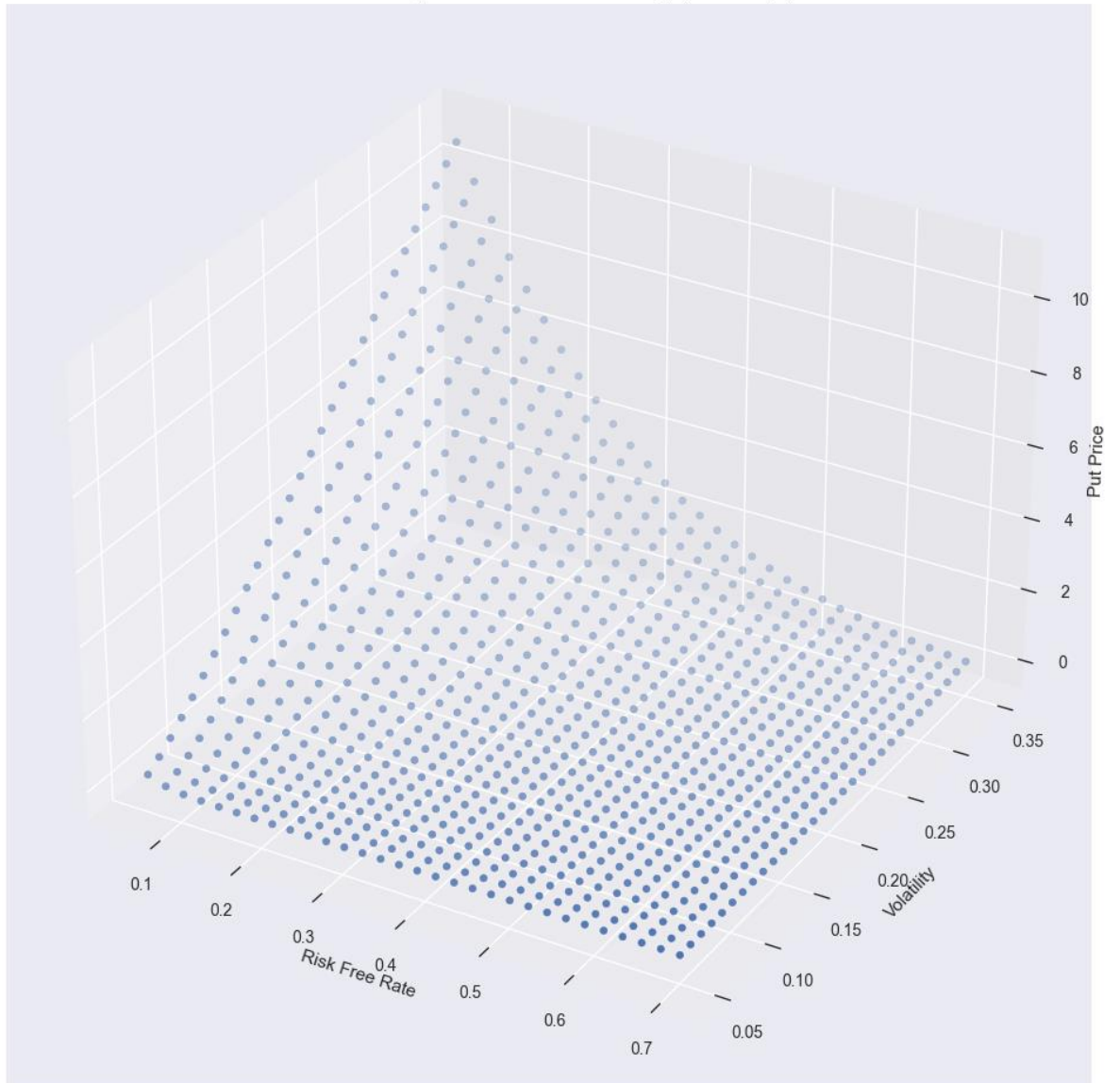
Put Price vs (Volatility and No of steps) (Set 2 of u,d)



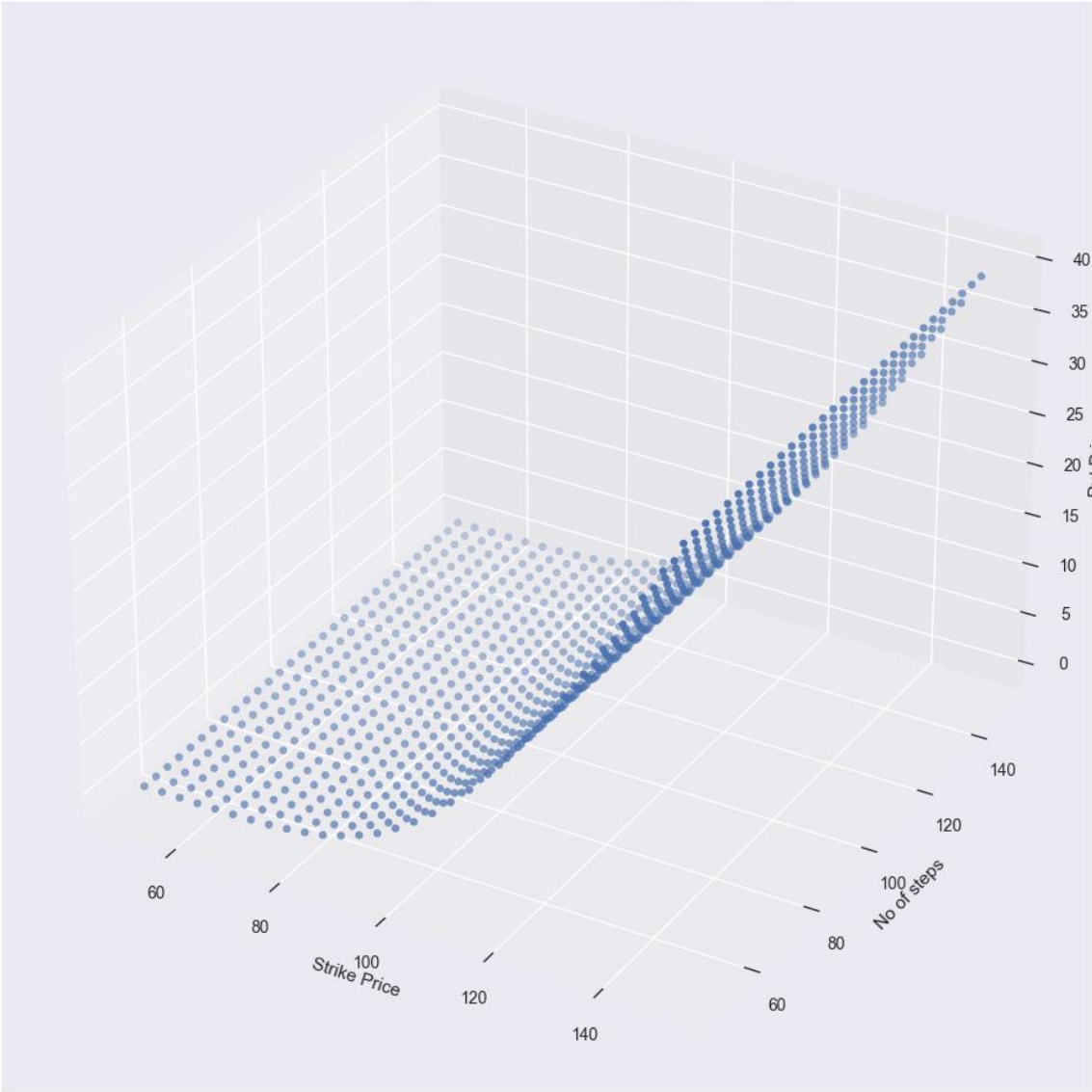
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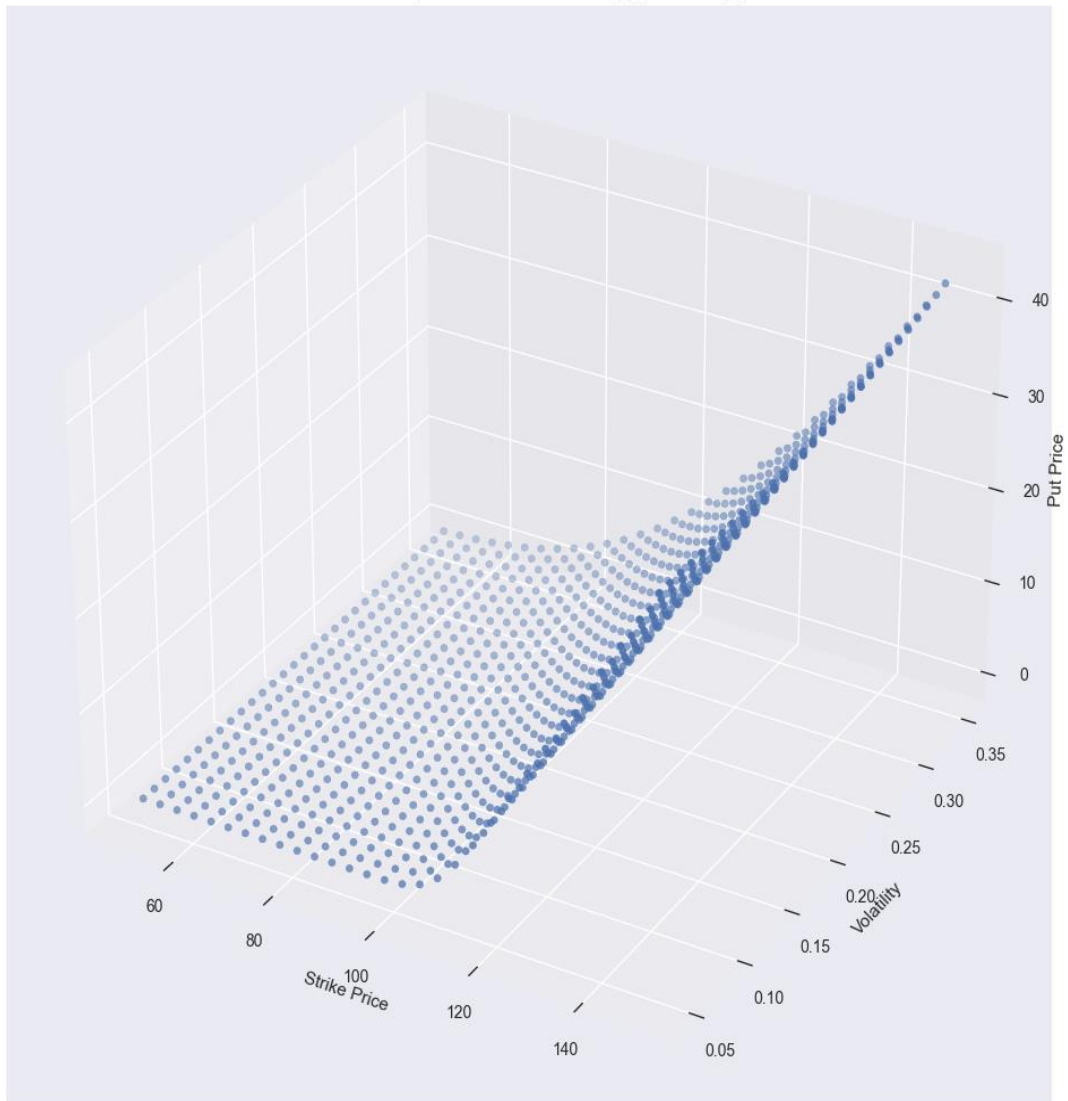
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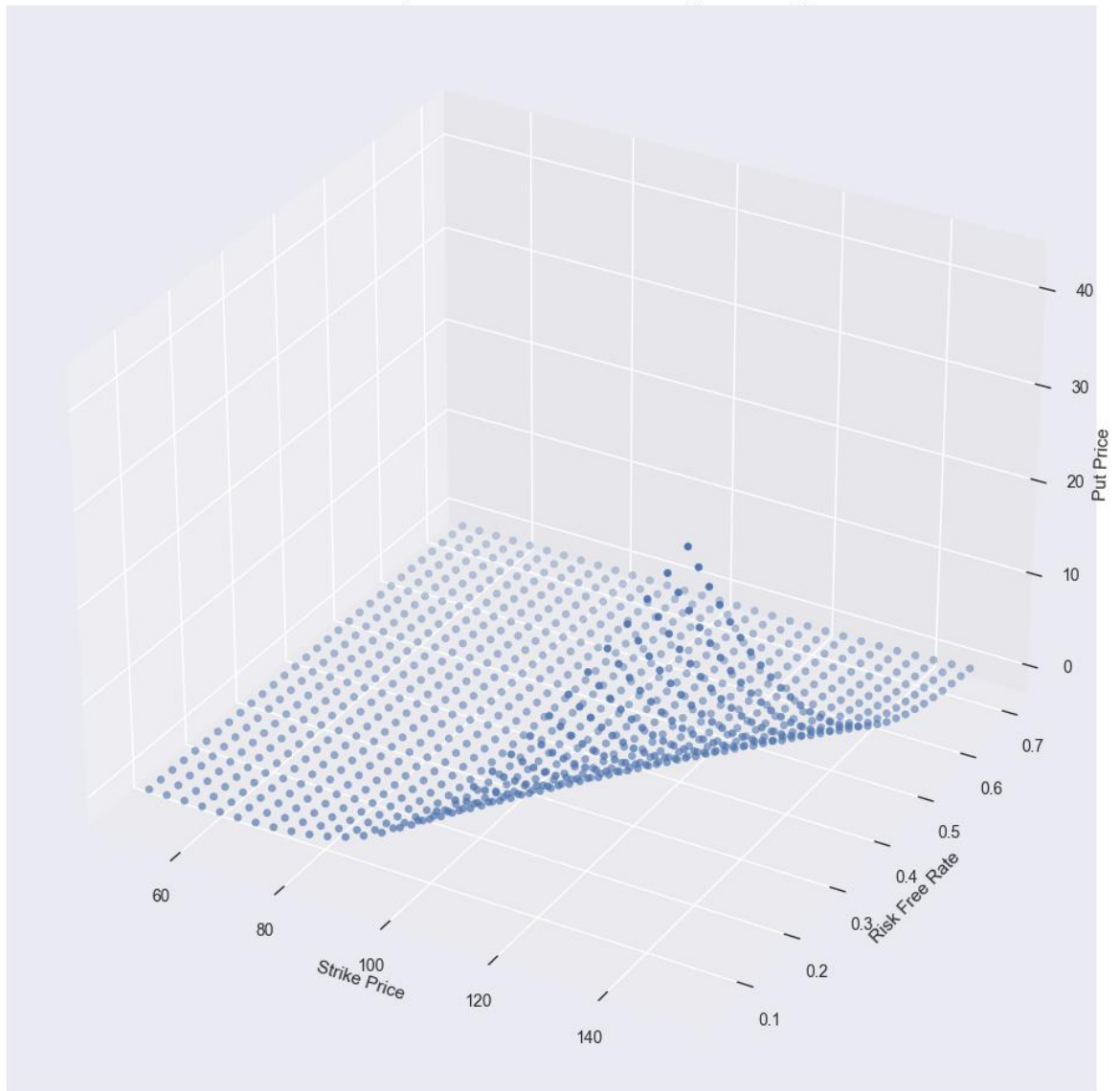
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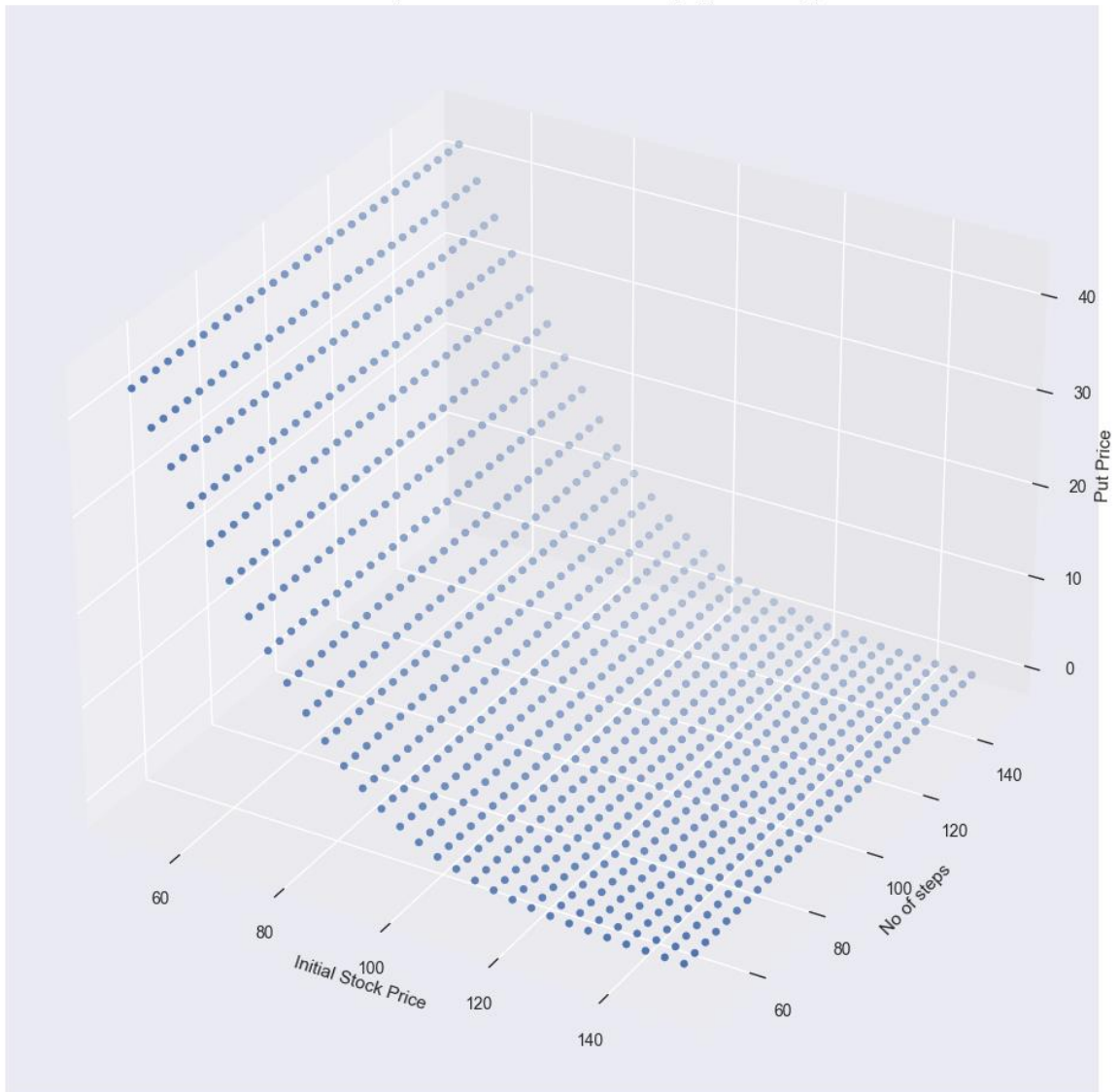
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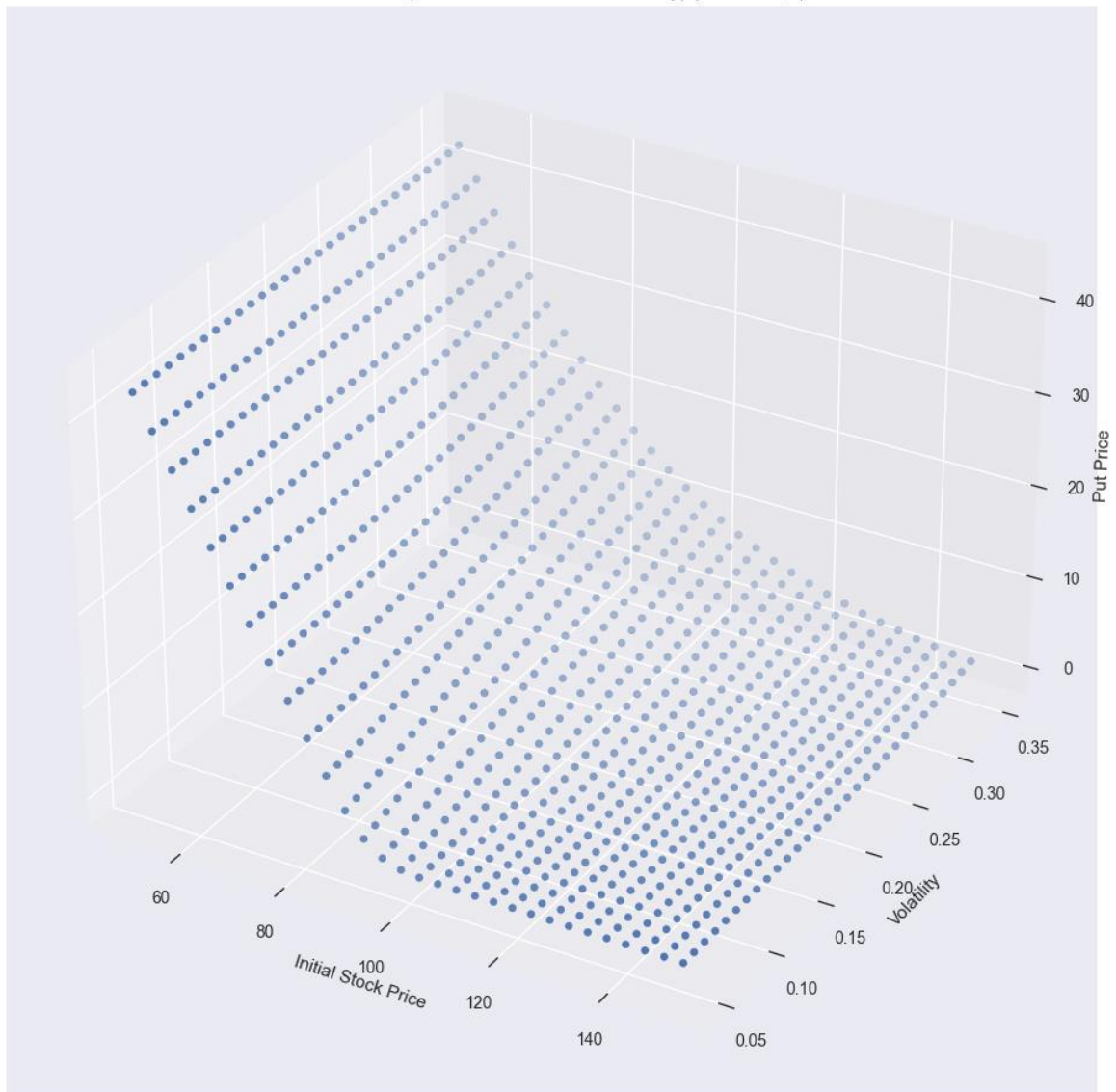
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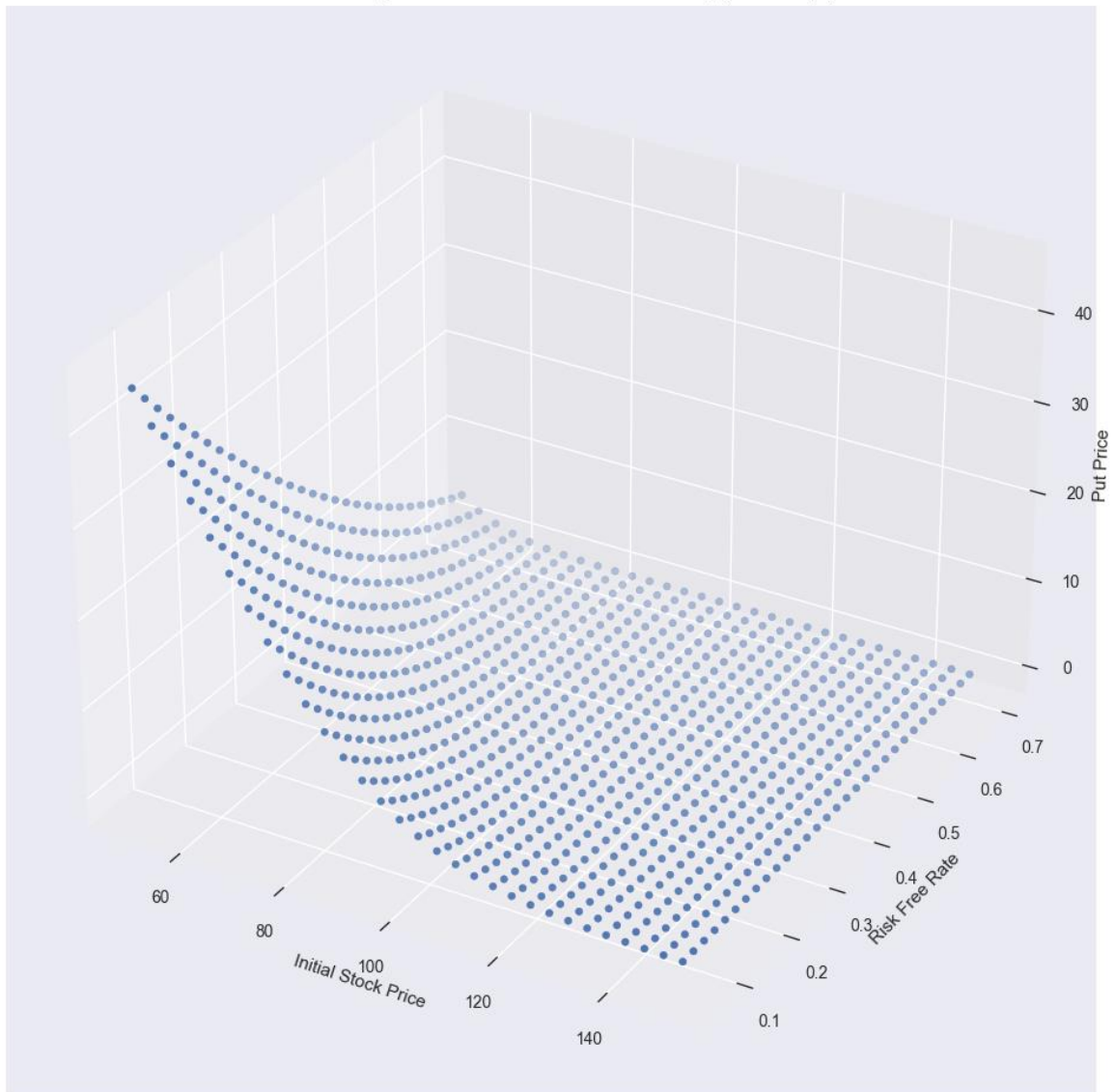
Put Price vs (Initial Stock Price and No of steps) (Set 2 of u,d)



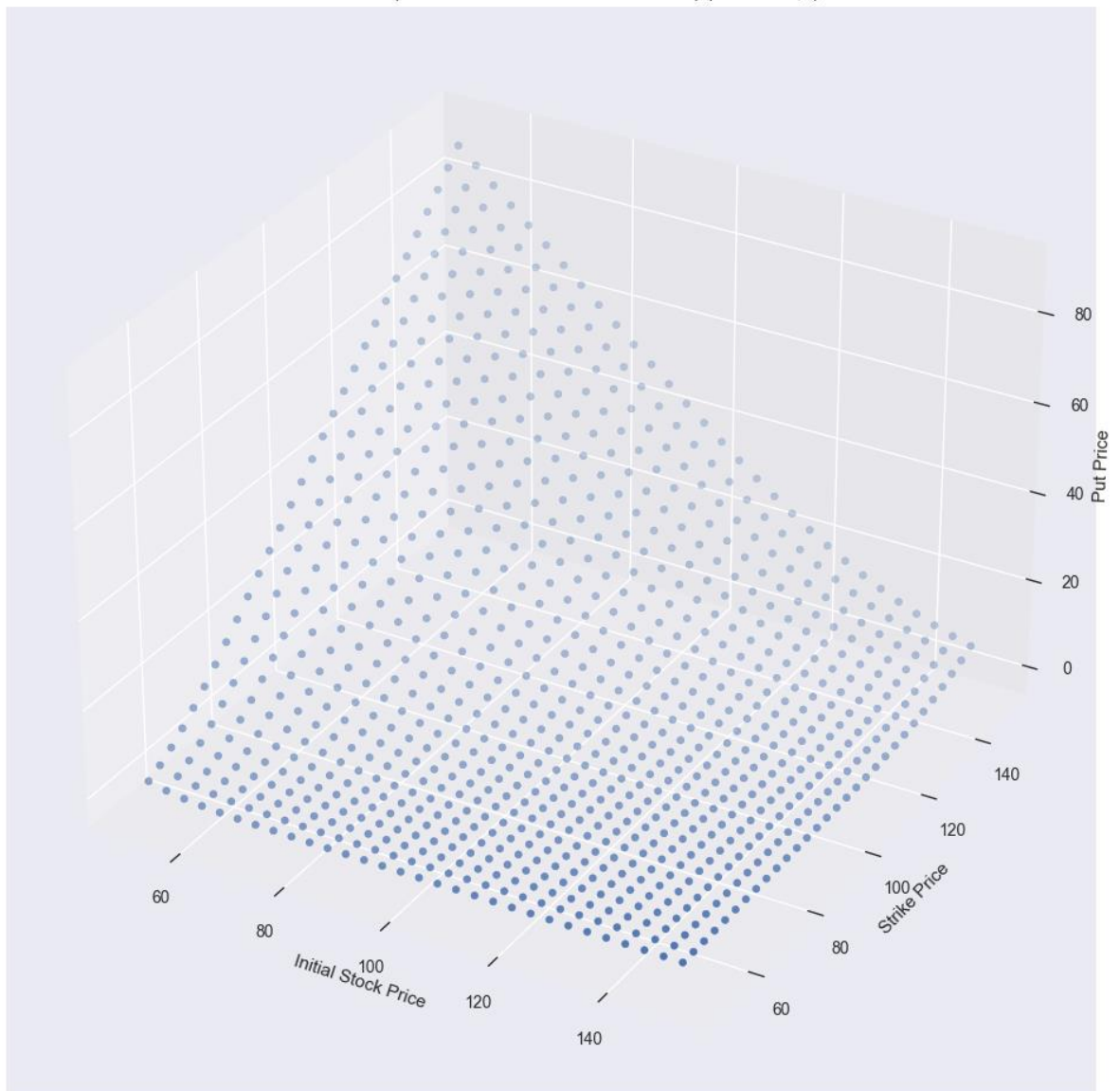
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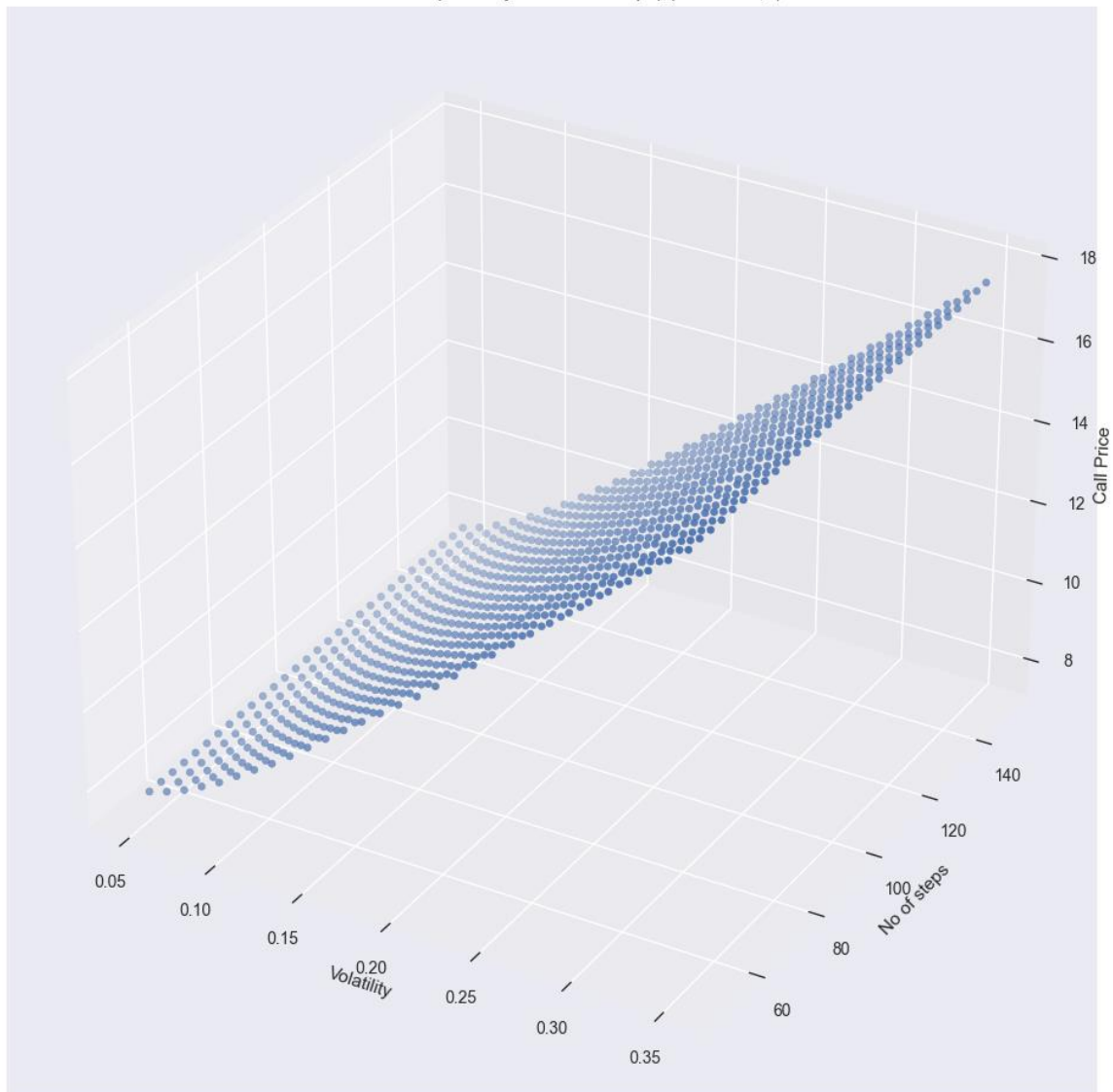
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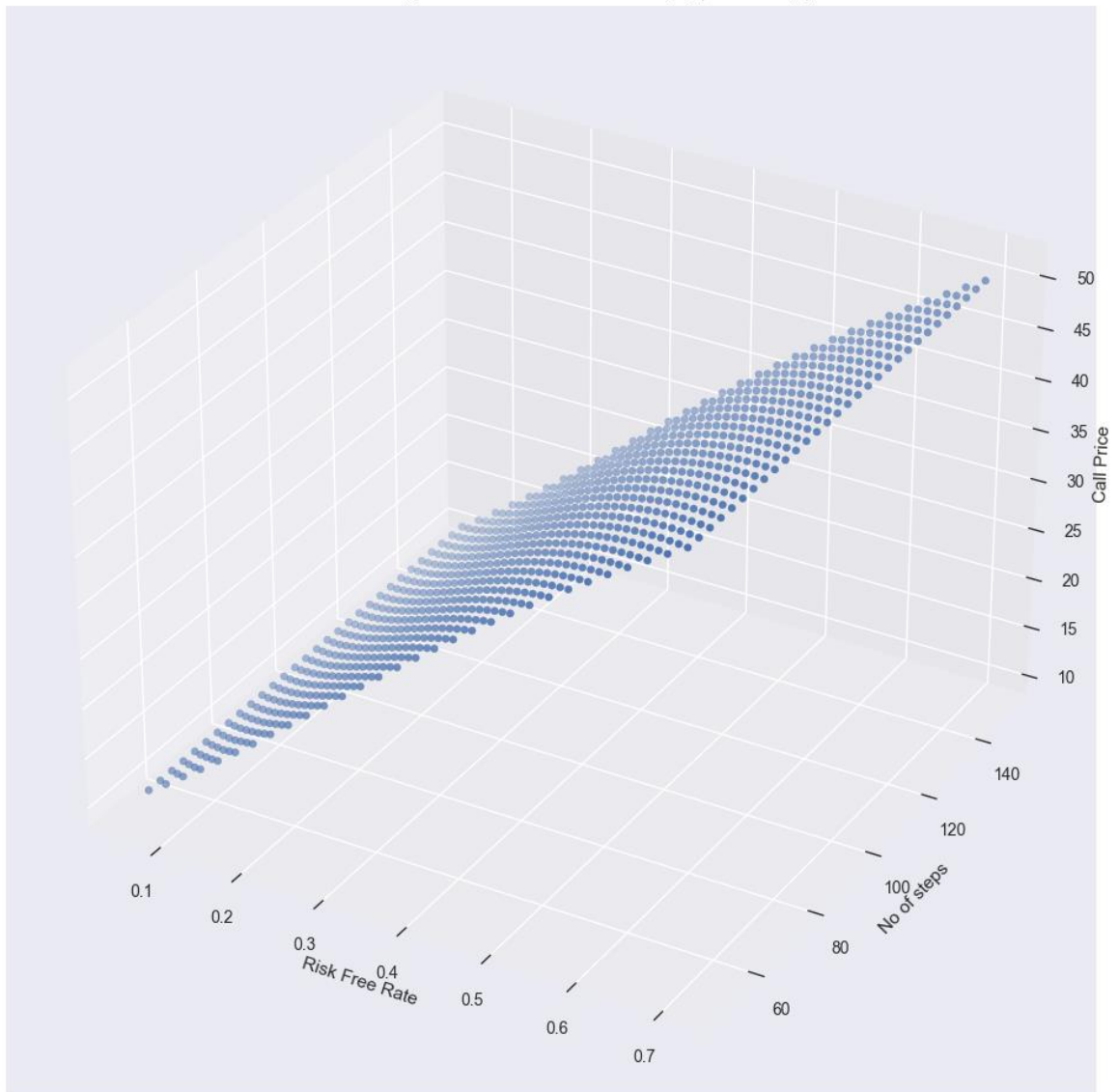
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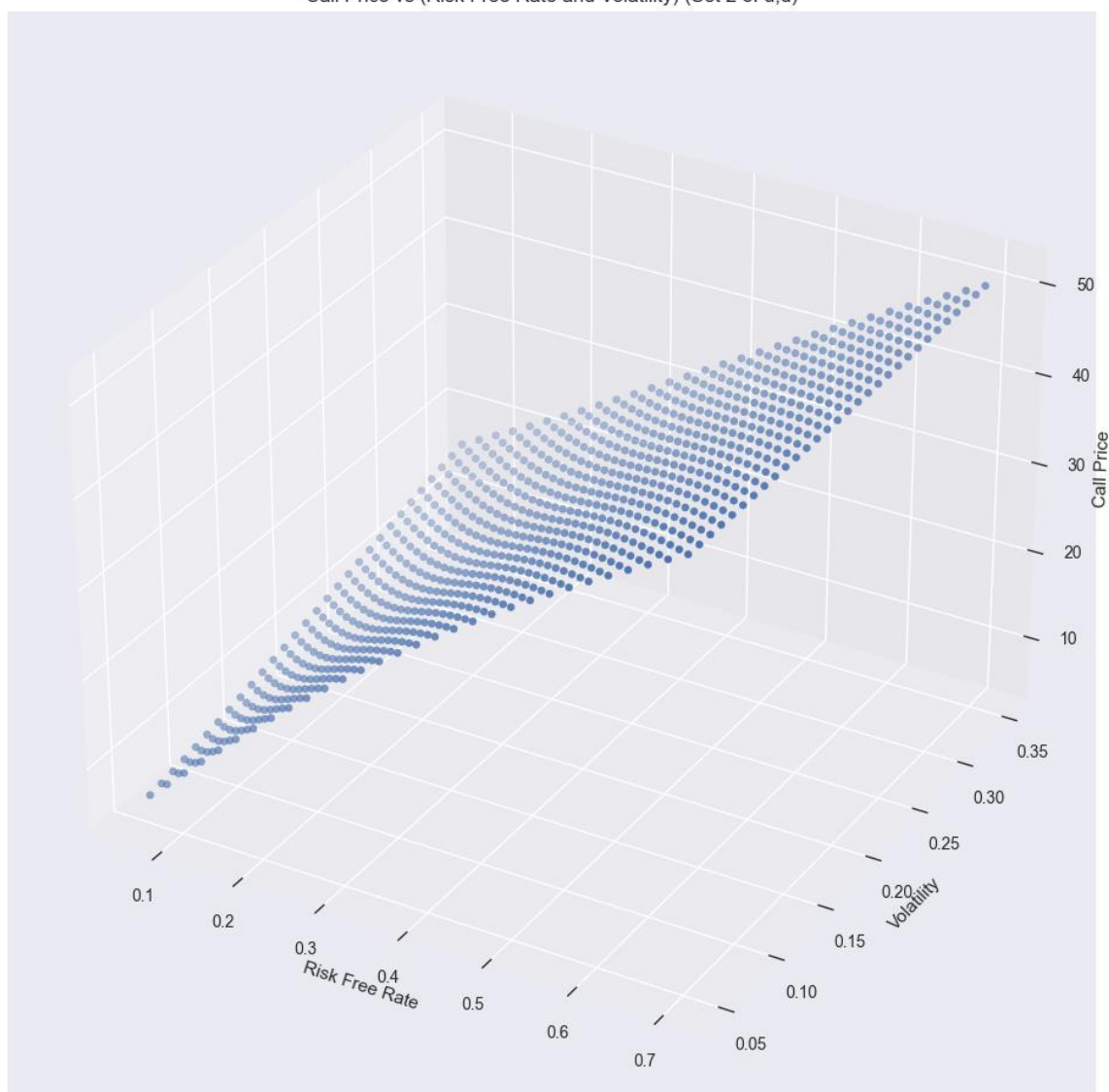
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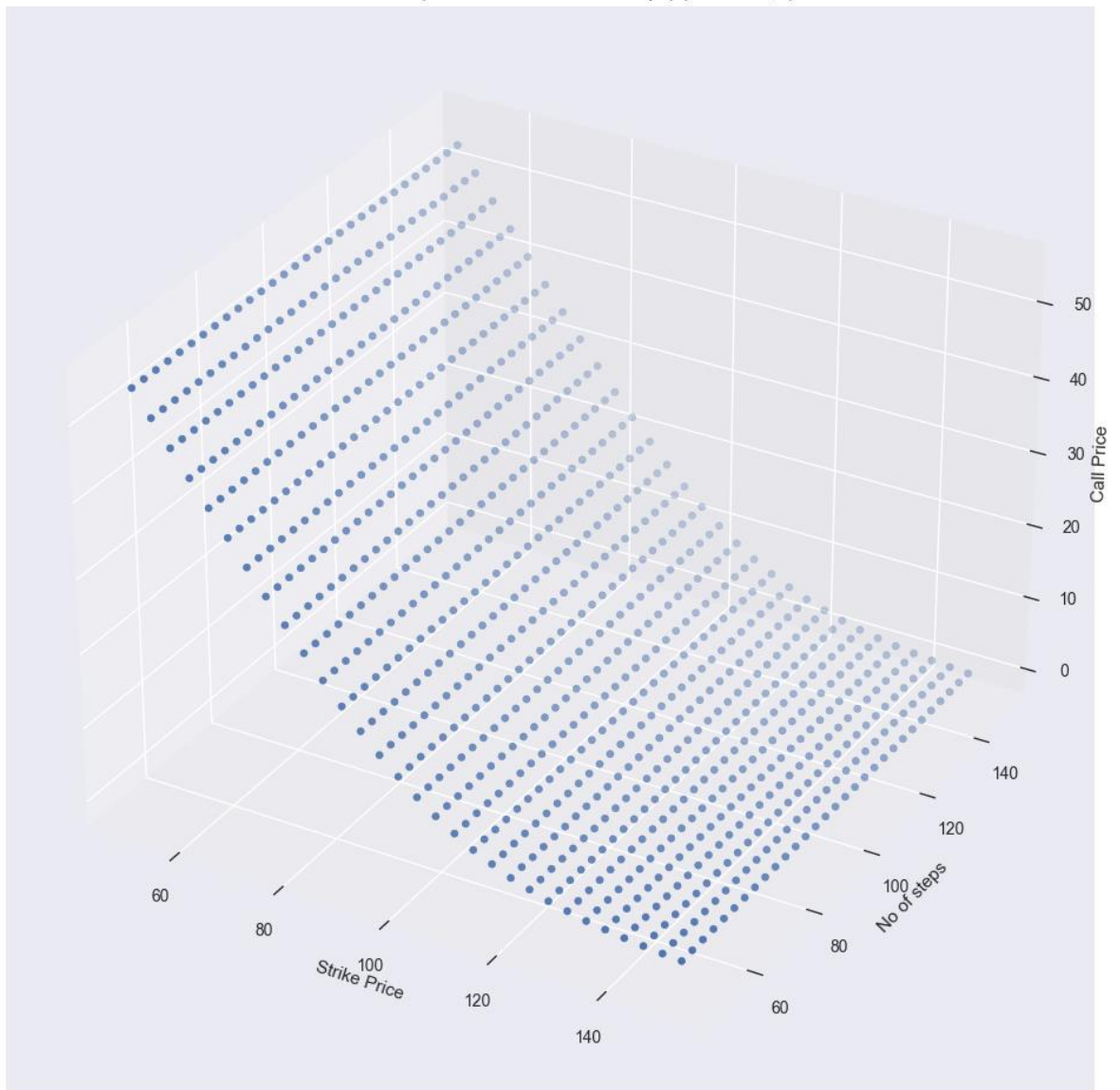
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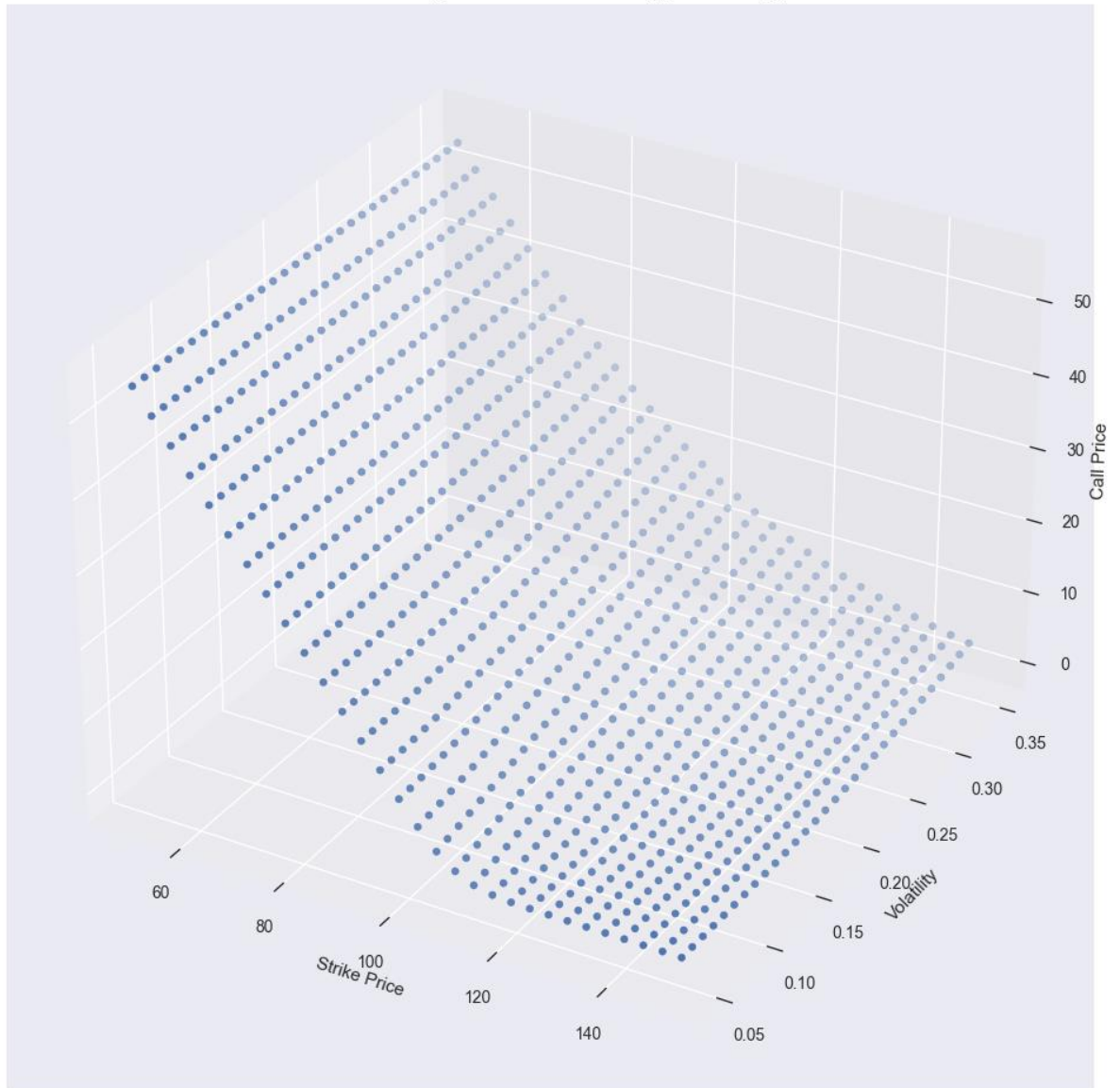
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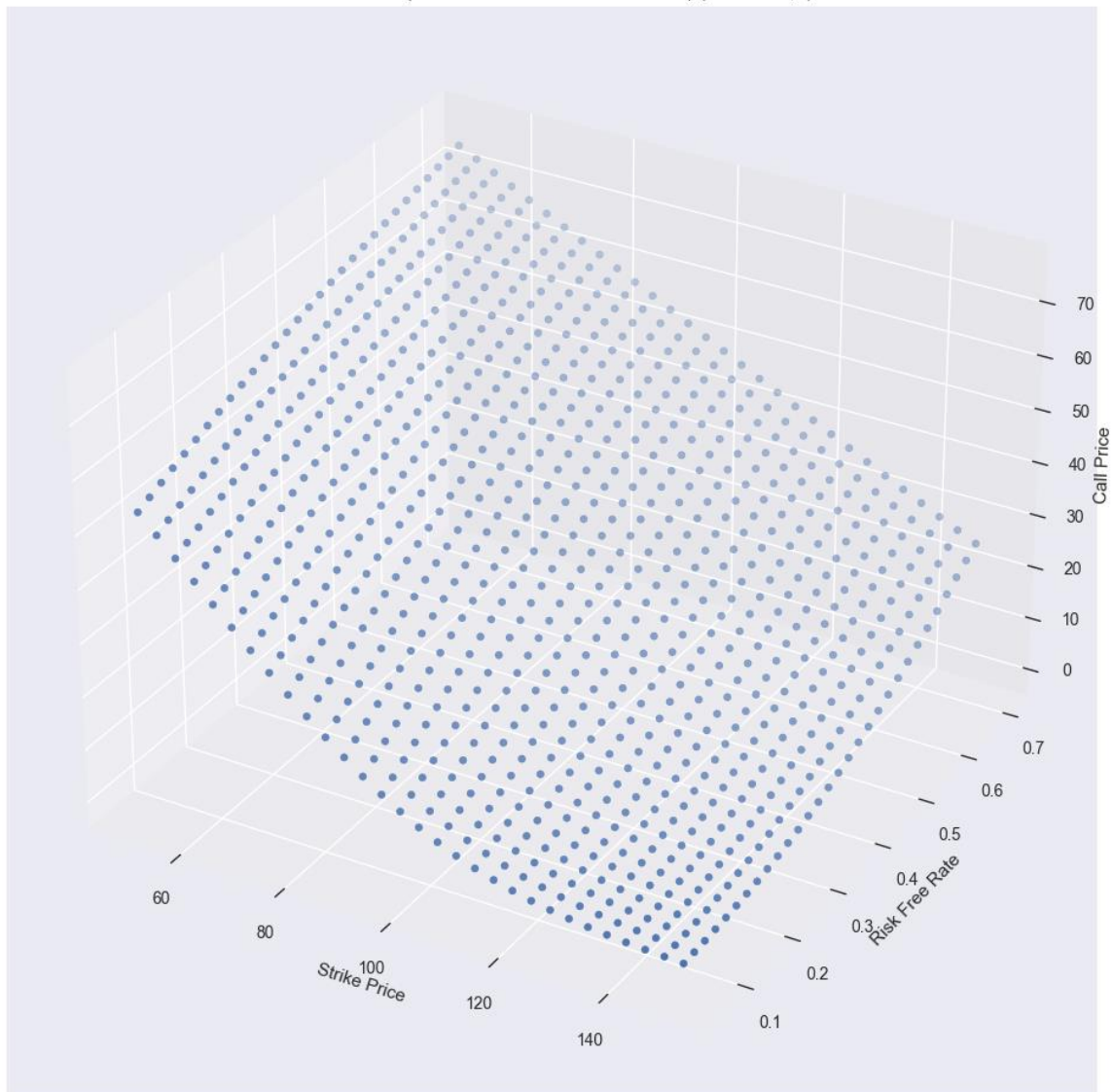
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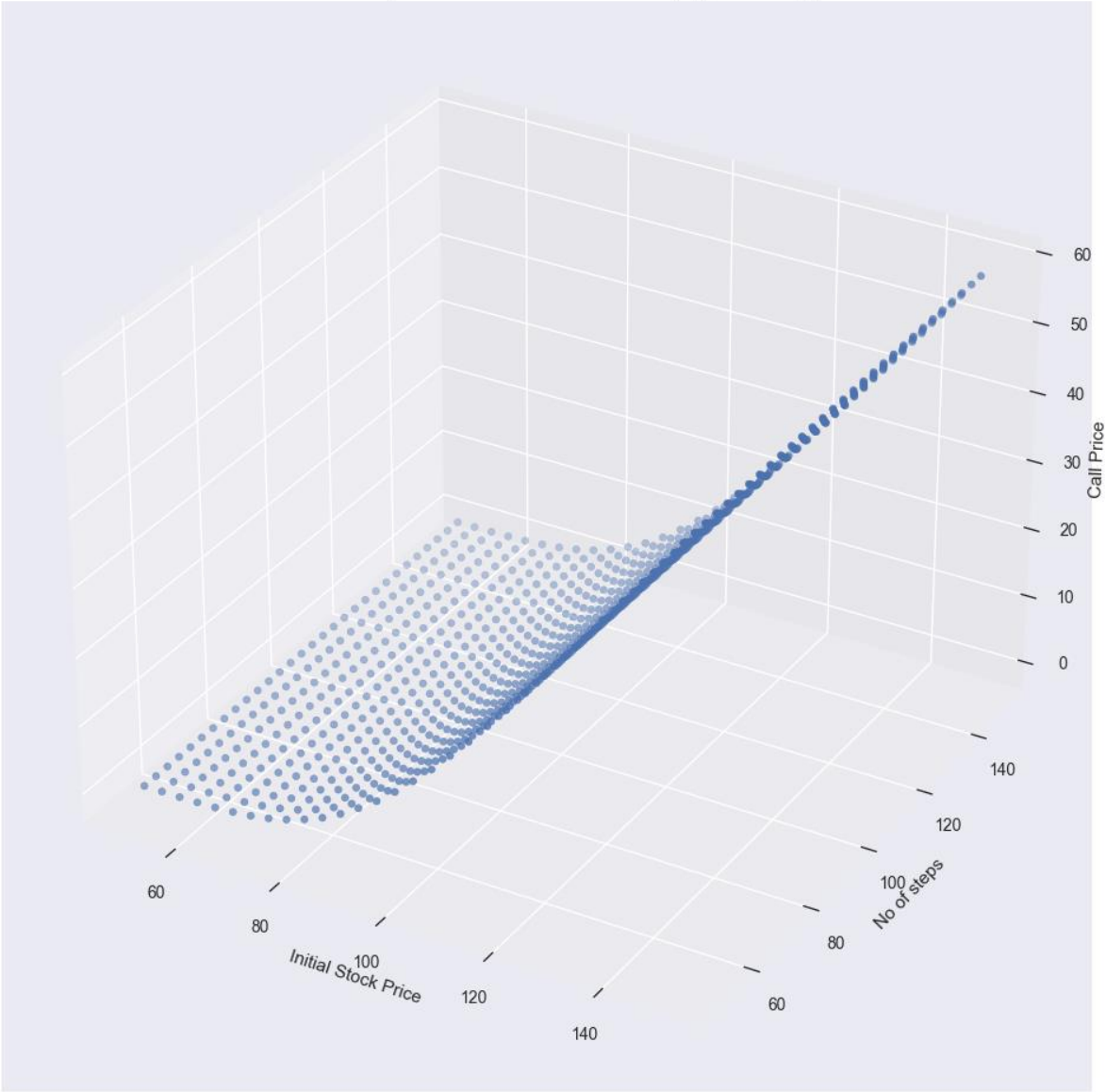
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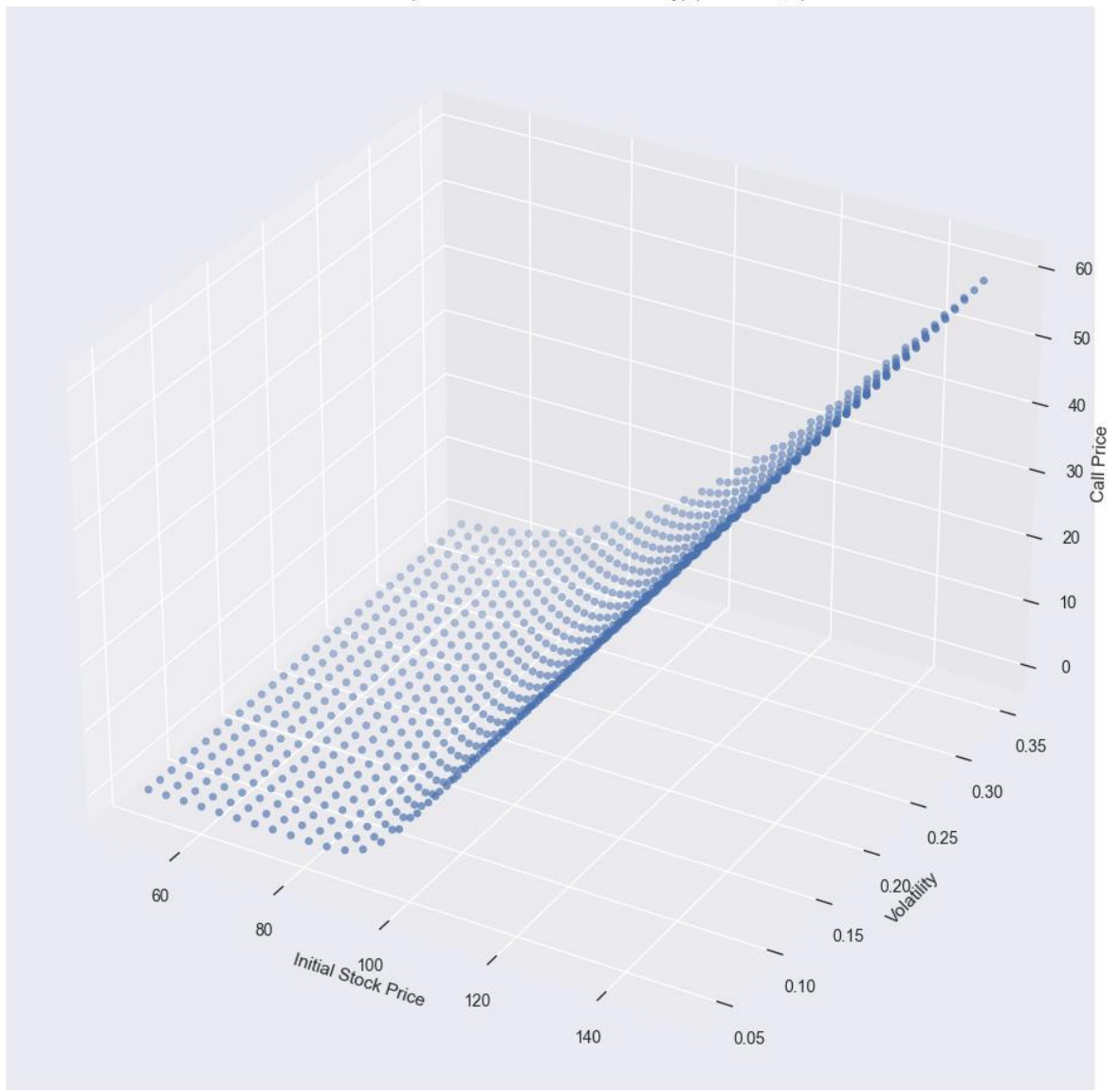
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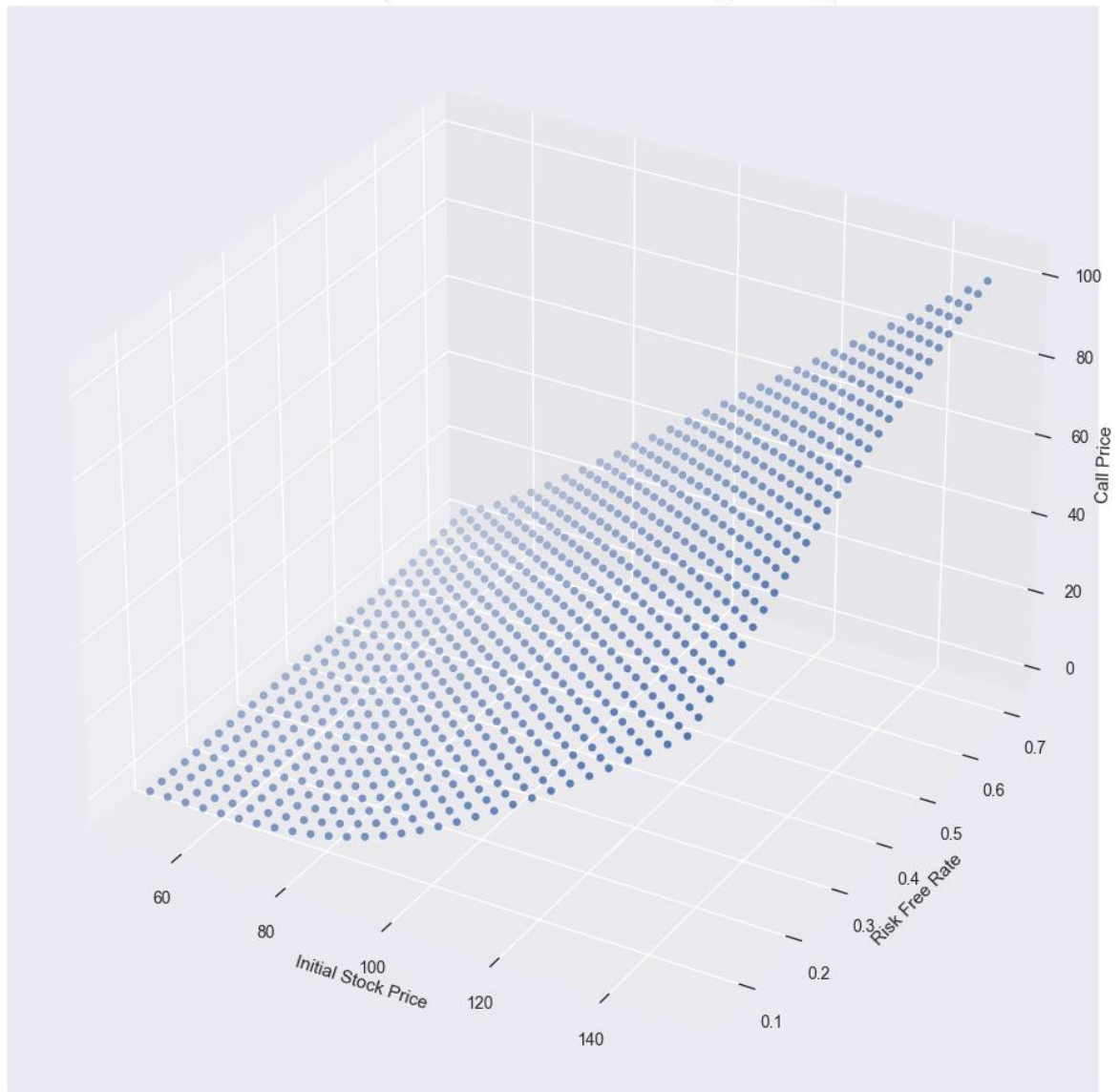
Call Price vs (Initial Stock Price and No of steps) (Set 2 of u,d)



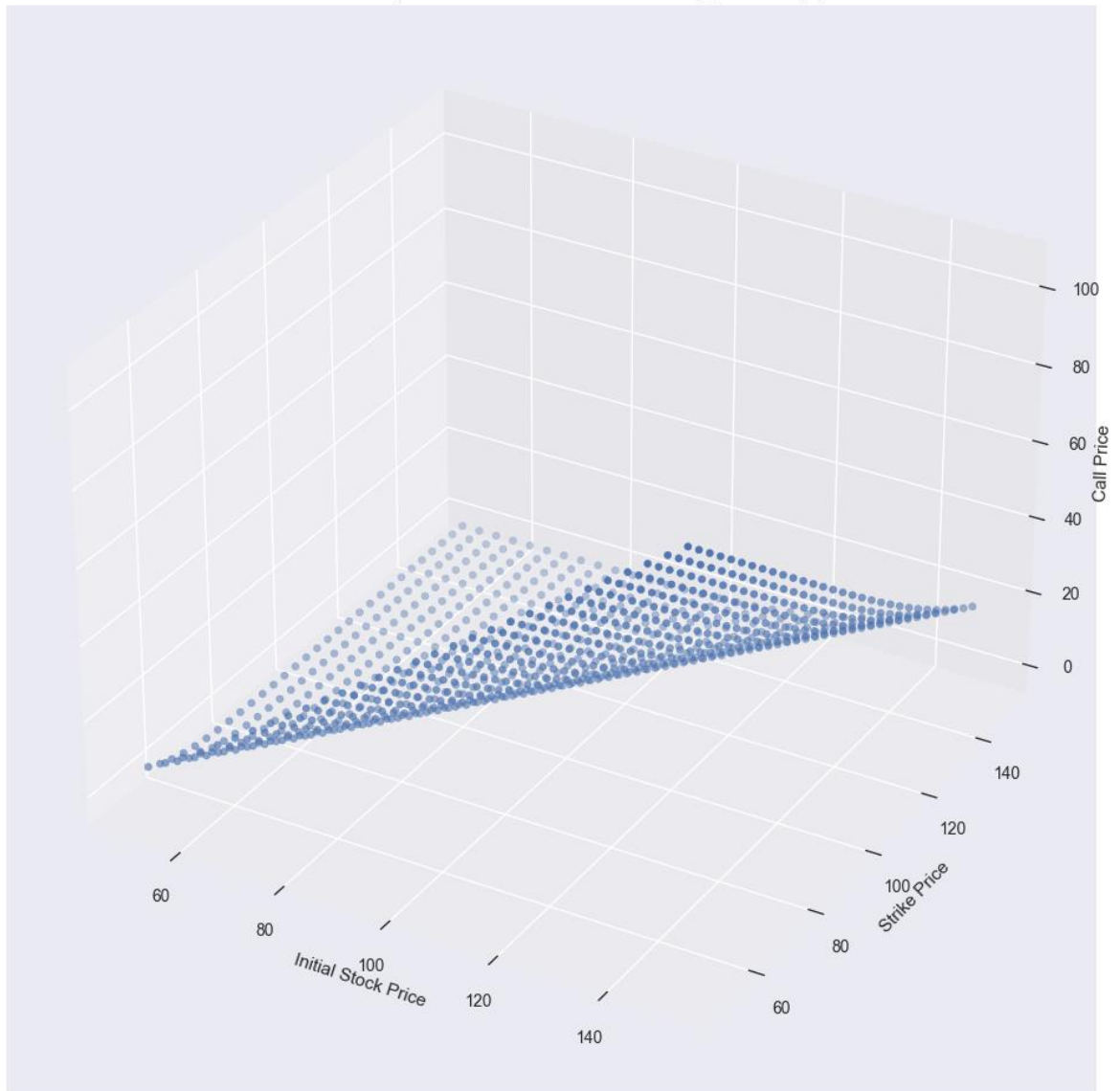
Call Price vs (Initial Stock Price and Volatility) (Set 2 of u,d)



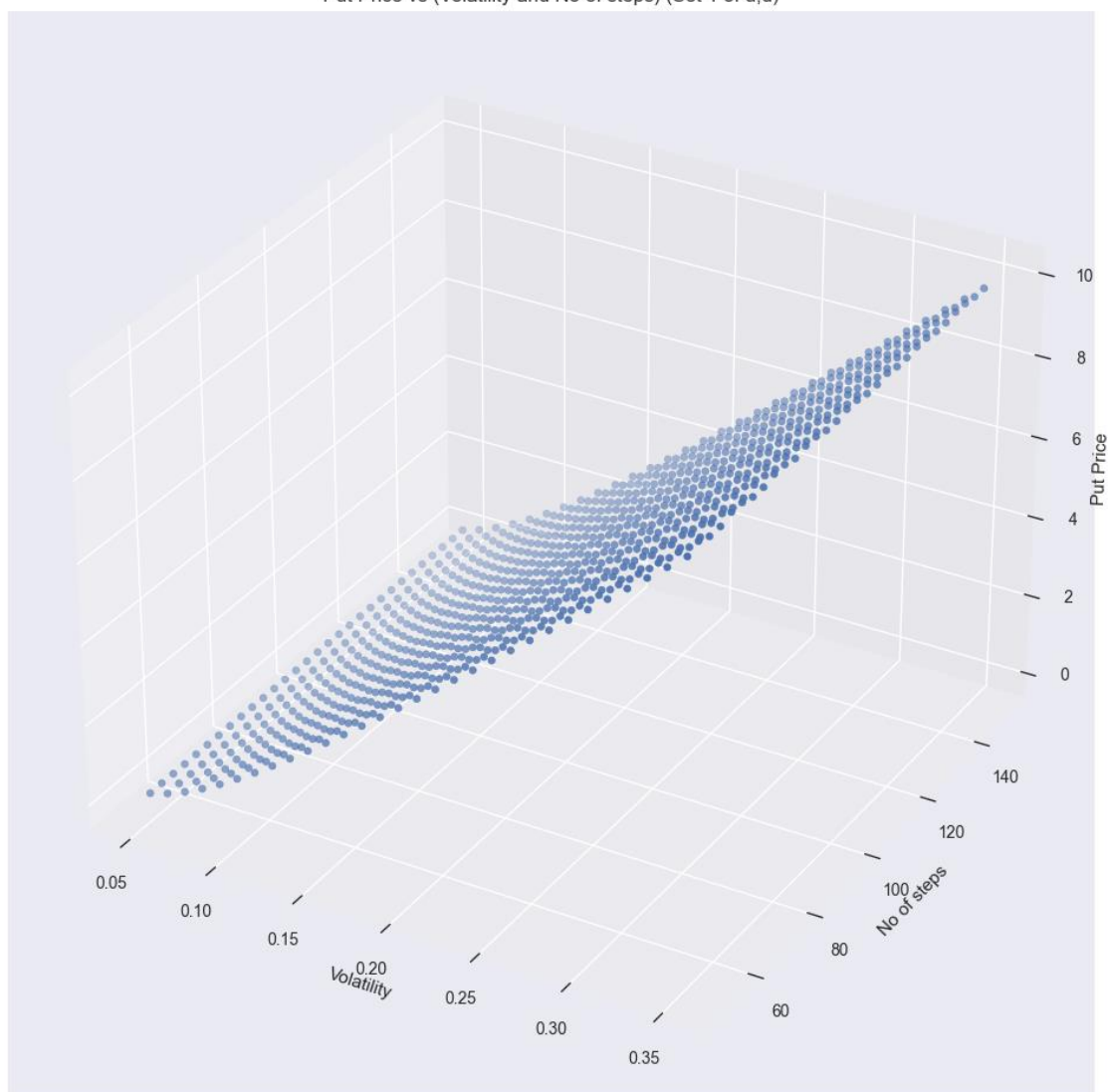
Call Price vs (Initial Stock Price and Risk Free Rate) (Set 2 of u,d)



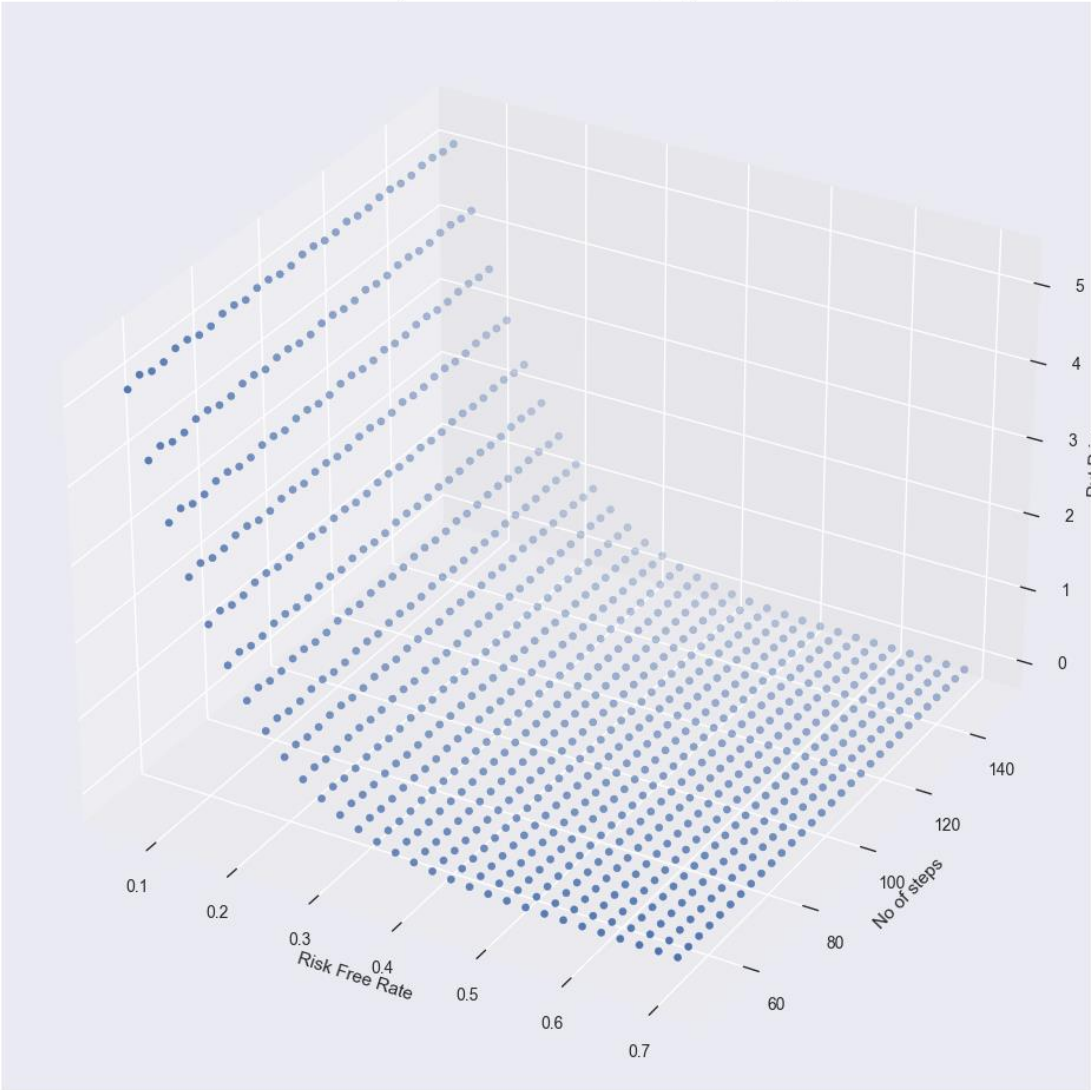
Call Price vs (Initial Stock Price and Strike Price) (Set 2 of u,d)



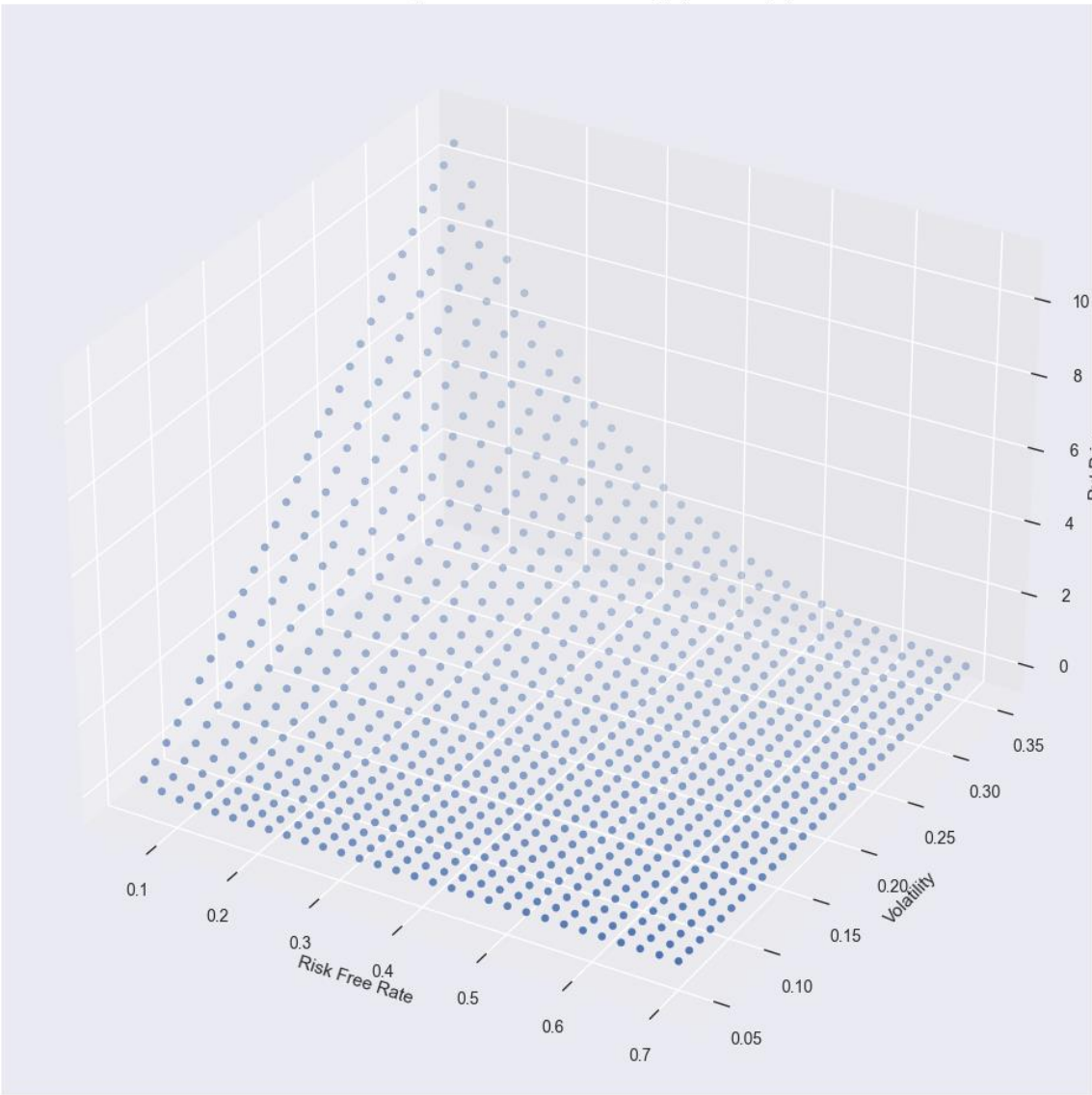
Put Price vs (Volatility and No of steps) (Set 1 of u,d)



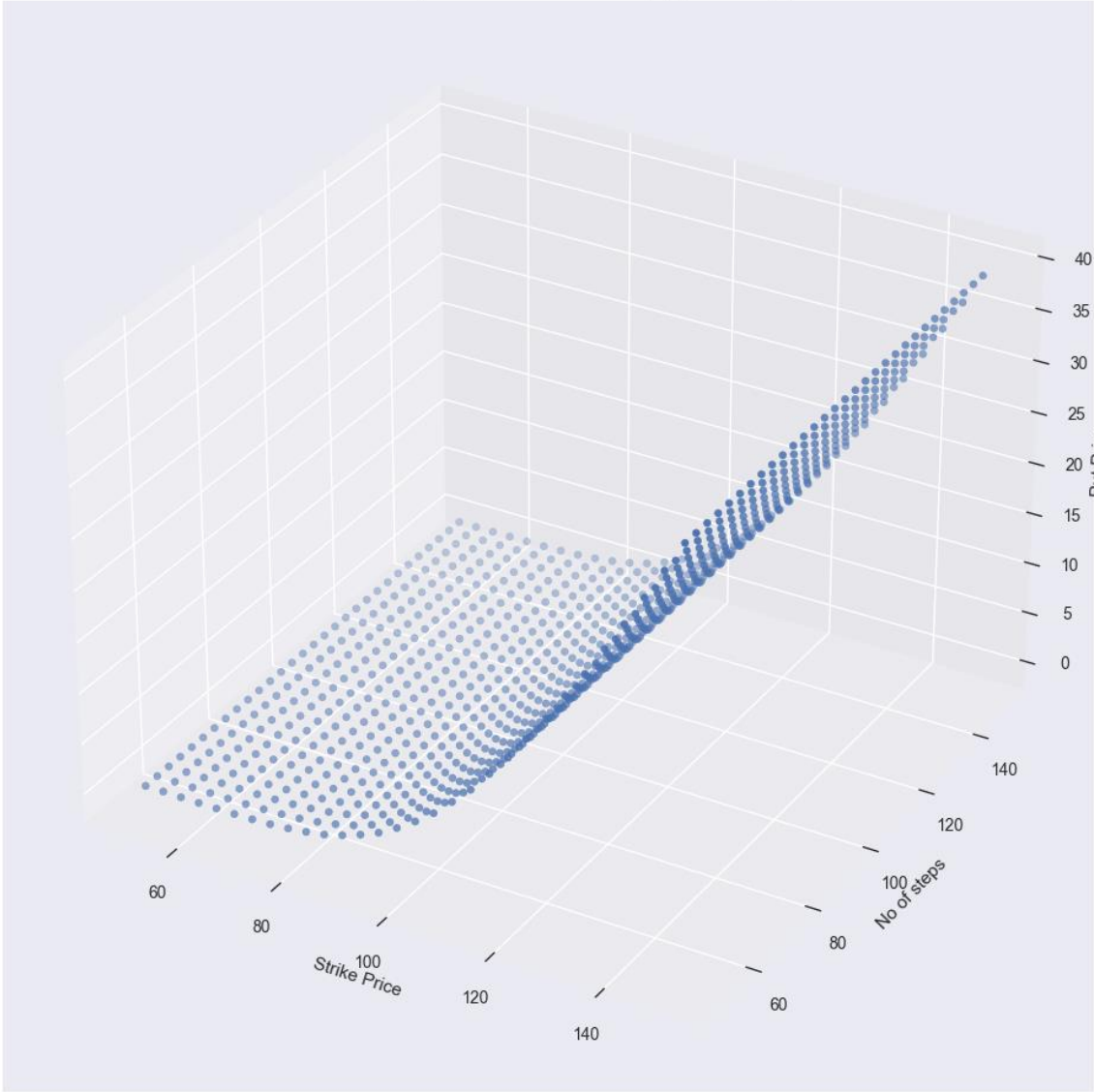
Put Price vs (Risk Free Rate and No of steps) (Set 1 of u,d)



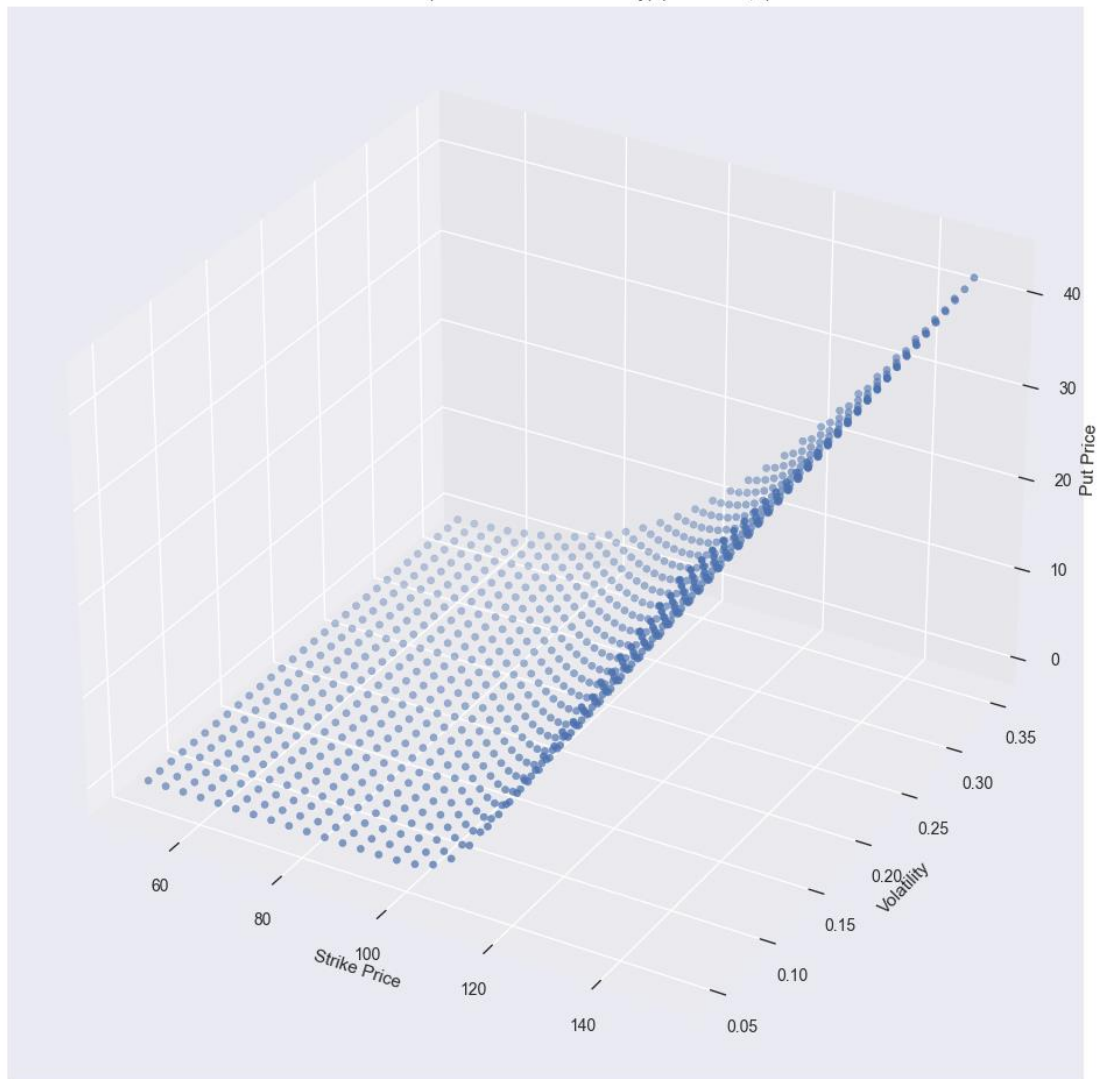
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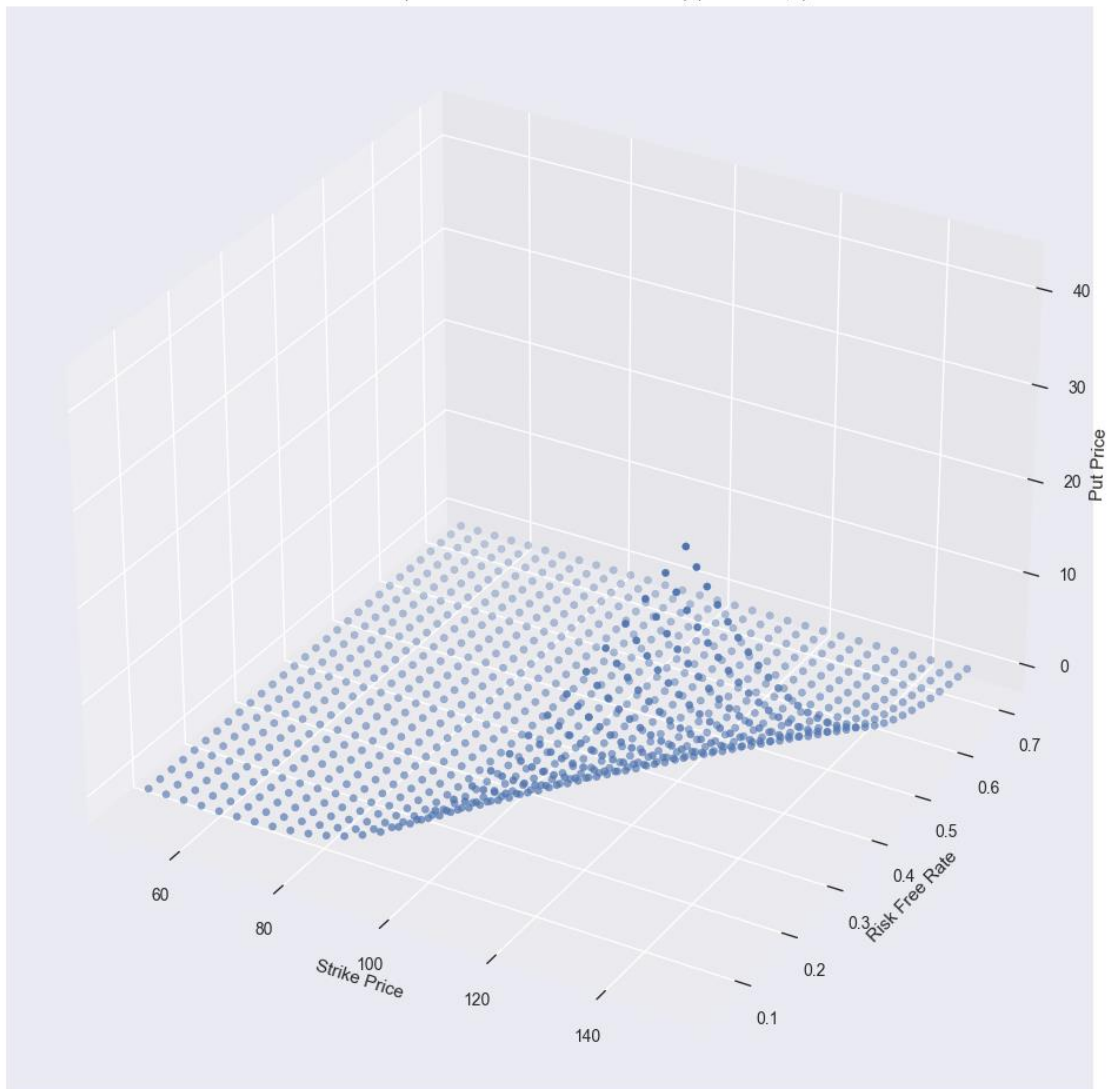
Put Price vs (Strike Price and No of steps) (Set 1 of u,d)



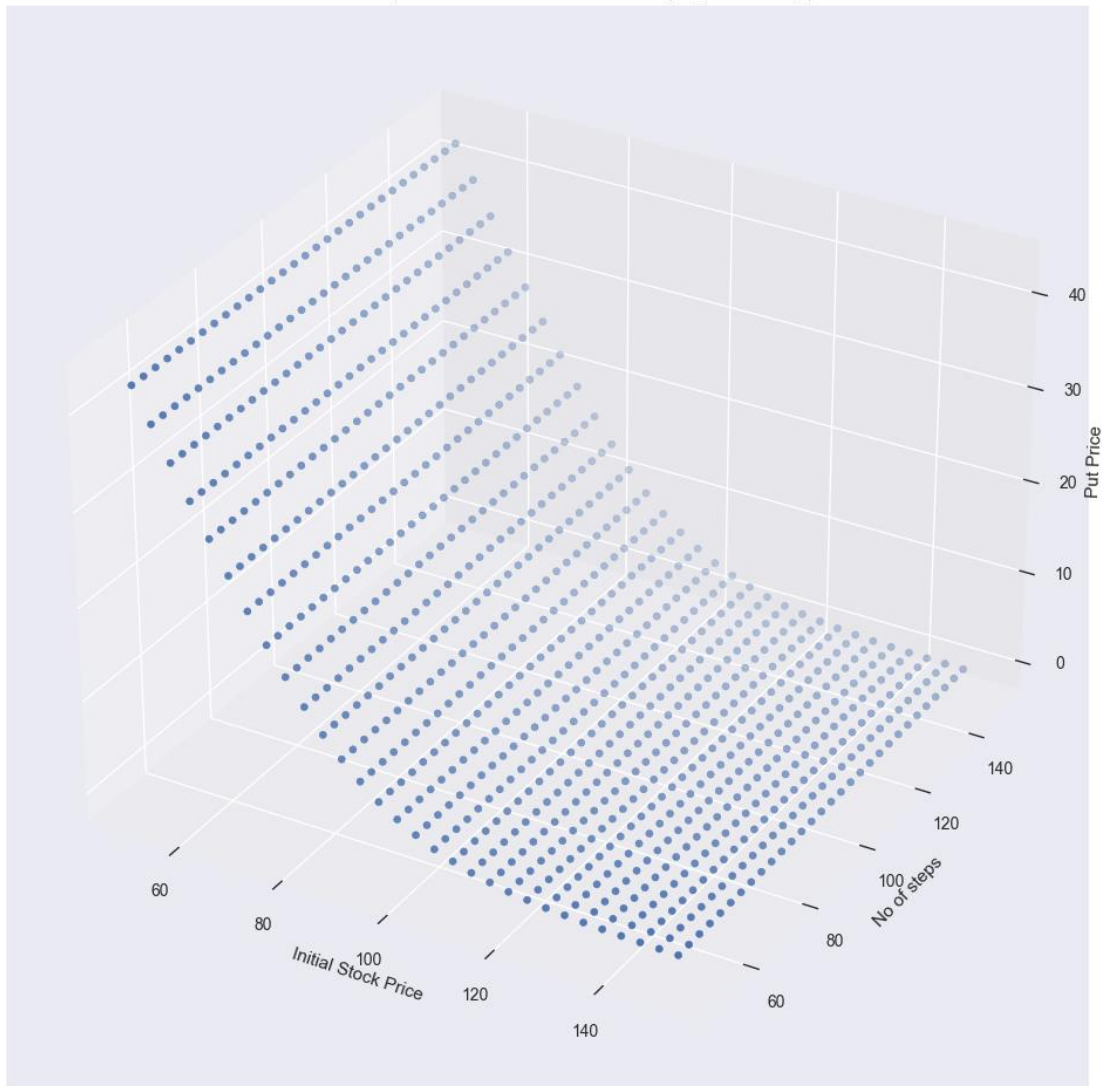
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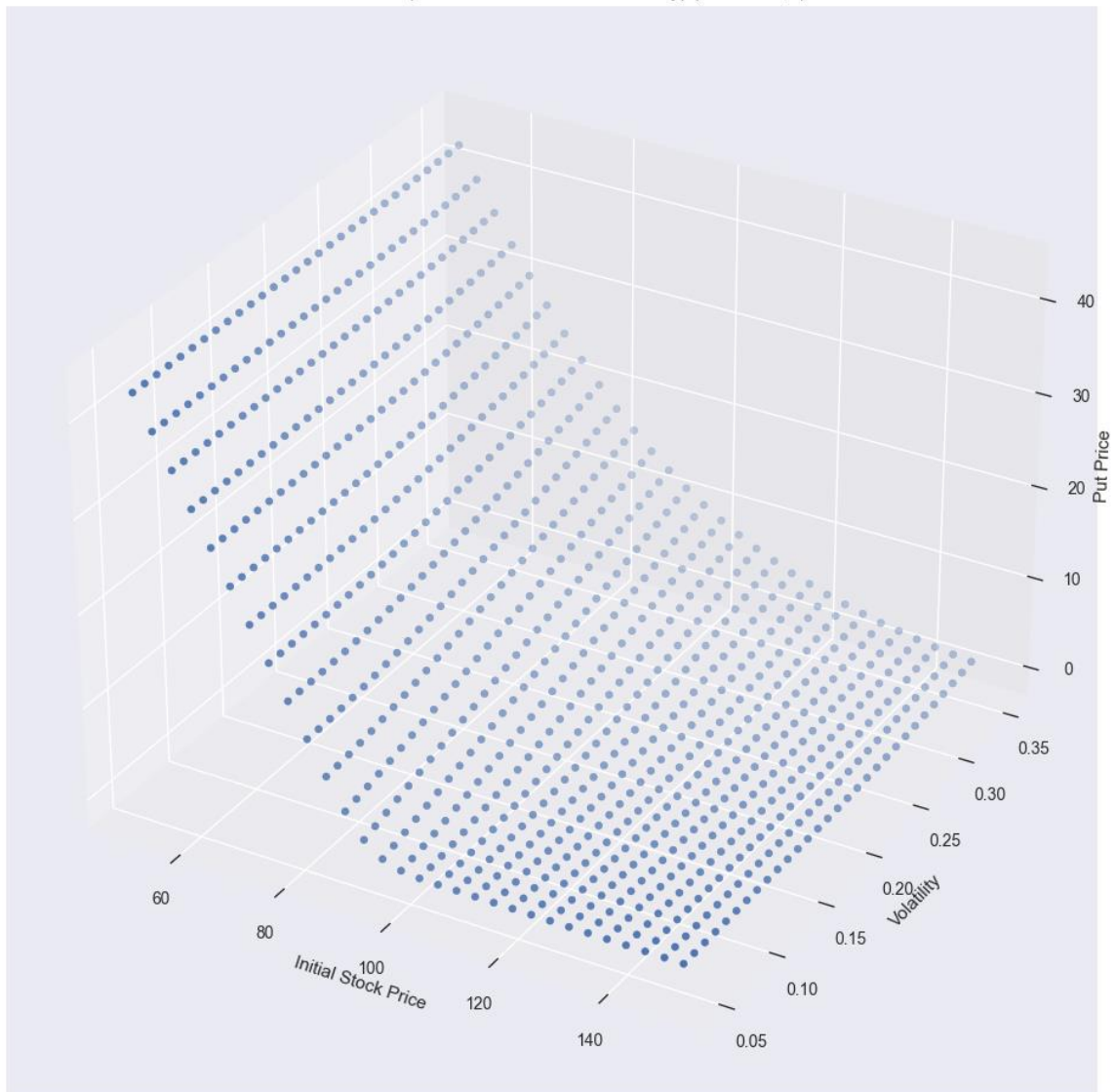
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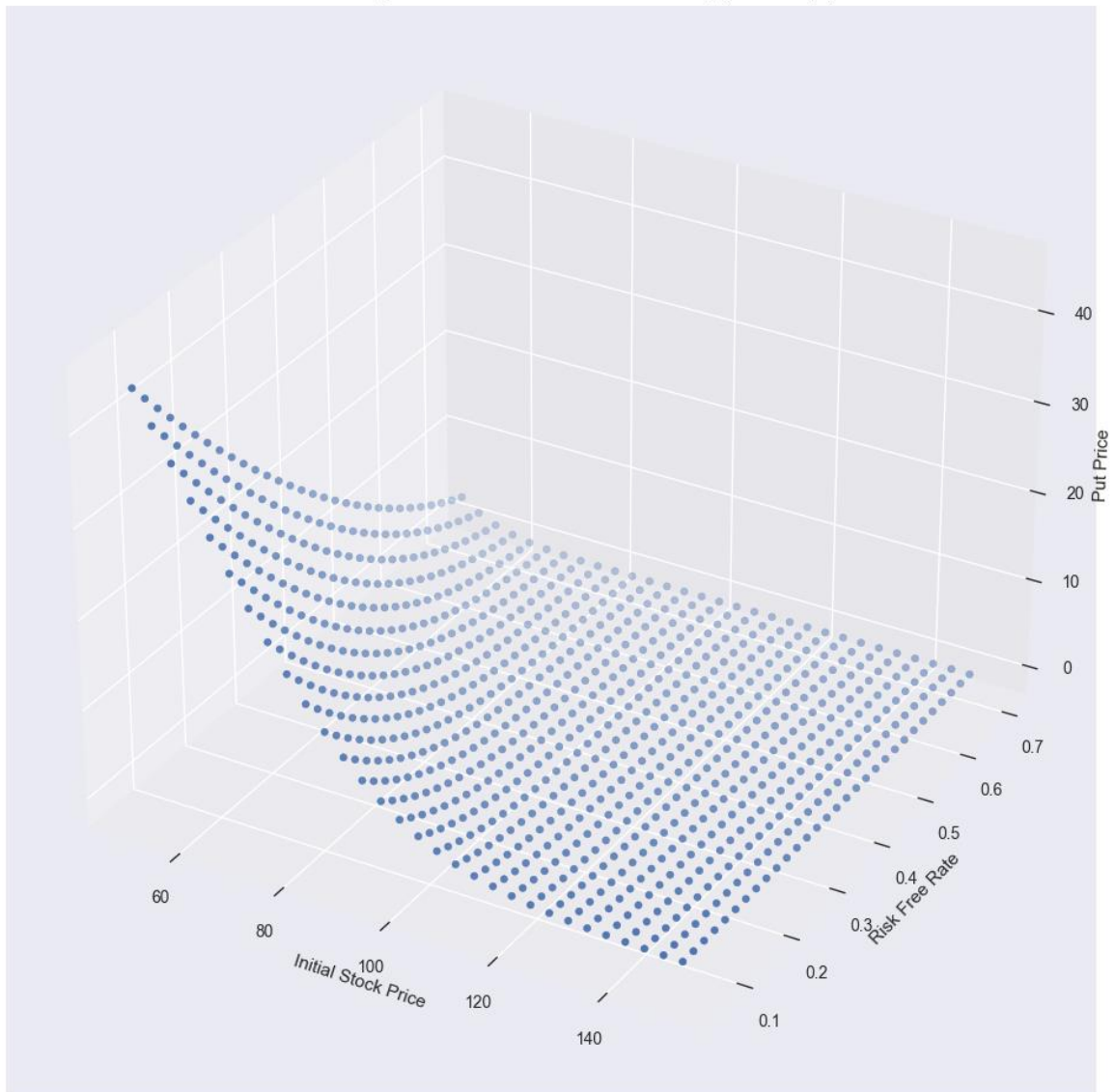
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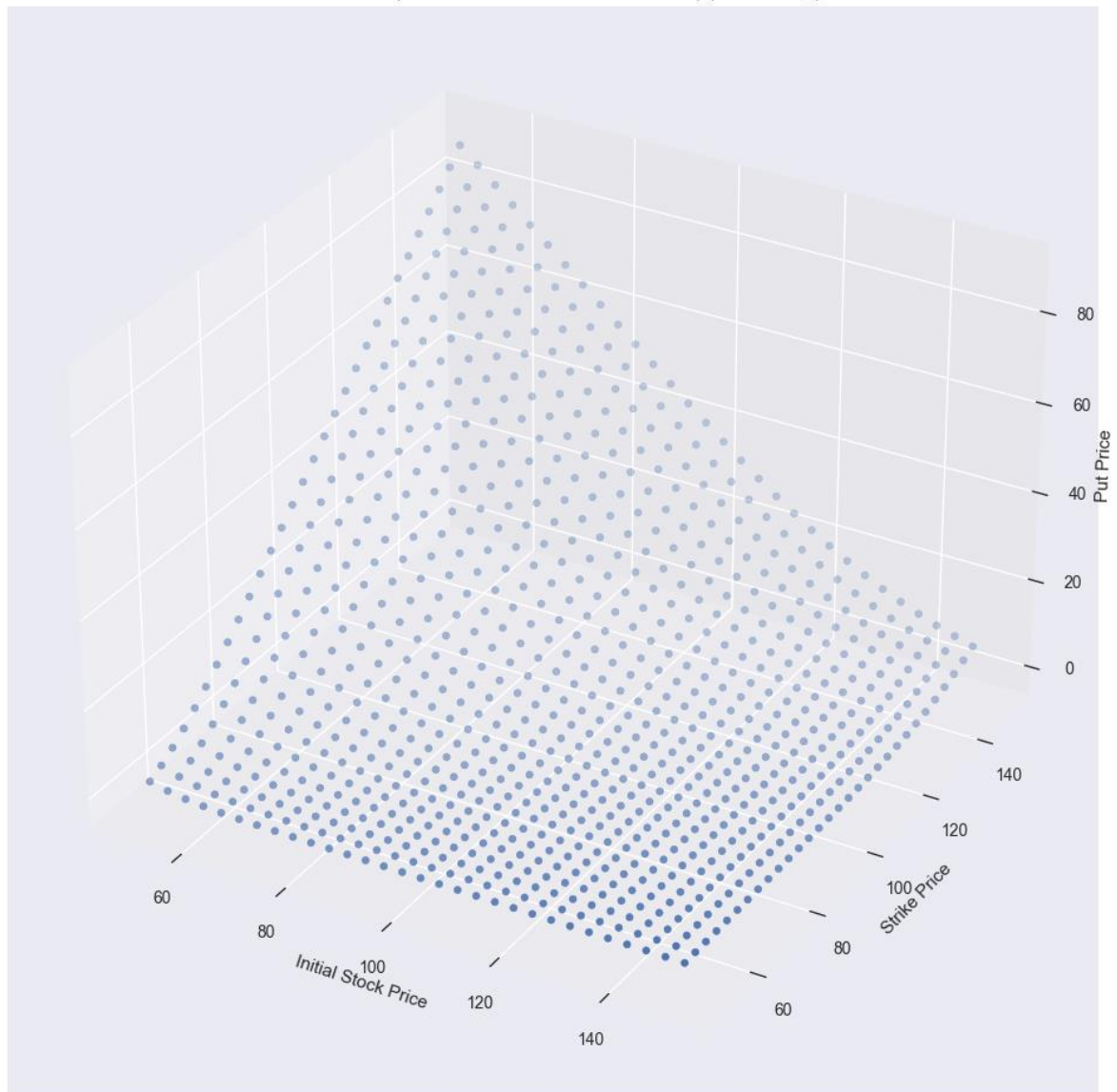
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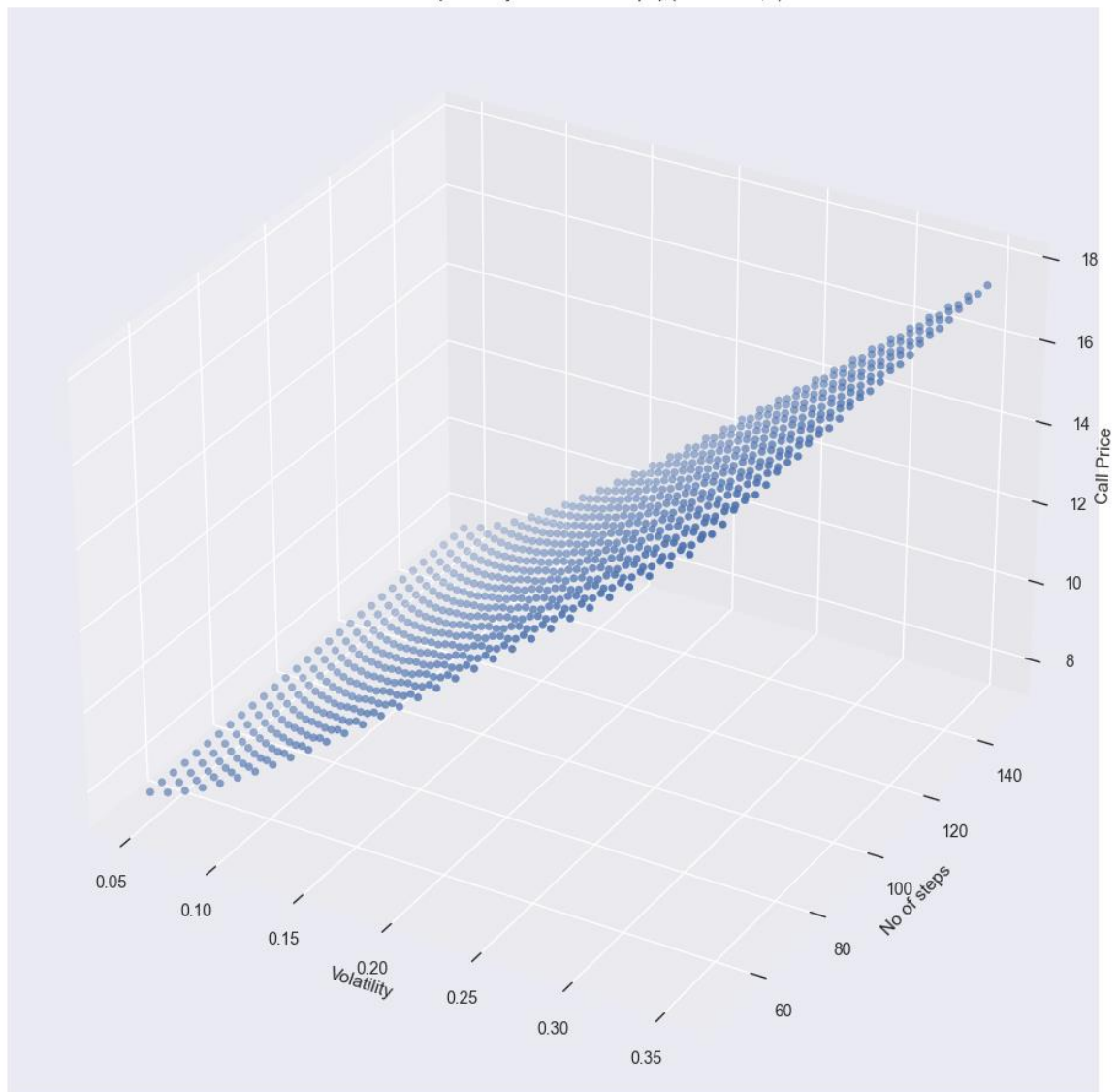
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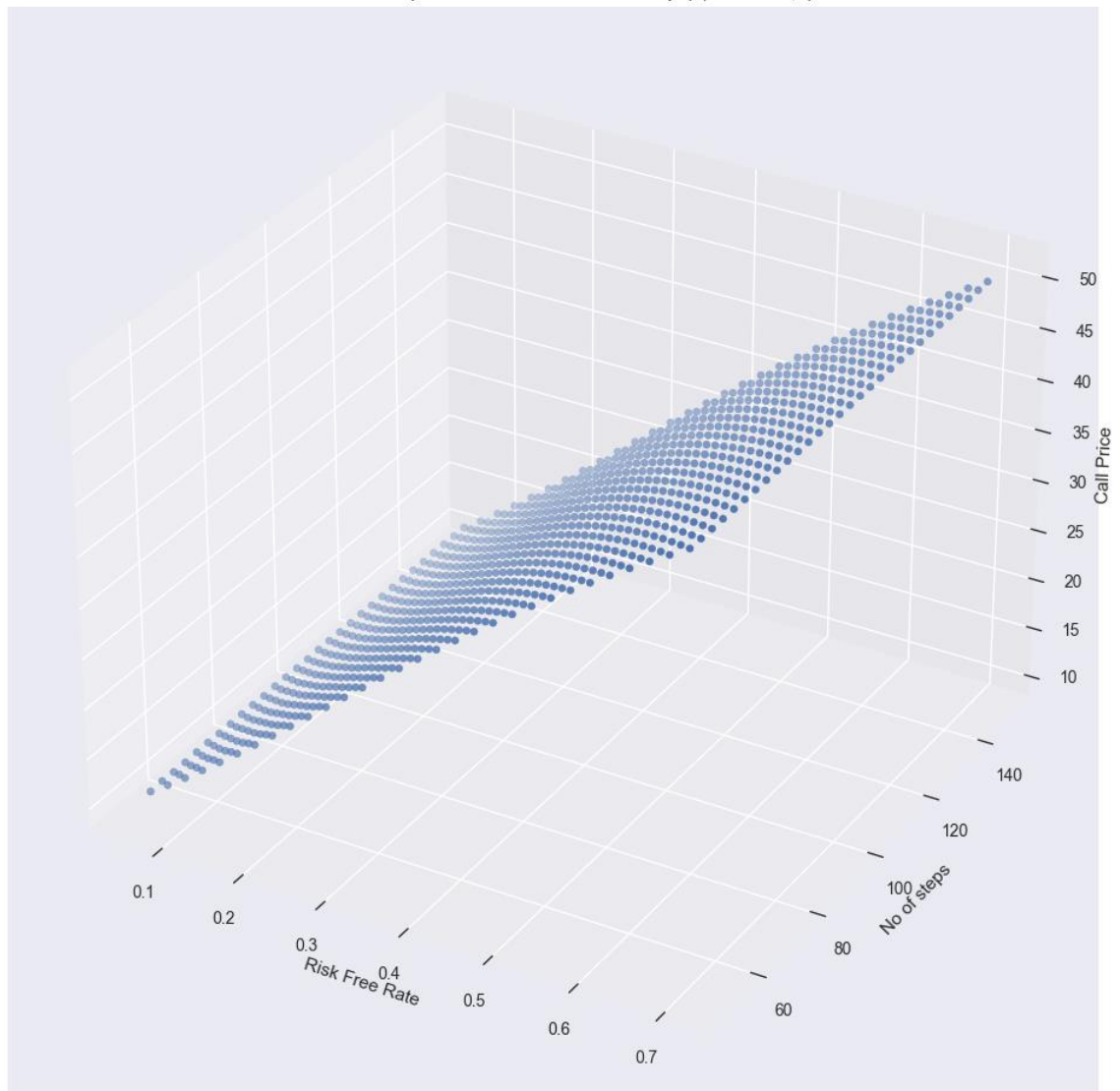
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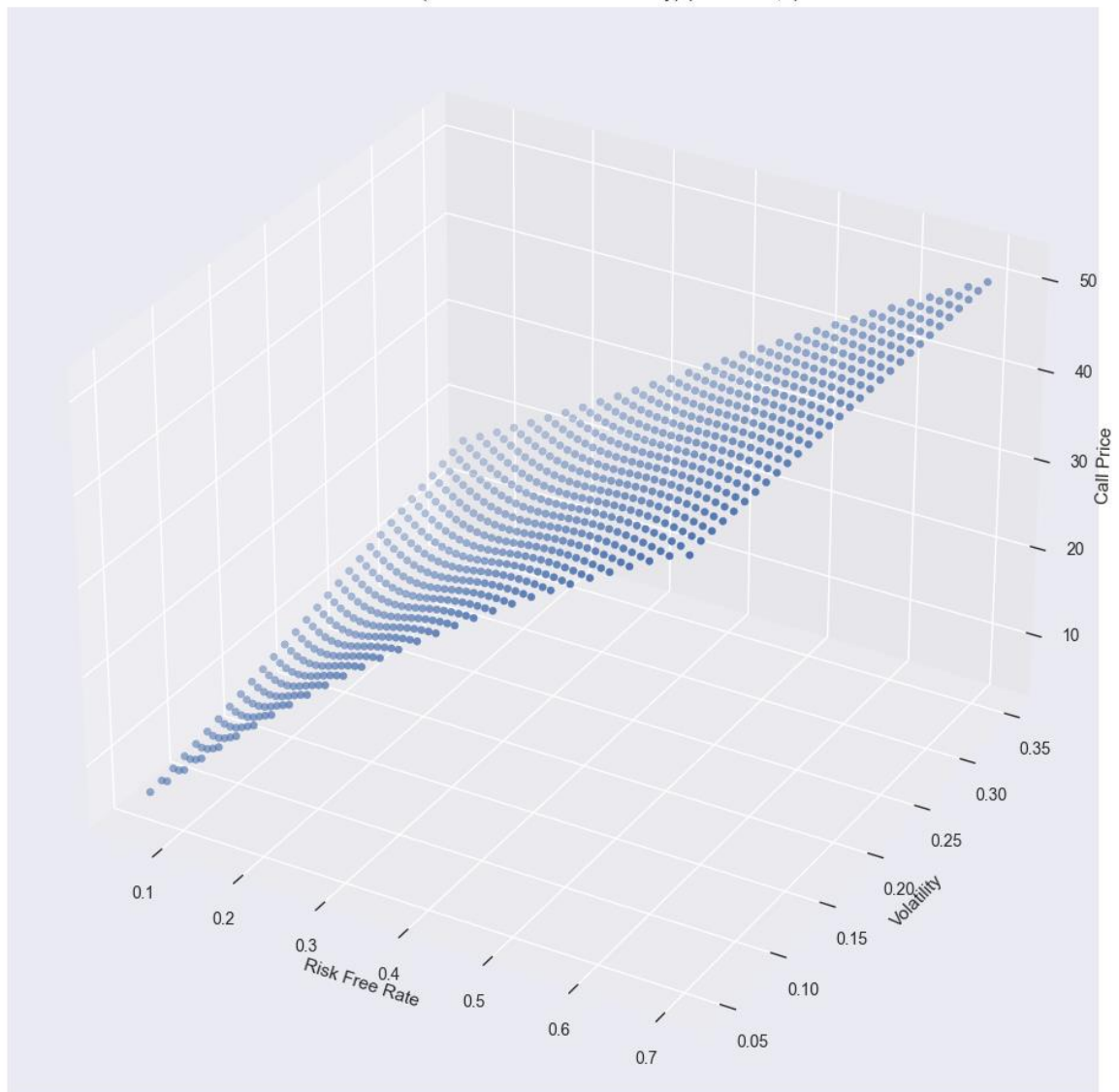
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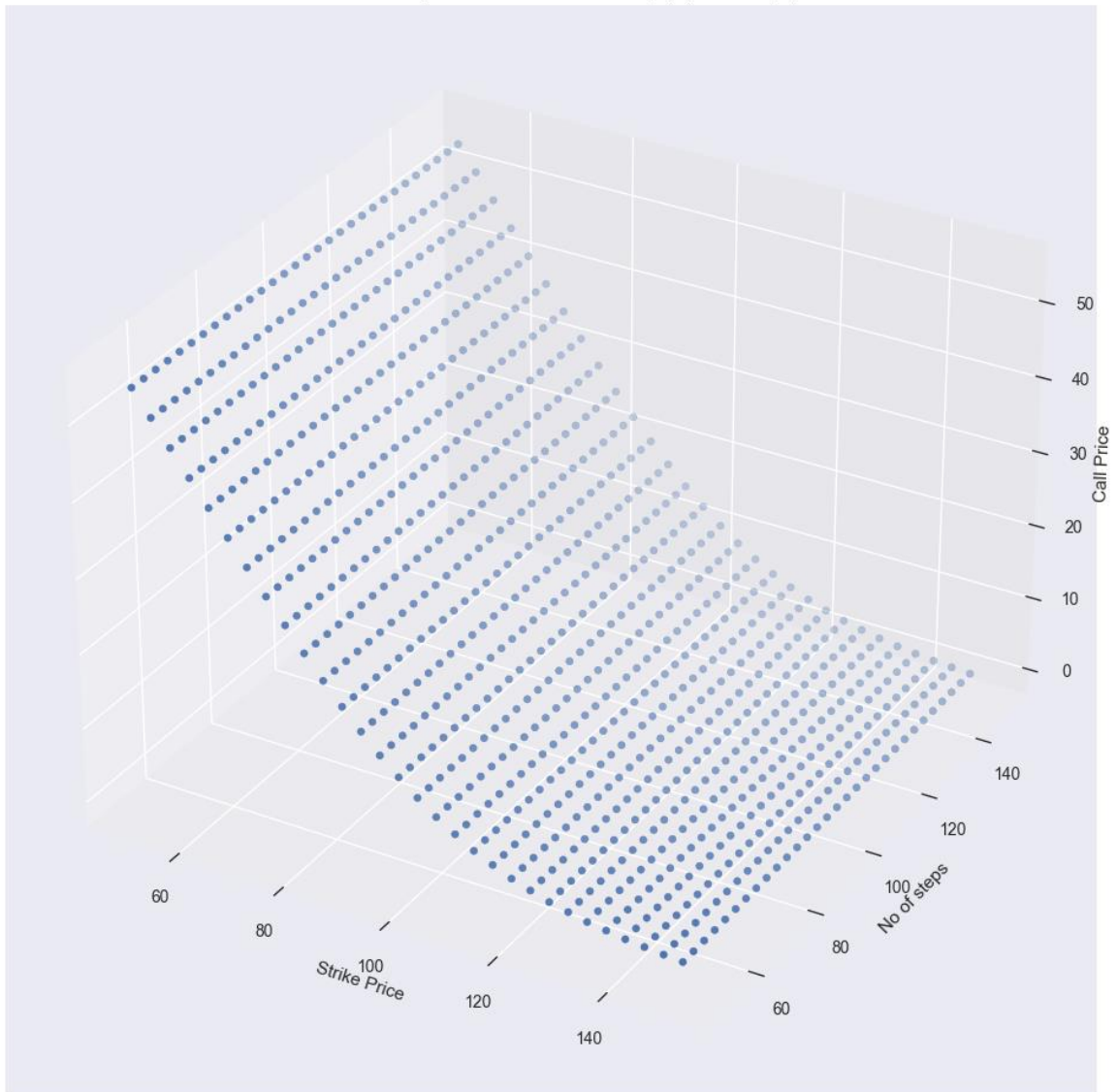
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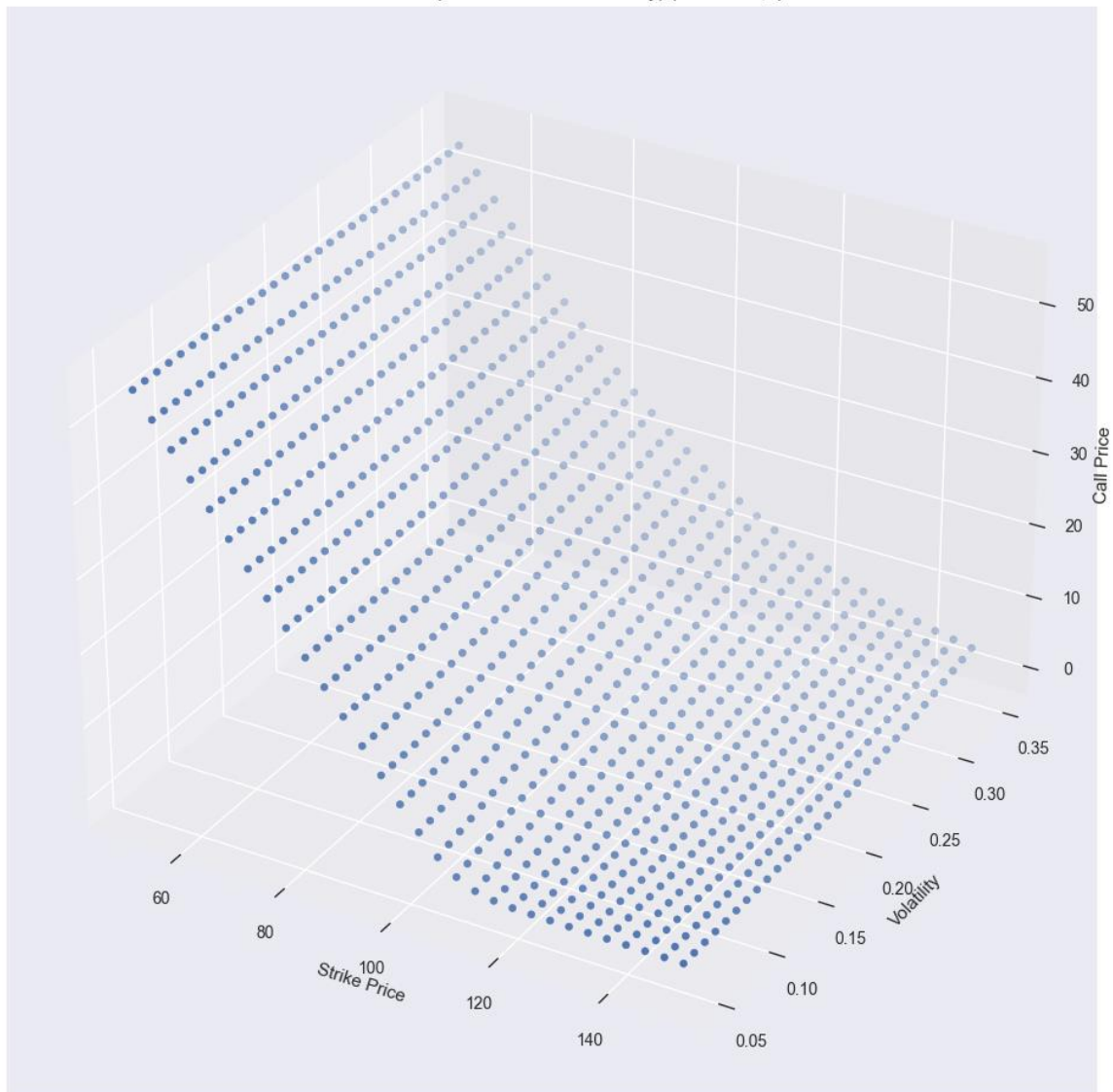
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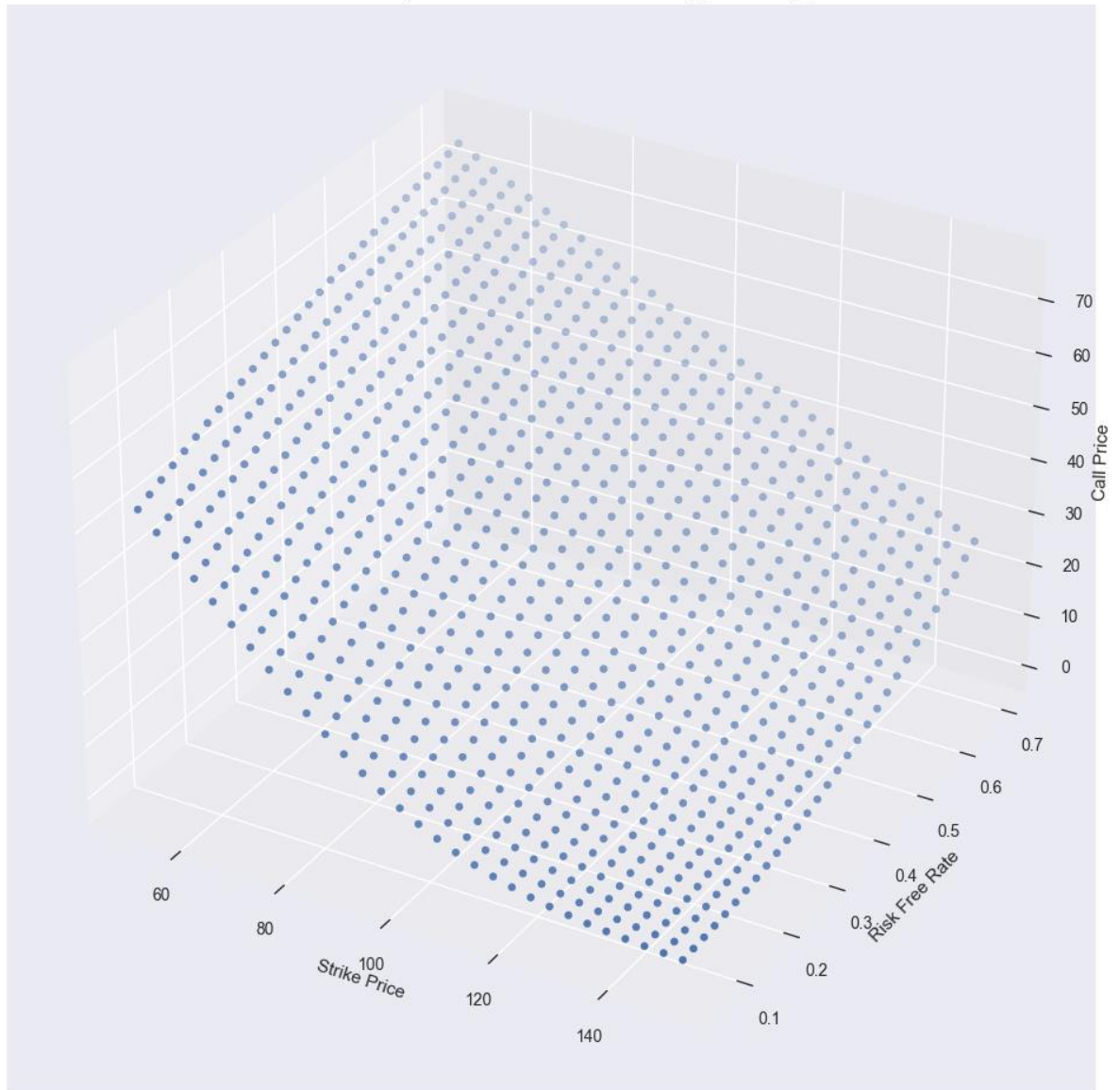
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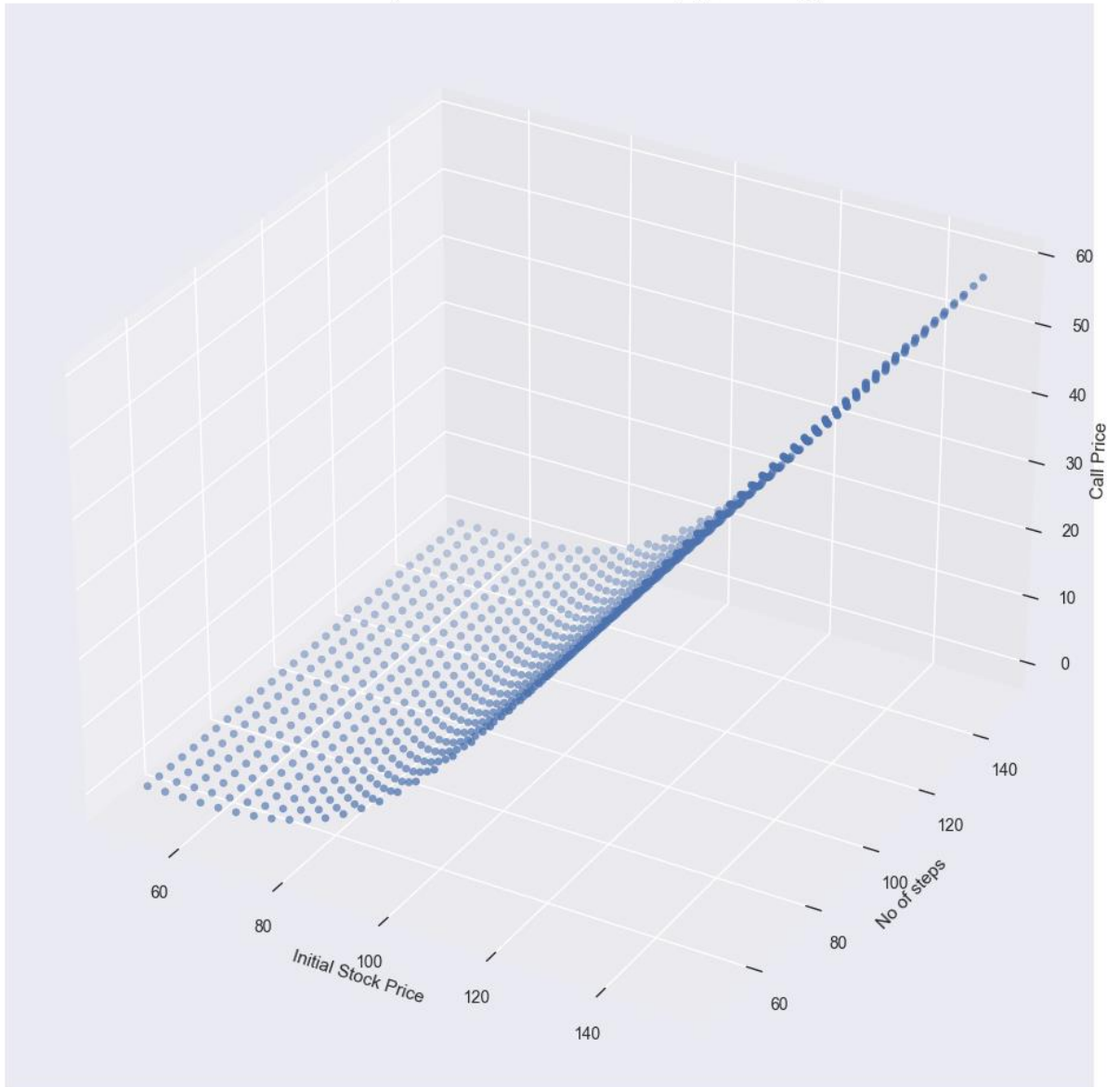
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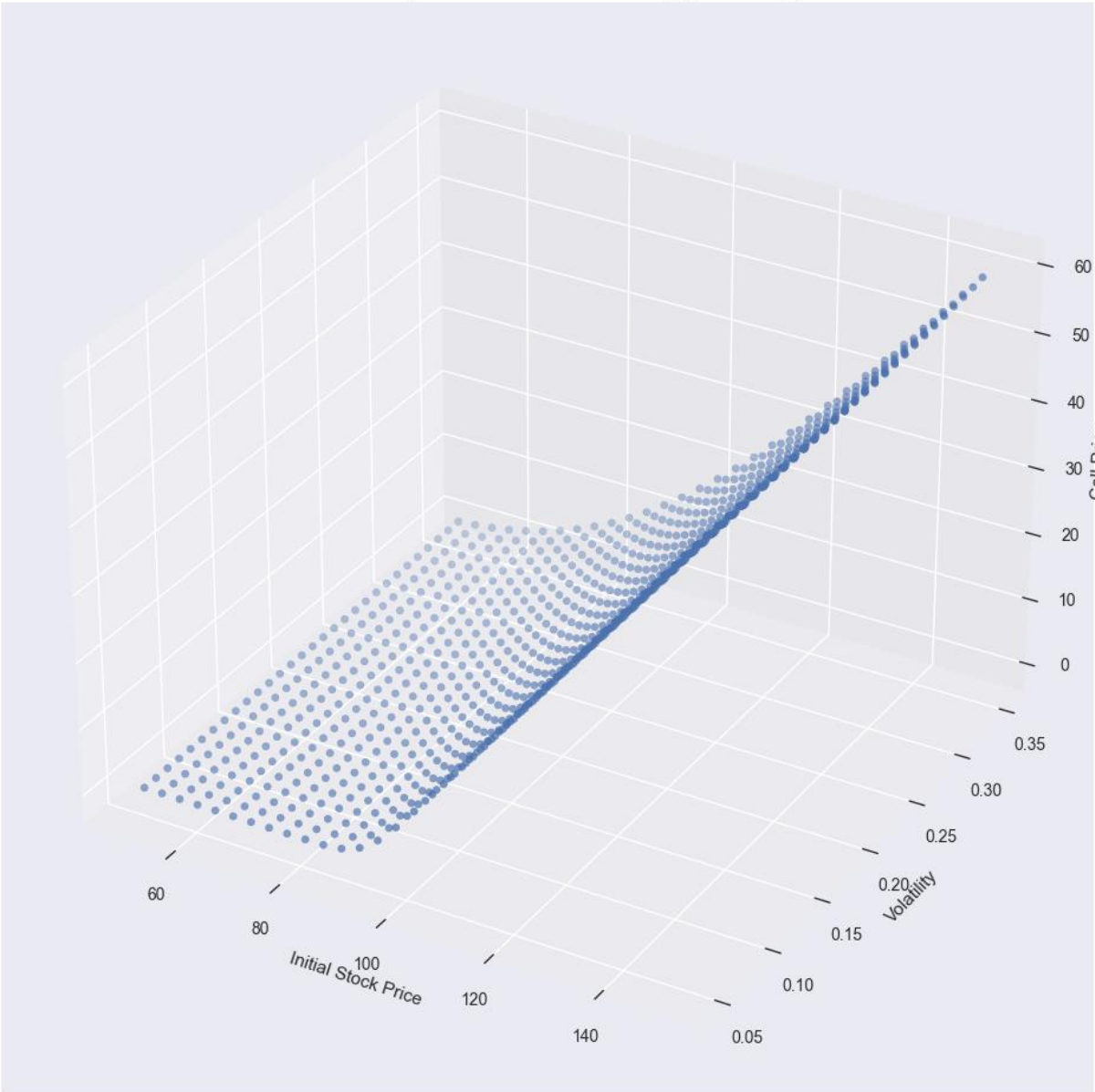
Call Price vs (Strike Price and Risk Free Rate) (Set 1 of u,d)



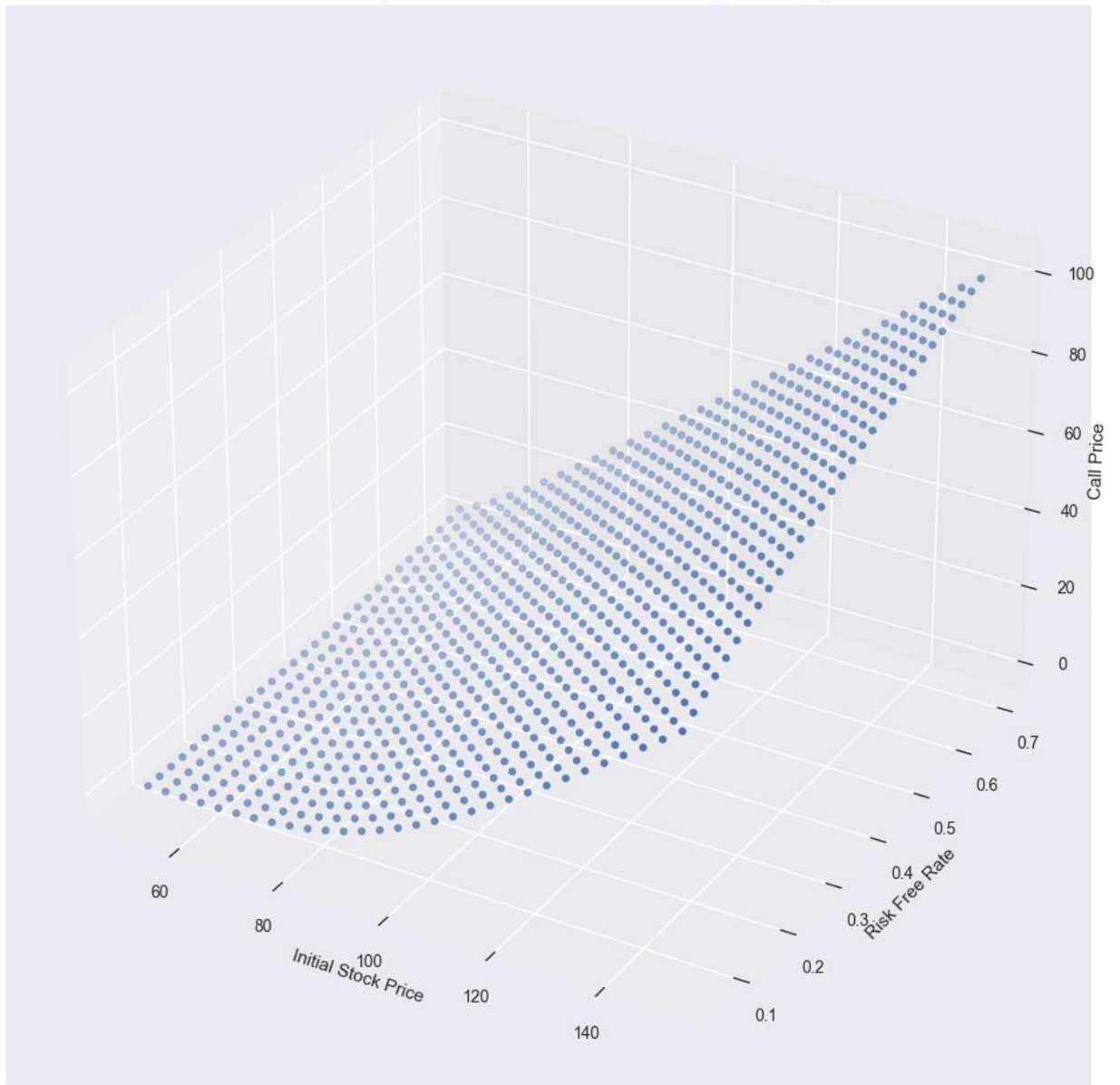
Call Price vs (Initial Stock Price and No of steps) (Set 1 of u,d)



Call Price vs (Initial Stock Price and Volatility) (Set 1 of u,d)



Call Price vs (Initial Stock Price and Risk Free Rate) (Set 1 of u,d)



Call Price vs (Initial Stock Price and Strike Price) (Set 1 of u,d)

