Buying Derivatives - A Monte Carlo Approach

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2023-04-06

Contents

Chapter 1

Introduction

Over the course of the last year, I have developed an algorithm that calculates the expected outcome for security[1] derivatives[2]. In this paper, I am specifically referring to put options[3] and call options[4] when I reference derivatives. To do

[1]In finance, a security refers to a tradable financial asset that has monetary value and can be bought or sold in a financial market. Securities include a wide range of assets, such as stocks, bonds, options, futures, and exchange-traded funds (ETFs), among others.

[2]A derivative is a financial instrument whose value is derived from the value of an underlying security, such as a stock, bond, commodity, or currency. In other words, the value of a derivative depends on the value of the underlying asset. There are many types of derivatives, including options, futures, forwards, and swaps.For example, an option is a type of derivative that gives the holder the right, but not the obligation, to buy or sell an underlying asset at a specific price within a specified time period.

[3]A put option is a type of financial contract that gives the holder the right, but not the obligation, to *sell* an underlying security at a predetermined price (known as the strike price) within a specific period of time (known as the strike date).In other words, a put option gives the holder the ability to sell an asset at a certain price, even if the market price of the asset falls below the strike price. This can be useful for investors who believe that the price of an asset is likely to decline, as it allows them to profit from the decline without actually owning the asset. For example, if an investor buys a put option for a certain stock with a strike price of $50 and an expiration date of one month, and the stock's market price falls to $40 during that time, the investor can exercise the put option to sell the stock at the higher strike price of $50, making a profit of $10 per share. However, if the stock's market price remains above the strike price of $50, the investor may choose not to exercise the put option and will lose the premium paid to purchase the option.

[4]A call option is a type of financial contract that gives the holder the right, but not the obligation, to *buy* an underlying asset, such as a stock, bond, or commodity, at a predetermined price (known as the strike price) within a specific period of time.In other words, a call option gives the holder the ability to purchase an asset at a certain price, even if the market price of the asset rises above the strike price. This can be useful for investors who believe that the price of an asset is likely to increase, as it allows them to profit from the increase without actually owning the asset.For example, if an investor buys a call option for a certain stock with a strike price of $50 and an expiration date of one month, and the stock's market price rises to $60 during that time, the investor can exercise the call option to buy the stock at the lower strike price of $50, making a profit of $10 per share. However, if the stock's market price remains below the strike price of $50, the investor may choose not to exercise the call

this, I calculate several probabilities[5] and expected values, then combine them to understand if it is worthwhile to purchase a security derivative.

These probabilities are bootstrapped through the use of a Monte Carlo simulation. I am first simulating the price of the security on the strike date. I am then able, with this information, to obtain the probability the security will be above or below a certain strike and the expected value of the security if it does go above (below) the strike for a call (put). Combining this with the cost to purchase that derivative, I am able to create an expected value for a range of security derivatives.

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[5]Probability is a measure of the likelihood or chance that a specific event will occur, expressed as a number between 0 and 1. A probability of 0 means that the event is impossible, while a probability of 1 means that the event is certain to occur. A probability of 0.5 (or 50%) means that the event has an equal chance of occurring or not occurring.

Chapter 2

Calculating Expected Value

The expected value for each security derivative can be calculated as follows:

$$E_p(k) = (P_{ae} * C) + (P_{be} * G) \tag{2.1}$$

$$E_c(k) = (P_{be} * C) + (P_{ae} * G) \tag{2.2}$$

where

- $E_p(k)$ is the expected value of a put at strike price k
- $E_c(k)$ is the expected value of a call at strike price k
- P_{ae} is the probability a security price on the strike date is above the *expected price*
- P_{be} is the probability a security price on the strike date is below the *expected price*
- C is the cost to but the derivative
- G is the expected gain if the derivative is in the money