Volatility Analysis of AMZN: Implied vs. Historical

FRE-GY 6083 Final Project

Introduction

Main Objectives

- Calculate implied volatility from option prices using the Black-Scholes model, for AMZN
- Compare implied volatility with historical volatility.
- Explore trading opportunities based on the difference between implied and historical volatility

Why this project matters

- Market Sentiment and Expectations
- Pricing and Risk Management
- Potential for Trading Opportunities

Implied Volatility

- Value of the volatility of the underlying instrument which, when input in an option pricing model (usually Black–Scholes), will return a theoretical value equal to the price of the option.

- Reflects the market's expectation of future price movement.

Historical Volatility

- A statistical measure of the dispersion of returns for a given security or market index over a given period of time.

- Measures past volatility by calculating standard deviation of returns.

Implied Volatility Implementation
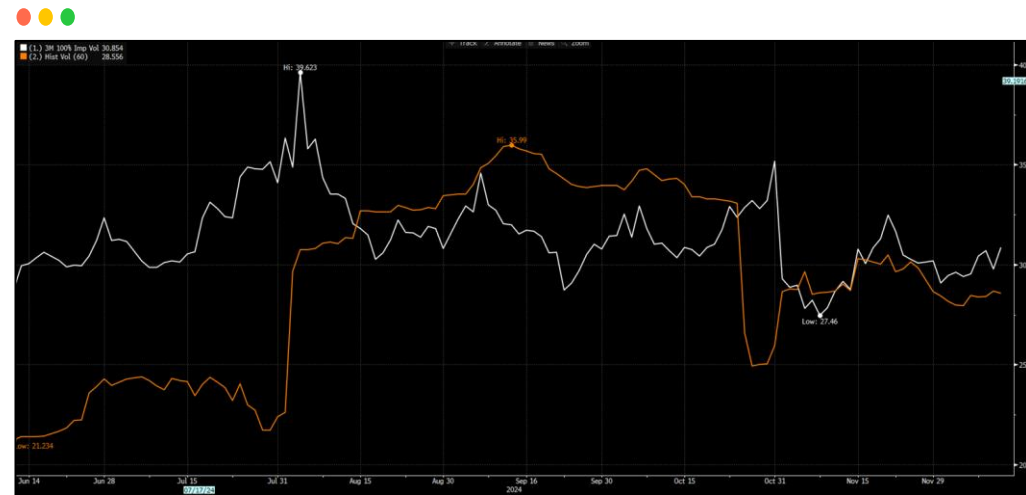
Black-Scholes Model:

$$C = S\,e^{-qt}\,N(d_1) - K\,e^{-rt}\,N(d_2)$$

$$P = K\,e^{-rt}\,N(-d_2) - S\,e^{-qt}\,N(-d_1)$$

$$N(x) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{x} e^{\frac{-t^2}{2}}\,dt$$

$$d_1 = \frac{\ln(\frac{S}{K}) + t(r - q + \frac{\sigma^2}{2})}{\sigma\sqrt{t}}$$

$$d_2 = d_1 - \sigma\sqrt{t}$$

Historical Volatility Implementation

Collect Daily Returns

$$r_t = \ln\left(\frac{P_t}{P_{t-1}}\right)$$

Calculate the Standard Deviation of Daily Returns

$$\bar{r} = \frac{1}{T}\sum_{t=1}^{T} r_t$$

Average daily return:

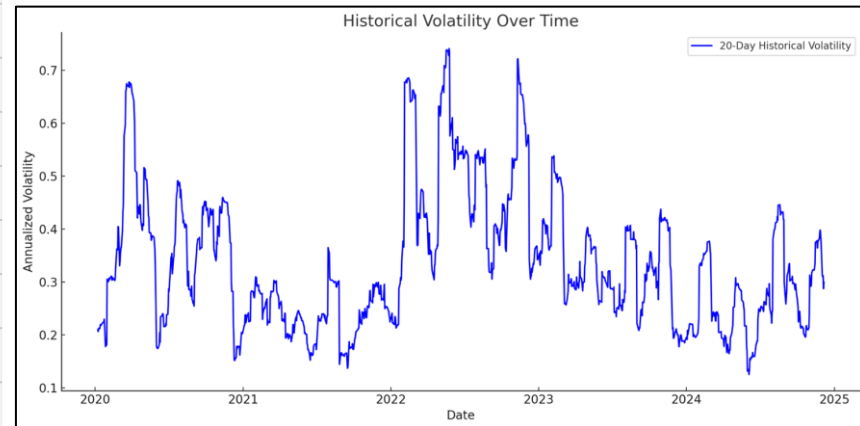$$\text{Var}_{\text{daily}} = \frac{1}{T-1}\sum_{t=1}^{T}(r_t - \bar{r})^2$$

Variance of daily returns:

$$\sigma_{\text{daily}} = \sqrt{\text{Var}_{\text{daily}}}$$

Standard deviation:
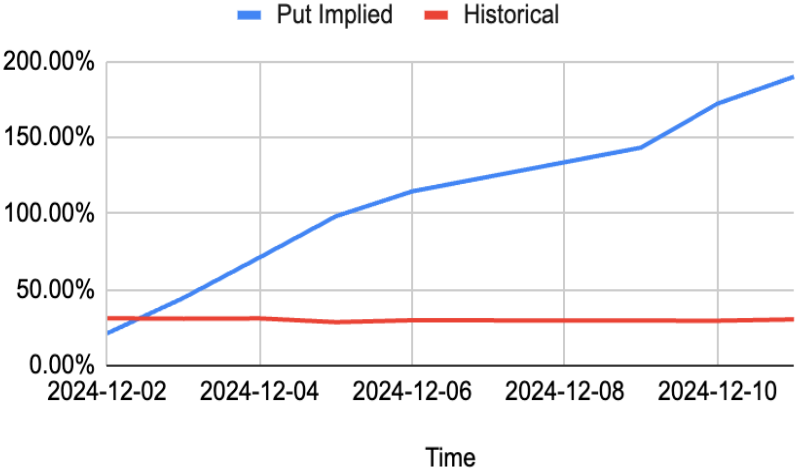
Annualize the Daily Standard Deviation
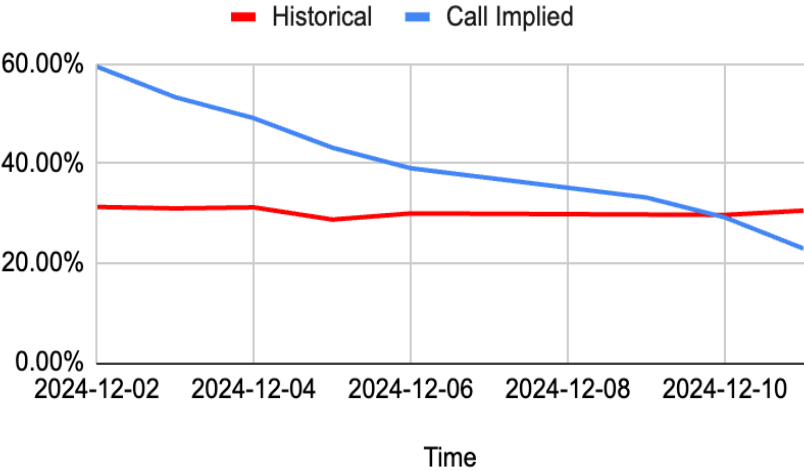
$$\sigma_{\text{annual}} = \sigma_{\text{daily}}\sqrt{N}$$

Historical Volatility Over Time

Implied Volatility VS. Historical Volatility Comparison

Trading Strategies

When IV > HV (Option overvaluation)

Selling options

Covered Calls: price of the underlying asset not rise much above the strike price / remain relatively stable.

Naked Calls: benefits by collecting a high premium, betting that the price of the underlying will stay below the strike price

Writing Strangles/Straddles

-premium for both the call and put options is inflated.

-the underlying asset (AMZN) will remain between the strike prices of the call and put.

Volatility Arbitrage

-profit from this by betting that the implied volatility will revert to more normal (historical) levels.

Profit from higher option prices relative to realized volatility.

When IV < HV (Option undervaluation)

Buying options

Straddles: underlying asset will make a significant move in either direction, an increase in volatility, higher option premiums.

Strangles: more room for underlying asset to move, potential for significant profits from a large price movement.

Long Volatility Strategies

-as volatility increases, option premiums rise, leading to potential profits from long volatility positions.

Synthetic Long Position (Call + Put)

-allows the trader to capture large price movements in either direction, with the expectation that volatility will increase and the options will appreciate in value.

Profit from potential future volatility increase.

Thank you!