**I. Introduction**

The Black-Scholes model tells us what an option should be worth given its strike price, the risk-free interest rate, the remaining time until expiration, the stock's price, and the implied volatility. However, when calculating the price of an option, we run into an issue when investigating implied volatility. All the variables in the Black-Scholes equation are typically known, and we can calculate the call or put price by plugging directly into the formula; however, we are incapable of isolating the σ in this formula algebraically. Instead, it must be solved numerically.

In this project, the root finding algorithm known as the Newton-Raphson Method (a recursive algorithm for approximating the root of a differentiable function) was used to calculate implied volatility. Newton's method works well when the function and its derivative are well-behaved. In our case, the function only has one root, so there was no need to worry about the possibility of having several mathematically allowable answers. For the purposes of this project, ATM option data taken from the Bloomberg Terminal was used for calculations.

**II.** **Put-call parity results**

S = 250, T = 6 months, K = 260, r = 4%, σ = 20%, δ = 2%

Call = 14.648651406403559

Put = 14.648651406403559

When inputting the given information into the Black-Scholes formula, put-call parity was shown to hold. This calculation was executed using Python.

**III.** **Put/Call: Limit as σ →ꚙ; Limit as σ →0**

Neither a call or put option will ever be more expensive than the underlying stock. As the implied volatility goes to infinity, the price of the option approaches to the stock value. Since, the value of the option can't go over the stock, it will act like the underlying stock. If the implied volatility goes to zero, the stock becomes a risk-free asset and needs to return at the risk-free rate.

**IV.** **Conclusions**

1. When the market prices go up, the actual and implied volatility go down and vice versa. The strike prices have an inverse relationship with volatility when examining the option chains.
2. When comparing the implied volatility with the volatilities taken from the Bloomberg Terminal, it was observed that larger jumps in the stock price (up or down) corresponded to a greater error when calculating implied volatility. This seems to show that the more volatile the stock, the more difficult it is to correctly gauge implied volatility.
3. Greater stock value corresponds with greater option prices.
4. Generally speaking, the Newton-Raphson Method seems to underestimate actual volatility.