LUISS

Master's degree in Corporate Finance

Course of Advanced Corporate Finance

TRADING AND HEDGING STRATEGIES WITH OPTIONS : A QUANTITATIVE ANALYSIS

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Abstract

The following thesis aims at analyzing the effectiveness of trading and hedging strategies with options through a quantitative analysis conducted on two separate financial instruments : Amazon (AMZN), a high volatility technology stock, and SPY , an Exchange Traded Fund that replicates the S&P 500 index.
The paper opens with a theoretical background on options, a specific type of financial derivative instrument, and then continues with a practical analysis of directional strategies, volatility-based strategies and advanced strategies, such as the bull call spread and the straddle.

The empirical part is based on historical data of the two stocks from the first trading day of 2018 to the first trading day of 2023.
The strategies are implemented in Excel using the Black-Scholes model for option valuation, with monthly rebalancing and no transaction costs, thus creating a kind of paper portfolio.
The effectiveness of the strategies is evaluated through performance indicators such as total return and Sharpe ratio, taking into account different market environments and the different risk profile of the two underlyings.

The results provide evidence that directional strategies are more effective in a bearish market environment and bullish strategies in a bullish market environment, in particular they are more effective on low volatility instruments such as SPY.
Non-directional strategies, such as the straddle, benefit from high unpredictable volatility, while hedging strategies such as the protective put are more cost-effective on stable instruments.
This analysis emphasizes the importance of implementing the right strategy depending on the type of underlying but also on the expected volatility regime.

Although it simplified some aspects of reality, such as the exclusion of transaction costs and the use of historical volatility, this study provides useful operational tips for investors and portfolio managers.
The work emphasizes the flexibility of options as a strategic tool and the importance of a careful reading of the market for an efficient and result-driven application.
In addition, this study aims to make investors aware that this type of financial instrument is complex and not a game, it can be used wisely but also speculatively, and one should be aware of all its facets in order to take full advantage of its qualities.

1. Introduction

1.1 Research purpose and motivation

In the modern financial context, options represent a complex and very versatile financial instrument that can be used both for speculation and risk hedging purposes. They are key instruments for institutional investors, professional traders and portfolio managers.

The objective of this research is to analyze trading and hedging strategies using options, evaluating their effectiveness under different market conditions.

The thesis aims to :

- Analyzing the most important strategies used in trading with options;
- Analyzing risk management techniques using these derivative instruments;
- Determine, through empirical analysis of historical data, which strategies are most effective in terms of return and risk mitigation

1.2 Importance of options in financial markets

Options are nowadays one of the most widely used derivative instruments in the financial markets and offer investors many opportunities for trading, risk hedging but also speculation.

Being derivative instruments, their value is derived from and thus depends on the performance of an underlying asset, which can be a share, an index, a commodity or a currency.

Options can play different roles within the market, they can be used to protect against unfavorable market movements, they can be used to amplify returns thanks to leverage, allowing for significant gains with a low investment cost compared to the direct purchase of the underlying asset, as well as they can offer the possibility of profiting from changes in volatility.

1.3 Objective of the thesis

The objective of this thesis is to analyze the effectiveness of trading and hedging strategies with options, using an empirical approach based on

historical data and Excel simulations.

With this research we aim to examine the main trading strategies with options (spread, straddle, iron condor) in order to understand under which market conditions they are most effective.

We will also analyze risk hedging strategies; we will conduct a quantitative analysis by simulating the strategies in excel to measure returns, risks and appropriate performance metrics.

We will also determine the impact of volatility on trading and hedging strategies.

2 Fundamentals of options and trading strategies

2.1. Definition of options : main characteristics

Options are complex financial instruments that give the holder the right (and not the obligation) to buy or sell, whether we are talking respectively about a call or a put option, an underlying asset at a predetermined price (strike or exercise price) before or at a specified expiration date (maturity date). (Investopedia,2024)

Let's now talk about the main characteristics of options ; We can divide options in 2 types : call and put .

The call option gives the holder the right to buy the underlying asset at the strike price and the put option gives the holder the right to sell the underlying asset at the strike price. (Investopedia,2024)

The strike price is the price at which the holder can buy or sell the underlying asset while the expiration date or maturity date is the predetermined date by which the option must be exercised or not exercised; even tho it depends on whether the option is an American or European option: while the American option can be exercised at any time up to the expiration date, the European option can only be exercised on the maturity date.

The main difference between options and futures is that the option has an option premium : in order to receive the right to buy or sell the underlying asset, the option holder has to pay an option premium to the seller , therefore the option premium is the cost of purchasing an option, that is influenced by several factors such as market volatility, time to expiration and intrinsic value.

A call option can be in the money (ITM) , at the money (ATM) and out of the money (OTM).

- ITM : A call option is ITM when the underlying price (S) is higher than the strike price (K) ; a put option is ITM when the underlying price (S) is lower than the strike price (K);
- ATM : The underlying price (S) is equal to the strike (K);
- OTM : A call option is OTM when the underlying price (S) is lower than

the strike (K); a put option is OTM when the underlying price is higher than the strike (K).

The price of options depends on the underlying price, the time to maturity, the volatility and the interest rates. The greeks measure the sensitivity of option price with respect to the presented factors; We will explain one to one the five greeks we are talking about :

- Delta : Measures change of the option price in respect of the price of the underlying asset. If delta equals to 0,4 it means that option price approximate change is 0,4 times change of the underlying asset. Delta is calculated as partial derivative of the option price with respect to the underlying price

Source : https://thepythonlab.medium.com/option-pricing-and-volatility-modeling-with-python-implementing-black-scholes-and-garch-models-a53e1ed1b1e3

Those charts present relation between price of call and put options respectively and price of the underlying asset.

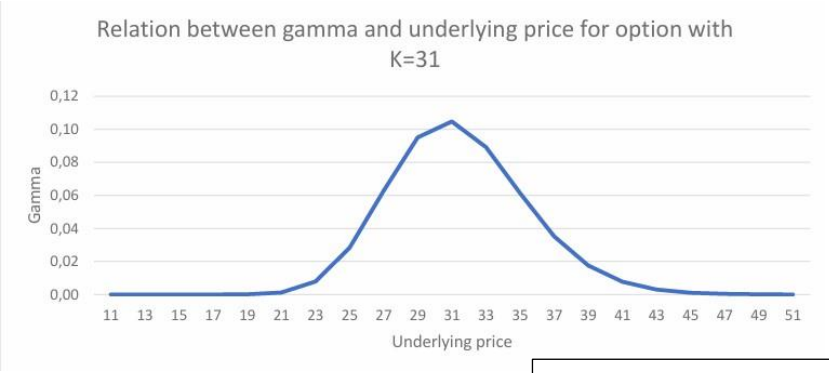
As can be seen , the relationship between option price and the price of underlying is non-linear. Hence , delta which is estimated as partial derivative, can be used to approximate option price change only with respect to small change in the price of underlying.

Delta also shows the probability at that time the option will be in the money at the time of maturity.

- Gamma:

  Gamma measures change of the option's delta with respect to the price of the underlying asset. It is calculated as the second partial derivative of the option with respect to underlying asset price.

  Gamma for long positions (both call and put) is always greater than 0; for options with fixed time to maturity , gamma is the greatest for ATM options.



Source: Author's elaboration

- Theta:

  Theta measures change of the value of the portfolio with respect to the passage of time where all else remains the same.

  Theta is generally negative for both long positions on call and put options, even tho deeply ITM put options may have positive theta

- Vega:

  Vega presents change of the option value with respect to the volatility of

the underlying asset with all else remaining the same. The higher the vega , the more sensitive is the value of option portfolio to small changes in volatility of underlying instrument. Vega is always positive for long positions.

- Rho:

  Rho measures changes of the option value with respect to the interest rate.

2.2 Option pricing: the Black-Scholes model

In the field of quantitative finance, the subject of option pricing is a crucial and technically very complex issue.

Determining the "right price" of an option requires a model that considers several factors: time value, volatility, interest rates and other market variables.

In this work, the Black-Scholes method, the most widely used in academic and professional contexts for European options (the ones we are going to deal with) has been adopted to estimate the premiums of call and put options on a monthly basis.

It is therefore necessary to dwell in depth on the structure and also the limitations of this model.

The Black-Scholes method was proposed in 1973 by Fischer Black and Myron Scholes, later extended by Robert Merton.

This method provides a formula to calculate the theoretical price of a European option, assuming that the price evolution of the underlying asset follows a geometric Brownian motion with constant volatility and normal logarithmic returns.

The model also makes a number of assumptions, namely that there are no transaction costs or taxes to be paid, that there are no liquidity risks and that one can therefore disinvest with no problem and ease, and that the market is efficient and therefore there is no opportunity for arbitrage and therefore no risk-free profit.

The price formula for a European call, according to Black-Scholes, is given by:

$$C = C = S0 \cdot N(d1) - K \cdot e - rT \cdot N(d2)$$

Where: $$d1 = \frac{ln(S0/K)+(r+\sigma 2/2)T}{\sigma\sqrt{T}}$$

And: $$d2 = d1 - \sigma\sqrt{T}$$

S0 in this formula is the price of the underlying asset at time 0, K is the strike price, r is the risk-free interest rate, T is the time to maturity in years, σ is the volatility of the underlying and N(·) represents the cumulative distribution function of the standardized normal.

For simplicity and consistency with data availability, implied volatility has been replaced in this thesis with historical volatility, calculated from the annualized logarithmic returns of the selected assets.

This represents one of the main approximations adopted in the model: implied volatility represents market expectations and is considered a more accurate measure of future risk than historical volatility, but is not always readily available.

Despite these simplifications, the above model is an important reference for option pricing due to its mathematical elegance and its ability to provide useful results for risk management, strategy analysis and portfolio construction.

Nevertheless, one must also recognize the limitations of this extraordinary model.

Among the most important limitations is the fact that it assumes constant volatility: in the reality of the financial world, however, markets are characterized by stochastic volatility, with periods of turbulence alternating with phases of stability, just like the period we are going to

analyze.
Moreover, the European option type does not allow for early exercise of the option, which is the case in American options, reducing the applicability of the model in some practical contexts.

There are alternative models that attempt to overcome these limitations, such as the Cox-Ross-Rubinstein binomial model, which allows greater flexibility in modelling American options and permits a multi-state structure that approximates Brownian motion in the limit of infinite time steps.
Another approach is the Monte Carlo method, mostly used to evaluate exotic or structured options, where the payoff characteristics do not allow the use of closed formulas such as the Black-Scholes formula.

The choice therefore to use the Black-Scholes method is motivated by the trade-off between theoretical rigour and operational simplicity.
In an educational context such as the one in which we find ourselves, where the objective is to implement and compare different strategies with options and their effectiveness on two different underlying securities and under different market conditions, the Black-Scholes model makes it possible to maintain a coherent and sufficiently realistic methodological structure.
In addition, the model allows the time value of options to be incorporated and the effect of volatility to be assessed, a key element for some of the strategies analysed such as calendar spreads, straddles and protective puts.
In conclusion, the approach to option pricing used in this thesis is based on a robust, widely accepted model that is flexible enough for the purpose of the analysis.
Despite some simplifications, the use of the aforementioned model, combined with real historical data and Excel simulations, allows for an effective comparative evaluation between different strategies adopted on different underlyings, offering the reader-investor useful insights into the practical implications of pricing and risk management through options.

3. Trading option strategies

3.1 Directional strategies

Directional strategies are a set of strategies based on the expectation of an underlying asset's price movement, whether upward or downward. The main goal is to profit from a fair prediction of the market regarding its future direction, instead of other factors such as volatility or the passage of time. A bullish directional strategy is defined as one that generates profit if the price of the underlying asset goes up, conversely a bearish directional strategy generates profit if the price goes down. Unlike neutral strategies, which focus on the change in volatility, these strategies depend on the price movement of the underlying asset. These strategies can be implemented through the sale or purchase of call and put options, either individually or in combination with each other, or even through the combined use of options and the underlying asset. The simplest directional strategies are the long call and the long put and offer an asymmetric risk/reward profile, with a maximum loss limited to the premium paid to acquire the call or put and a potential profit that is not limited in the case of a long call or limited to the drop of the underlying to zero in the case of a long put. Then there are other strategies such as vertical spreads, protective put or covered call that introduce a risk control or return optimization component. Directional strategies can be used either in a purely speculative function, where the investor wants to take advantage of a precise market expectation, or in a protective function, to improve risk management or protect an existing portfolio. In the remainder of this chapter we will analyze the main directional strategies , focusing on their structure, payoff, ideal market conditions, and their risk/return implications.

- **Long call and long put**

The **long call** consists in acquiring the right (and not the obligation) to buy an underlying asset at a predetermined strike price on a predetermined maturity date, while the **long put** consists in acquiring the right to sell an

underlying asset at a predetermined strike price on the maturity date.

Thus, the long call aims to make a profit if the price of the underlying rises by being able to pay the underlying at a lower price than the market price and the long put aims to make a profit if the price of the underlying decreases by being able to sell the underlying at a higher price than the market price.

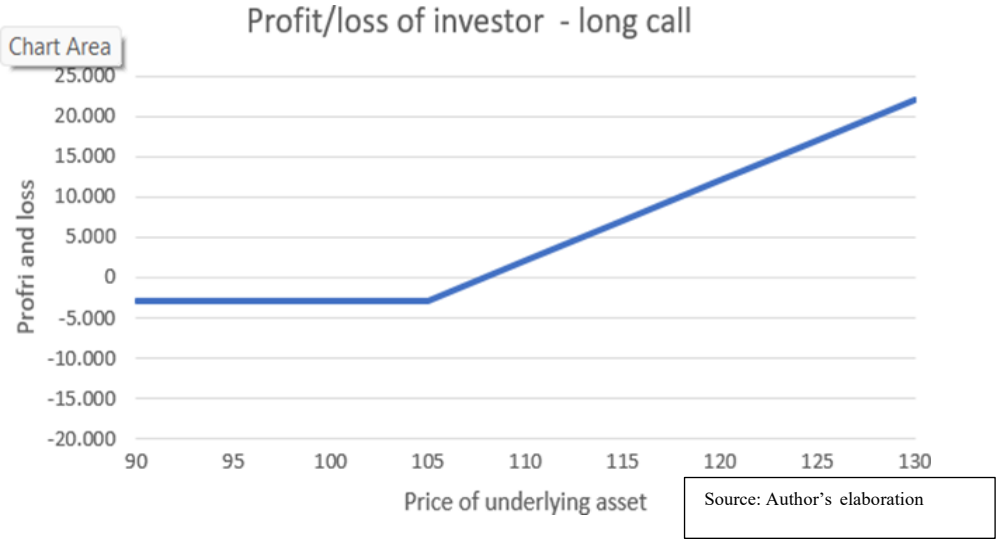
The potential profit is theoretically unlimited for the long call since the underlying (let's say a stock) can rise to the infinity while the potential profit for the long put consists in the strike price adjusted by the premium if the price drops to zero.

The maximum loss in both of the two cases is the premium paid, on the other hand the breakeven point is the strike price increased by the premium in case of the long call and the strike price minus the premium in case of the long put.

Now let us make an example :

Long call: an investor thinks the stock "AMZN" currently listed at 100 EUR (S) will be higher in the future. He decides to take a long position on 1000 call options with a strike price (K) equal to 105 EUR and a premium equal to 3 EUR (price of the option c), with a one month maturity date.

If the price of the underlying asset at the maturity date is lower than the strike, the option holder will not exercise his right to buy the underlying asset at the strike price, while if the price rises above the strike price plus the premium the investor starts to earn by buying the underlying.



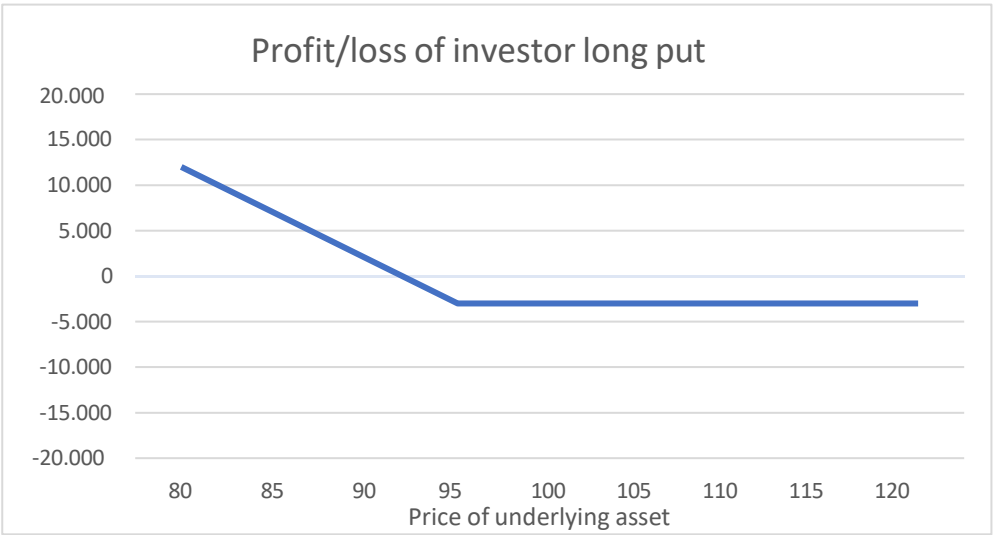
Source: Author's elaboration

As we can see from the graph, if the price of the underlying at maturity is 105 or lower, the option holder will not exercise the option and will lose the premium times the number of options (3.000 EUR).

If the price of the underlying at maturity is 108 or higher, the option holder will exercise the option and will gain the difference between the price of the underlying at maturity and the strike adjusted for the premium (always times the number of the exercised options); so if at the maturity the stock is valued at 110 then the option holder will gain 2.000 EUR (108.000 EUR -105.000 EUR -3.000 EUR).

Long put : an investor thinks the stock "AMZN" currently listed at 100 EUR (S) will be lower in the future. He decides to take a long position on 1000 put options with a strike price (K) equal to 95 EUR and a premium equal to 3 EUR (price of the option p), with a one month maturity date.

If the price of the underlying asset at the maturity date is lower than the strike, the option holder will exercise his right to sell the underlying asset at the strike price, while if the price rises above the strike price the investor will not exercise his right to sell the asset.

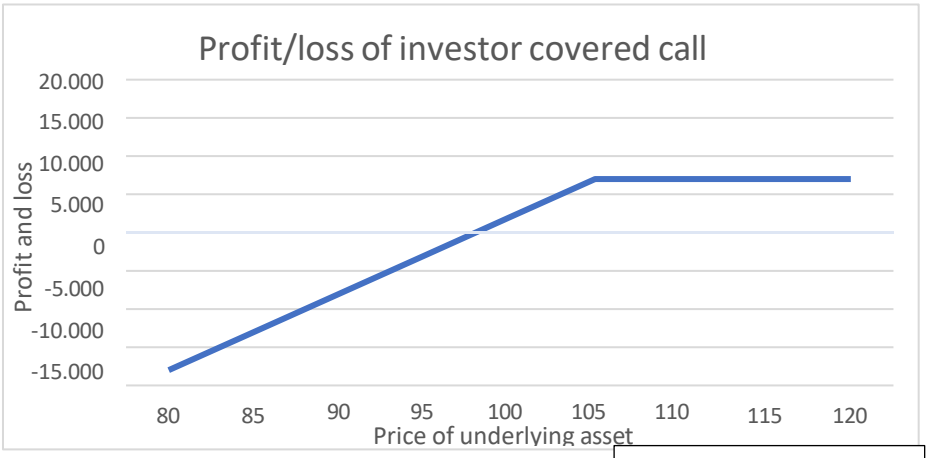


Source: Author's elaboration

As we can see from the graph, if at maturity date the price of the underlying will be 95 or higher , the investor will not exercise the right to sell and will lose the premium paid (3.000 EUR), while if it will be lower than 95, the option holder will exercise his right to sell the underlying , starting to earn money if the former price is lower than the breakeven point (92).
For instance if at the maturity date the underlying has a value equal to 90, then the gain obtained by the long put will be 2.000 EUR (strike – market price – premium) .

- **Covered call and protective put**

We will now look at two more moderate directional strategies. Those strategies are characterized by the purchase of the underlying asset, simultaneously taking a short position on call options or the long position on put options, and are used to optimize the return or hedge a position.
The first one is called "**covered call**" that is a strategy that combines the purchase of the stock with a short position on call options on the same asset (underlying). This strategy aims at obtaining an additional profit from the sale of the call premium while taking advantage of a moderate rise in the stock price.
Let us make an example: An investor purchases 1.000 stocks and simultaneously take a short position on 1.000 calls with a strike price higher than the current market price.
By doing this way, he earns the premium of the sold call, but he limits the profit due to the cap represented by the strike of the call. The investor purchase 1.000 AMZN stocks at 100$ per stock.
Simultaneously he takes a short position on a call with strike price 105$ and earns a premium equal to 2$ per stock.



Source: Author's elaboration

We can notice from the graph that the maximum profit the investor can make from this strategy is 7.000$, since if the stock price at maturity is higher than the strike (105$) then the option holder will exercise the right to buy at 105$ and the profit of the investor will be the difference between the strike price and the price at which he bought the stock plus the premium received by short-selling the option.

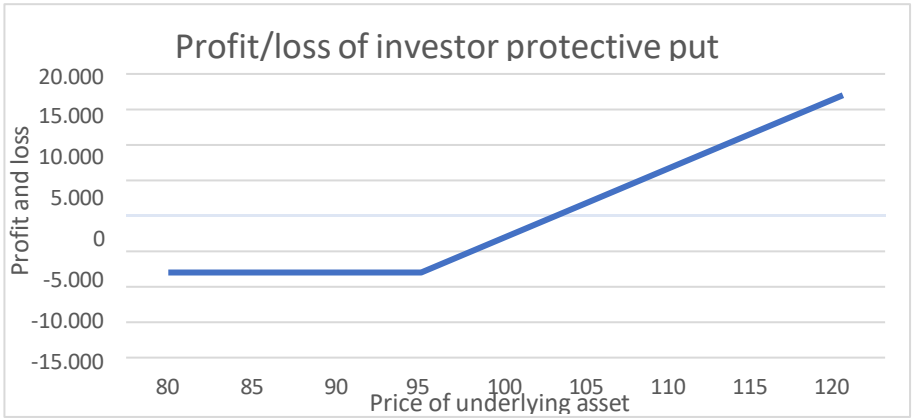
On the other hand, if the stock price declines significantly, the investor is still exposed to losses on the stock, which are only partially offset by the premium received from selling the call. This strategy exposes the investor to considerable downside risk while restricting the potential for upside returns. Let's now introduce the **protective put**, that is a strategy that combines the purchase of the underlying asset with the long position on put options.

This strategy is also called married put and it works like an insurance policy, on the one hand you hold the stock , on the other hand you take a long position on a put so as to protect yourself from a price drop.

In this case, the goal is to protect oneself in case the stock falls, while retaining the possibility of a theoretically unlimited gain in case the stock price rises.

Let us make an example : an investor decides to buy No. 1000 AMZN stocks, the price at t=0 is 100$, he decides to apply the married put strategy

and therefore he simultaneously takes a long position on No 1000 put options with a strike K= 95$, the cost of a single put is 3$/stock.



Source: Author's elaboration

As we can see from the graph the loss of the investor is limited because the falling price of the underlying is offset by the long position on the put with the same underlying, while the profit is potentially unlimited since as the share price rises , so does the investment profit, which is partially reduced by the price paid to take a long position on the puts.

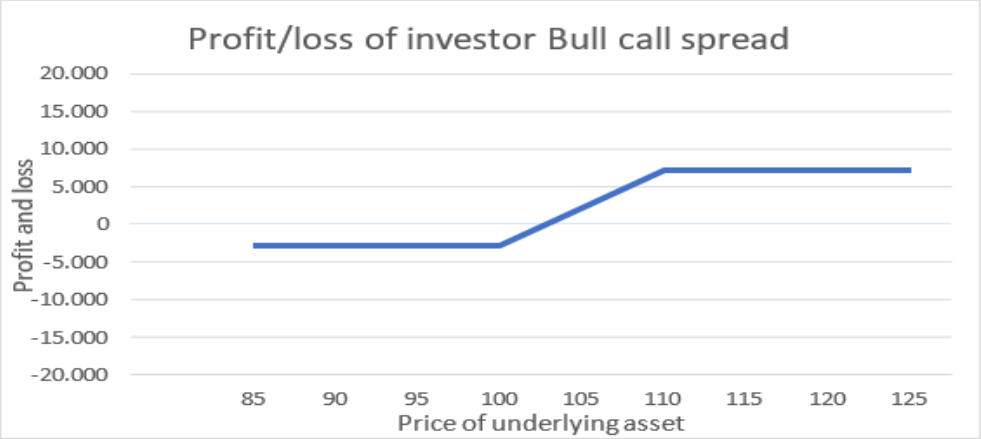
This is a strategy implemented by the investor when he has a bullish or uncertain view on the stock and wants protection from the risk of major loss.

- **Vertical spreads**

  It is time now to talk about vertical spreads, another important category of strategies with options, intended to optimize the investor's risk/return profile, allowing her to contain potential losses and define maximum profit, based on a moderate directional forecast on the market.

  These strategies involve two options of the same type, either put or call, with the same expiration date but different strike prices.

The two variants we are going to analyze are the bull call spread and the bear put spread. The bull call spread is a bullish strategy implemented using call options; the goal of this strategy is to take advantage of a moderate rise in the underlying stock while limiting both risks and gains. We will now go on to introduce the structure of the strategy and give an example for a quick and practical understanding of the purpose of this strategy. The bull call spread consists of buying a call with a lower strike price and therefore a call that is at the money or in the money and at the same time selling a call with a higher strike price therefore out of the money. Suppose the investor has a moderately bullish view on amazon stock and wants to limit the risk and contain the initial cost compared to a simple long call. Suppose he buys No. 1000 call options with a strike price (K) = $100 and a premium = $5/stock and at the same time sells No. 1000 call options with a strike price (K) =$110 and a premium= $2/stock. Obviously the expiration is the same for both and the net cost of the strategy will be $3000, resulting from the $2000 (the premium received for selling the calls) minus the $5000 (the premium paid for buying the calls).



Source: Author's elaboration

As we can see from the graph the investor faces both limited potential profit and limited potential losses : while the maximum loss is $-3000 (the net premium paid for the strategy), the maximum profit is $7000 (when the stock price at maturity is equal or above $110).

If the stock price falls down both of the option will expire worthless and the investor loses the premium paid , while if the price at maturity is

between $100 and $110, then only the long call is exercised and if the price rises ahead the $110 value, then both of the option will be in the money and therefore exercised and the one with the higher strike offset the one in which the investor has taken the long position, capping the total profit at $7000.

The bear put spread, on the other hand, is a bearish strategy that is implemented by the investor when he expects a moderate decline in the price of the underlying asset.

It consists of buying a put option with a higher strike than the asset price and at the same time selling a put with a lower strike, again with the same expiration date and the same underlying asset.

This strategy allows the investor to limit the risk and costs compared to a simple put, but also accept a limited maximum profit.

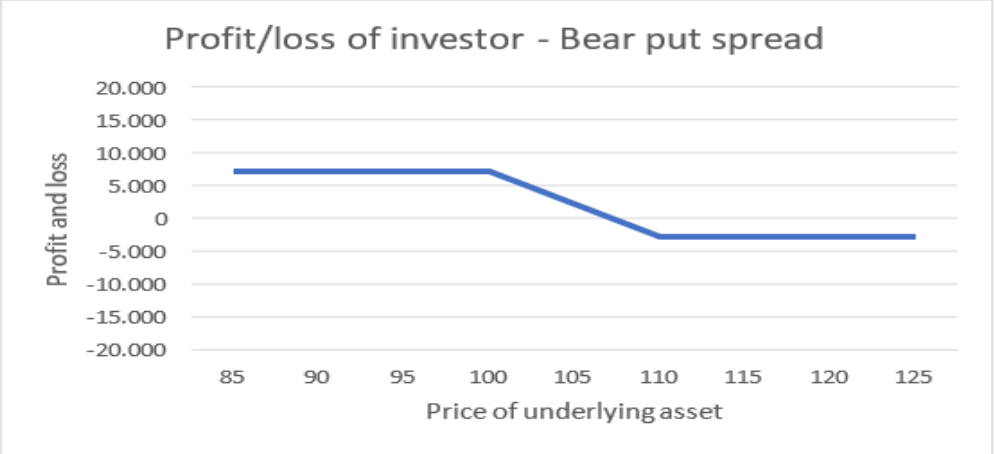
Let us now take an example based on the underlying asset used above: amazon shares.

The AMZN stock is quoted now at $110.

Since the investor has a moderately bearish outlook, he decides to take a long position on 1000 AMZN put options with strike price (K)=$110 at $5 each and to take a short position simultaneously on 1000 AMZN put options with strike price (K)=$100 at $2 each.

Again, the initial cost of the investment is $3000 resulting from the difference in the price of the put with strike $110 and the put with strike $2 multiplied by the nominal value.

Source: Author's elaboration



As we can see from the chart there are three scenarios depending on the amazon share price on the expiry date :

the first scenario sees the AMZN stock at or above $110, which means that both options expire out of the money and are therefore not exercised, so the investor will suffer a loss limited to the initial cost of the strategy.

The second scenario sees the share price fall between $110 and $100, the put purchased by the investor in this case begins to generate a return, while the put sold remains out of the money and will not be exercised. Within this range, the payoff gradually increases until it reaches a maximum, which remains when the share price falls below

$100, both options in this case are in the money and are exercised, but the profit on the put purchased is partially offset by the loss on the put sold, causing the payoff to stabilize at the maximum possible profit which in this case is $7000.

3.2 Volatility-based strategies

Let us now discuss volatility-based strategies, a very interesting category, because in this case, unlike directional strategies, the investor bets on the magnitude of the movement, that is, how much the price of the underlying will move and not on a specific movement, whether bearish or bullish.

Thus, the objective of these strategies is to profit from an increase or decrease in the expected volatility of an underlying security.

Thus the investor may use these strategies when he expects strong price movements , linked to high volatility; or he expects the price to remain stable and so linked to low volatility.

There are four main strategies that fall under volatility-based strategies : the “straddle” strategy which involves buying a call and a put with the same strike price (K) and the same expiration date by which the investor profits if the asset price moves a lot; the “strangle” strategy which involves buying a call and a put with

different strikes, has a lower investment cost but needs larger movements to be profitable; the “butterfly spread” strategy to which the maximum profit is associated if the price remains close to a target level and is a strategy based on three strike prices; and lastly the “iron condor” strategy which is a more flexible variant of the butterfly that always consists of the investor expecting low volatility for the stock and includes a combination of two vertical spreads, a put spread plus a call spread.

In this paper we are going to analyze only two of these strategies and they are going to be the straddle strategy and the iron condor strategy. As mentioned above the straddle is a strategy that involves the simultaneous purchase of a call and a put with the same strike price , same expiration and same underlying.

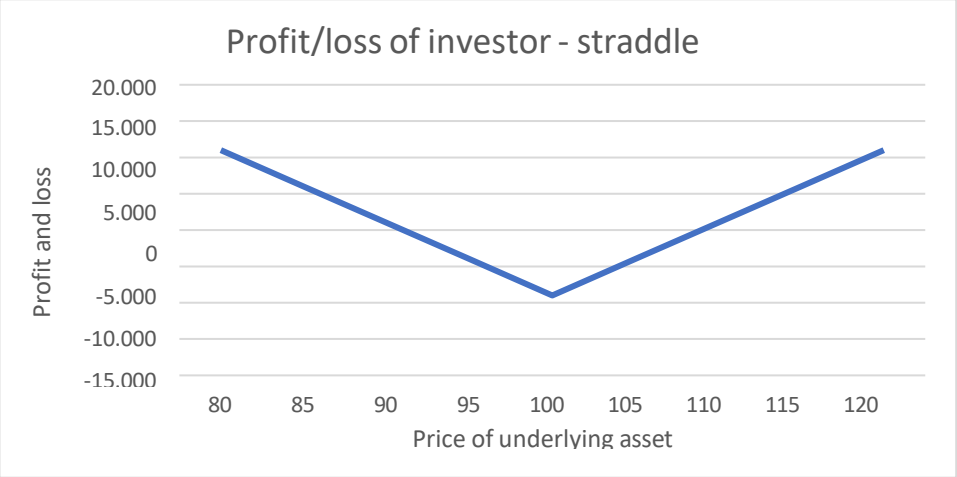
The objective of the investor in this case is to profit from strong movements in the stock price in any direction.

This strategy allows a gain if the price moves significantly above or below the strike, resulting in a loss if the price remains stable near the strike.

This is a strategy used prior to major events such as announcements that are made quarterly , interest rate decisions, or even extraordinary m&a transactions such as mergers, so it is used when there is strong estimated future volatility but it is not known in which direction the stock may go.

Let us now make an example ; the current price of the AMZN stock is $100 , the investor decides to take a long position both on 1000 call with strike (K) $100 costing $4 each and 1000 put with strike

$100 costing $5 each; therefore the cost of initial investment to implement the strategy is $9000.



Source: Author's elaboration

As we can clearly see from the graph, the maximum loss will be equal to the premium paid , i.e. $9000, if the price on the expiration date is exactly equal to the strike.

The break even point will be equal to $109 if the asset price goes up and $91 if the asset price goes down.

With this strategy you will have a large profit if the price falls far below the strike value and you will have a potentially unlimited profit if the price rises above the strike.

Obviously as the AMZN stock price changes only one of the two options will be in the money and will be profitable, but the investor will see a profit

only when the option that ends in the money is profitable enough to cover the entire cost of the investment, which also includes the purchase of No. 1000 options that will expire out of the money.

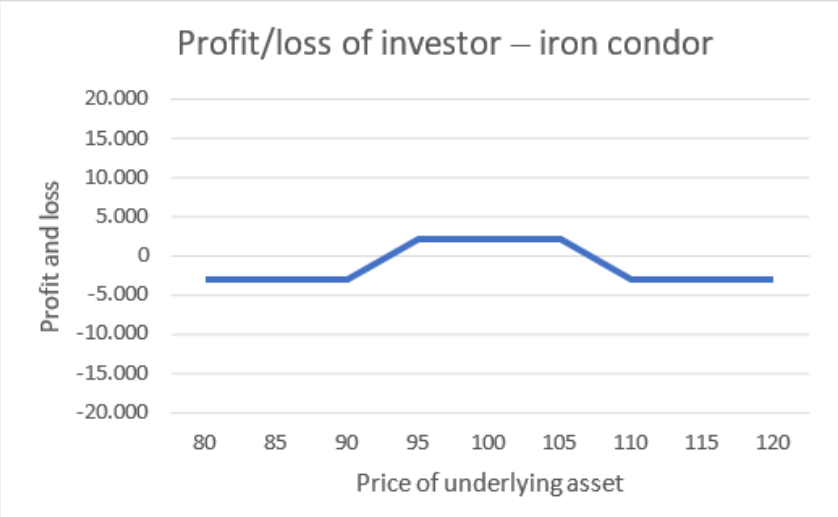
The **iron condor** is a strategy that predicts a gain when the price of the underlying asset remains within a narrow range between two strike levels. It is a strategy that includes the presence of two vertical spreads, one with put options and one with call options : the investor sells a put with a lower-medium strike, buys a put with a lower strike, sells a call with a higher-medium strike, and buys a call with a higher strike; all options have the same expiration date and are cash-settled (i.e., there is no physical exchange of the underlying asset , but the difference is settled in cash).

The goal of this strategy is to earn the net premium if the price remains between the middle strikes, that is, between the call and the put sold.

Let us now make a practical example: the current price of AMZN stock is $100, the investor decides to implement the iron condor strategy by taking :

- Long position on No. 1000 put , $90 strike , $1 each;
- Short position on No. 1000 put , $95 strike , $2 each;
- Short position on No. 1000 call , $105 strike , $2 each;
- Long position on No. 1000 call , $110 strike , $1 each;

Notice that the investor receive $2000 by implementing this strategies.



Source: Author's elaboration

We see how the investor's maximum profit consists of the difference between the premiums received and the premiums paid, only in the case where the price of the underlying asset on the expiration date remains between $95 and $105.

After that, having shorted the call and the put at a medium-high and medium-low strike price, the investor begins to lose in the event that the asset price on the expiration date is less than $95 or greater than $105 , a loss, however, that is limited to $3000 because it is offset by the long position taken on the call and the put at a higher and lower strike price, respectively.

3.3 Advanced strategy

These are strategies in which the investor not only takes a directional view on the price of the underlying asset, but also tries to exploit the passage of time (theta), implied volatility (vega), and the maturity curve.These are strategies used in more sophisticated contexts, where the goal is not just to profit from a rise or fall in price. The objectives of these strategies are to exploit expected volatility more precisely, build positions with a customized risk/return profile, actively manage time decay, and diversify exposure by also using futures on derivatives.

We will now go on to analyze two strategies in particular, the calendar spread and the ratio spread. The calendar spread is in which the options have the same strike price and different expiration dates. To implement this strategy we need to sell an option with a closer maturity date and buying an option with a longer maturity date; the options are the same, whether they are put or call, and will have the same strike price.

On the investor's view depends the type of option to trade with, a call calendar is used if one has a moderately bullish view, or a put calendar vice versa, but without expecting large movements.

The strategy takes advantage from the faster time decay of the short option and any increases in implied volatility that affect the long option.

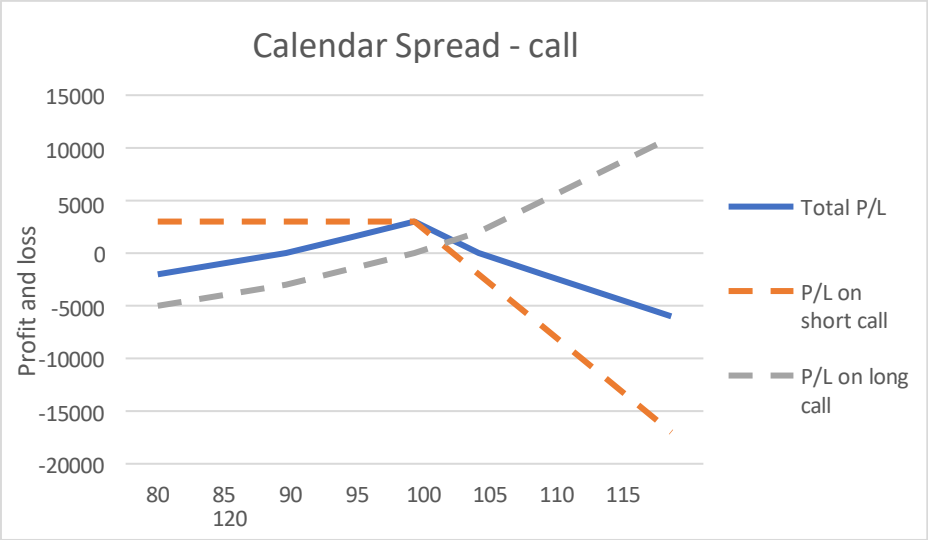
The objective is to benefit from the stability of the price of the underlying asset near the strike in the short run; the strategy is therefore optimal in moderately directional markets , where low

volatility is expected in the short run but volatility is expected to increase in the medium to long run.

Let us now make an example with our No. 1000 AMZN stocks currently quoted at $100.

The investor decides to buy No. 1000 call options having a strike equal to $100 expiring in 3 months, premium $6 each and simultaneously sell No. 1000 call options with the same strike but expiring at 1 month, premium received $3 each. So the net cost of the strategy will be $3 per option and therefore $3000.

Source: Author's elaboration



As we can see from the graph, the blue line represents the total payoff resulting from the payoff on the one-month maturity short call (orange line) and the three-month maturity long call (gray line).

The gain from the short call is limited to the premium received while the loss increases proportionally as the amazon share price rises; however, as for the payoff from the long call, it shows an increasing trend above the strike.

Adding up the two payoffs, therefore, results in the blue line, i.e., that of the total payoff, where it is observed that the maximum profit occurs when the amazon share price at the expiration of the short call is near the strike, while significant price movements lead to a reduction in the overall payoff..

This strategy is used in contexts of low expected volatility in the short term, with an expectation of increased volatility in the long term .

The purpose is precisely to profit from the time decay of the call sold.

We now explain why the increase in implied volatility over the medium to long term plays an important role in this strategy : because as implied volatility increases, the value of options increases, due to a higher probability that the option will end up in the money at expiration.

However, why does the value of options tend to go up if implied volatility

goes up and there is a chance that the option will go very much in the money, but also very much out of the money?

Because options have an asymmetric payoff profile, if it ends up very much in the money the gain can be huge, if it ends up very much out of the money the loss is only limited to the premium paid.

This is the reason why the market in the presence of high volatility tends to price options higher, especially those with long expiration or no intrinsic value.

Let us now turn to the ratio spread, a strategy of buying one option, put or call, with the sale of two or more options of the same type, such as the same expiration date but with different strikes.

Talking about call ratio spread, the investor buys one call with a lower strike and at the same time take a short position on two calls with a higher strike.

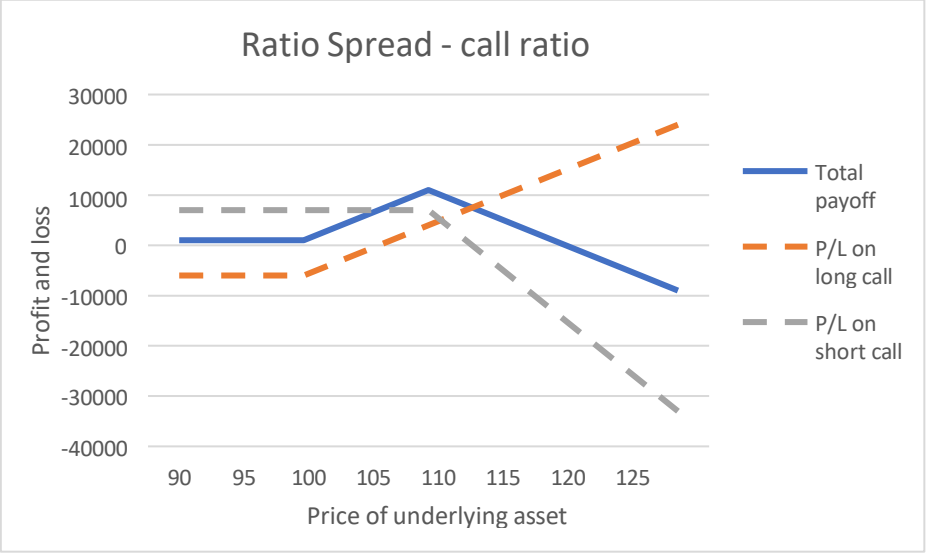
The aim is to profit from a directional but moderate movement; the investor hopes the price of the underlying will move to the strike of the shorted options.

In fact, the investor will profit most when the price stops around the short strike, but if the price moves much higher than the strike of the sold options, the losses can be significant.

Let us now make an example : let us suppose that an investor wants to implement a call ratio spread on AMZN, he buys No. 1000 call options with strike $100 (premium paid $6 each) and simultaneously sells No. 2000 call options with strike $110, (premium received $3.5 each).

Therefore initially the investor receive $1000.

Source: Author's elaboration



As we can see the maximum profit is made when the stock reaches exactly at the strike of the short calls, a price at which the call bought is well in the money and the short calls on the other hand are just out of the money.
There are two break even points, approximately at $92.5 and just after $120; beyond a certain price, however, losses are theoretically unlimited.

4. Hedging strategies with options

4.1 The concept of risk hedging

Risk hedging in the context of financial markets is central to every type of investor, whether individual or institutional.

Market volatility, macroeconomic uncertainties, changes in interest rates, or geopolitical events can significantly affect the value of a portfolio.

In this context, hedging consists of a strategy to limit or neutralize potential losses from unfavorable market movements.

Among the various instruments with which an investor can herself from the risk of portfolio's value loss, options are distinguished by their flexibility but also by the possibility of exploiting strategies tailored to the investor's risk profile. Options have one main characteristic: the asymmetric protection, i.e., it is possible to limit losses without completely giving up potential gains.

However, hedging entails a cost, in this case represented by the cost arising from the purchase of the option and can be interpreted as a kind of "premium" paid for insurance, which allows the investor to face adverse market scenarios with greater serenity, while accepting a sacrifice in terms of potential return.

In this section we will look at the main hedging strategies that can be implemented through the use of options, evaluating their effectiveness in terms of portfolio protection and impact on expected returns.

4.2 Hedging with protective put

The protective put discussed in the previous chapters is one of the most commonly used hedging strategies which involves owning the underlying asset and simultaneously purchasing a put option on the same asset in order to protect the value of the equity investment in the event that the share price falls below the strike of the put.

It is a strategy in which in each scenario the maximum risk is limited to a small loss, thanks to the work done by the put; if the share price rises, on the other hand, the investor participates in the gains, at the sacrifice, however, of the premium paid to take a long position on the put.

This strategy is used by investors when they are long on the stock but fear a temporary fall in the market, i.e. in contexts of uncertainty or volatility, or simply when they want to limit maximum losses without closing the long position.

4.3 Delta hedging

Let us start by recalling the definition of delta : a measure of the sensitivity of the option price respect to the price of the underlying asset. Delta is then the change in option price for every $1 change in share price.

Delta hedging is itself a strategy that aims to neutralize the directional exposure of a portfolio composed of options with respect to the price movement of the underlying asset.

Thus, if the share price moves, hedging with shares (or futures) offsets the losses or gains of the options.

Let's take a practical example with our 1000 AMZN call options, each with a delta of 0,5, meaning that every $1 change in the price of the underlying asset will change the call option price by $0,5. We will then calculate the delta of the portfolio which will be equal to 0,5 times the number of options and thus equal 500.

To make the portfolio delta neutral and thus protect it from the risk of a change in the price of the underlying asset, we would have to take a short position on 500 amazon shares.

However, it must also be said that the delta is not fixed but changes as the price of the underlying changes, but also according to the time to expiry or the implied volatility, so delta hedging is a strategy that requires frequent adjustments, and here lies the difference between dynamic and static hedging.

Static hedging is hedging against risk only once, when the position is opened. It is easy to implement and has low fees but is not very effective for significant or sudden market movements.

Dynamic delta hedging is a hedge that is updated frequently, when the option delta changes. It is a demanding strategy because it requires

frequent trades; it is much more accurate in protecting against market risk but on the other hand more expensive due to commissions.
Delta hedging can also be implemented via futures or forwards, which are more liquid and standardized instruments than equities, but above all there is no significant initial outlay but only margins.

4.4 Vega hedging and volatility management

Vega presents change of the option value with respect to the volatility of the underlying asset with all else remaining the same.
It is therefore a measure of the change in the option price if the implied volatility increases by 1%.
It is positive for long options, negative for short options, whether call or put.
So if an option has a vega equal to 0,25, it will decrease by $0.25 if the implied volatility decreases by one percentage point.

The objective of vega hedging is to protect oneself from losses due to changes in implied volatility. To hedge vega one can combine options with different vega, use strategies such as calendar spread or ratio spread that have specific vega or construct a vega neutral portfolio.
Let us take an example, we have a long position on call options at the money with a positive vega of 500, this means that if volatility falls there is a risk of a major loss and so we decide to hedge by taking a short position on options that have a similar vega but with different characteristics, bringing the vega to zero.
Volatility management consists of choosing strategies according to the volatility environment that awaits the investor.
In the case of high volatility, the intelligent investor prefers long vega strategies such as straddle or strangle (they gain if volatility increases), in the case of low volatility instead short vega strategies such as iron condor or butterfly (with the aim of cashing in premiums without expecting

significant movements).

4.5 Conclusions on chapter 4

In this chapter, we have analyzed the main hedging strategies available for managing risk in equity portfolios, with a focus on the use of options.

We have outlined the concept of hedging and focused on option strategies that offer asymmetric protection against market movements.

We analyzed various hedging strategies such as protective puts, a simple and effective form of insurance against sudden declines, but also delta hedging to neutralize a portfolio's directional exposure, and lastly vega hedging to reduce a portfolio's sensitivity to changes in implied volatility, relevant in situations of uncertainty or exogenous shocks.

These strategies have the same objective of putting a brake on risk while still leaving room for the possibility of return, although they differ not only in structure but also in specific purpose.

In the next section we will move on to the practical implementation of these techniques through the construction of a simulated portfolio and a backtest of different trading and hedging strategies.

Thanks to this, we will be able to evaluate performance under different market scenarios, drawing quantitative conclusions on the effectiveness of each strategy.

5. Data collection and preparations

5.1 Selection of assets for analysis

We chose to focus on two different portfolios, each characterized by a single security.

The two securities are : Amazon and SPY.

The choice is motivated by their different nature in terms of volatility, structure, and role in financial markets.

Amazon represents a tech company with high volatility and significant historical growth, on the other hand SPY is an ETF that replicates the S&P 500 index, which is characterized by greater diversification and thus lower volatility.

This choice is important because it allows us to compare the effectiveness of the strategies on two assets with a very different risk/return profile.

We analyzed the period from the first trading day of 2018 to the first trading day of 2023. We chose this interval because it includes phases of strong growth , but also market corrections and periods of high volatility, such as the COVID-19 pandemic in 2020.

By doing so, we were able to test the effectiveness of the strategies in very different market environments.

We did not include dividends distributed by SPY, focusing the analysis exclusively on price movements and option premiums.

In addition, we would like to point out that an important aspect of the selection of AMZN and SPY is their different volatility, which significantly influences prices and thus strategies with options.

To reflect these differences, different OTM and ITM strike prices were chosen for each asset :

- Amazon : OTM and ITM strikes calculated by multiplying the closing price by 1.15 and 0.85, respectively, to reflect the wider price swings typical of high-volatility stocks;
- SPY : OTM and ITM strikes calculated by multiplying the closing price by 1.05 and 0.95 , respectively, to reflect the lower volatility of the index compared to individual stocks.

5.2 Downloading historical data

Historical stock price data were downloaded from Refinitiv, a leading financial data platform known for quality and reliability of information.

From the closing stock prices, historical returns and volatility were then calculated. Option prices are calculated monthly using the Black-Scholes method.

This method was chosen because of its wide acceptance in the academic and professional world , despite being characterized by some limitations.

Because of the difficulty in finding implied volatility, internally calculated historical volatility was used.

5.3 Data organization in Excel

The data collected was organized in an Excel file with several worksheets, each portfolio in a different excel file. The first worksheet includes the data of the security's closing prices, the percentage change, and the logarithmic returns to calculate the security's annualized volatility on a monthly basis, which we find in the second worksheet. In the third worksheet we find the security's close prices, the ATM, OTM and ITM strikes, the annualized volatility and the risk free rate, and the time to maturity was calculated to price the options using the Black-Scholes method. In the following sheets, ATM, ITM and OTM options were then priced at one-month and three-month maturity. Then the strategies were implemented on a monthly basis, each strategy sheet including the price of the underlying asset, the option price, the payoff of the strategies, the monthly profit/loss and the cash outflows and the cash fund to monitor the performance of the capital over time.

6. Backtesting strategies in Excel

6.1 Methodology and key assumptions

This chapter will describe the methodologies used to test the strategies on Amazon and SPY, together with the assumptions adopted for simplicity and to make the results comparable.

The strategies tested include :

- Covered call
- Protective put (hedging strategy)
- Bull call spread
- Bear put spread
- Straddle
- Calendar spread

The main assumptions are as follows:

- Option prices calculated using the Black-Scholes method, using historical and not implied volatility;
- No transaction costs
- No dividends for SPY, consistent with the approach taken in the previous chapters
- Monthly rebalancing of strategies, with positions closed and new positions reopened each month
- OTM and ITM strike prices selected on the basis of the historical volatility of the underlying asset
- Risk free rate of 3%

6.2 Simulation of trading strategies

Trading strategies were implemented using the historical data organized in the excel file, including the following strategies:

- Covered call : taking a long position on 1000 shares of the underlying asset and a short position on a call OTM for each share purchased. Selling the call generates monthly profits, but this is a strategy that limits the potential gain while reducing the risk;

- Bull call spread : Purchase of an ATM call (in this case 1000) and simultaneous purchase of an OTM call (in this case 1000); to profit from moderate rises;
- Bear put spread : Purchase of 1000 ATM call and sale of 1000 OTM call to profit from moderate declines ;
- Straddle : Simultaneous purchase of 1000 ATM call and 1000 ATM put to profit from extreme movements regardless of direction;
- Calendar spread : Selling 1000 ATM calls at one month expiry and buying 1000 ATM calls at three months expiry to take advantage of differences in volatility and time decay.

6.3 Simulation of hedging strategies

The protective put strategy was implemented in order to protect the portfolio from strong declines; as we have seen before, it is a strategy in which the loss is limited while the gain is theoretically unlimited.

It was simulated by buying 1,000 OTM puts per lot of 1,000 shares, maintaining a conservative but costly approach in terms of premiums paid.

6.4 Performance evaluation metrics

With regard to the evaluation of the implemented strategies, several performance indicators were used:

- Total return : ratio of net profit to total cash out;
- Total profit/loss
- Total cash out
- Volatility of returns : standard deviation of monthly returns;
- Annualized sharpe ratio : measure used to assess the risk-adjusted return of an investment.

7. Comparative Analysis of Strategy Performance

7.1 Introduction to comparison

After illustrating the structure of the analyzed strategies, this chapter aims to conduct a comparative analysis of the same strategies implemented monthly on the two selected stocks Amazon and SPY. The objective is to assess the effectiveness of each strategy not only in absolute terms but also considering the consistency with the nature of the underlying and the operational sustainability over time as well as the stability of the risk/return profile. The comparison will be made strategy by strategy, highlighting how the structural characteristics of the two instruments affected the final results. The analysis will be supported by graphs in order to provide a more complete and critical view of the dynamics observed over the backtested period.

7.2 Bullish strategies

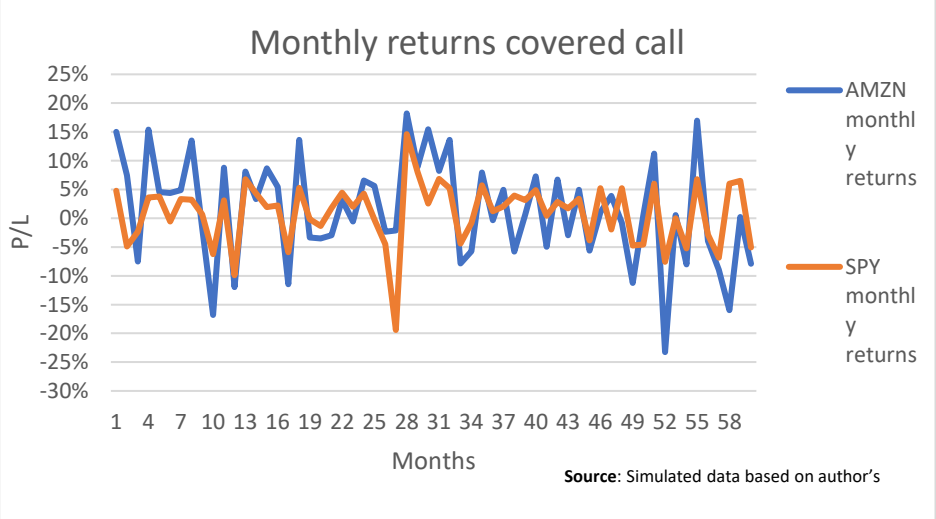
Comparing the implementation of the **covered call** on the two selected securities reveals two distinct return and management profiles, although the structure is the same. In both cases, the strategy produced an annualized sharpe ratio of 0.43, a sign of similar risk/return efficiency. Despite this, Amazon's percentage return was significantly higher than SPY (83% vs. 53%), but with a much more complex and volatile operational setup. Amazon, as a high-volatility growth stock, offered higher option premiums, translating into higher potential cash flow. This advantage is, however, offset by a riskier and more dynamic management: the high probability that the share price will exceed the strike of the calls sold leads to frequent allocations and loss of upside, making the return more prone to forced breaks in the strategy and less linear.

In addition, larger and more unpredictable movements in Amazon's stock require more active rebalancing, with operational risks associated with more frequent trades and the possibility of buying the stock back at higher

prices. In fact, the higher return is accompanied by more complex and nervous management.

In contrast, SPY showed greater operational stability. Its low volatility makes OTM calls more likely to expire worthless, allowing the investor to collect the premium on a regular basis and without interruption. In addition, the lower volatility and thus lower likelihood of large and unpredictable movements reduces the frequency of allocations and rebalancing, facilitating a more predictable management, suitable for an income-oriented profile.The lower return is due to lower option premiums, justified by the lower risk of the underlying.

Basically, although the covered call on AMZN generated a higher percentage return, the strategy on SPY is more sustainable over time with easier and more consistent management. This comparison underlines how the quality of return is not only measured by absolute performance, but also by the robustness of the strategy with respect to the nature of the underlying.



Source: Simulated data based on author's

From the graph we can see how the strategy implemented on Amazon's stock exhibits greater volatility in returns, with larger peaks, both in positive and negative terms, consistent with the more speculative nature of the stock. SPY on the other hand shows a more regular and stable

distribution of returns. This difference confirms how AMZN, while offering higher premiums as a more volatile security, makes the strategy more susceptible to directional breaks, requiring frequent rebalancing. SPY on the other hand, being a less volatile stock, allows a smoother and more consistent implementation of the strategy, despite a lower return. The graph reinforces the concept of return quality, distinguishing between a more profitable but unstable management like Amazon and a more sustainable one. Here we can also see that one of the fundamental principles of finance is also confirmed, namely that a higher return is associated with greater risk.

Let us now analyze the results of the **bull call spread** strategy, implemented using a combination of a long position on ATM call options and a short position on OTM call options with monthly expiry. The result was particularly significant for both stocks; the strategy was characterized by high implied leverage and a total absence of capital reloads. The total cash out was in both very low, around $1000 for AMZN and $1850 for SPY, despite this the profits generated were remarkably high in proportion to the capital allocated.

In the case of AMZN, the strategy generated a net profit of $19.000, with a total return of 1879%. The fact that this was achieved without any further capital injection reflects the strategy's high profit potential when the market is moderately bullish, moderately because remember that the profit is limited to the strike of the OTM call sold. In fact this is a strategy that limits the risk but also the potential gain if we compare it to a simple long call. Returning to the analysis of the results, the annualized sharpe ratio of 0.65 signals moderate risk/return efficiency: the volatility associated with the returns is therefore relatively high. The strategy therefore proved to be very profitable but exposed to phases of erratic performance.

Decisively more impressive are the results obtained by SPY, where it is true that the cash out was almost double, although we are still talking about

moderate figures, but the net profit amounted to $118.000 and no additional cash flow here either.The total return is about 6400% and greatly highlights the multiplicative effect of the spread structure in a market that tends to be bullish and stable. The annualized sharpe ratio of 1.07 confirms an excellent risk/return efficiency, signaling that the returns were not only high, but also well-proportionate to the volatility of the results. The more predictable nature of this stock favored a dynamic in which the moderately bullish movements of the underlying triggered the options' strike spread with regularity, generating consistent and repeatable profits.

However, we would like to emphasize that the results obtained are significantly influenced by the favorable market context observed during the period of analysis, characterized by short corrective phases, but above all by a bullish underlying trend. In a sideways or bearish scenario, this strategy would be much less effective: in sideways markets, movements insufficient to reach the upper strike would generate limited or even zero profits; in bearish markets, the maximum loss would coincide with the entire premium paid, making the strategy inefficient and disadvantageous compared to more conservative strategies.

We would therefore stress the point regarding the implied directionality of the bull call spread, which makes it a suitable strategy only in contexts with a well-defined bullish view. In both cases, in fact, the value of the stock and the ETF share after a month rose so as to be able to finance not only the strategy of the following month but potentially the strategies for the following 4 or 5 months, which allowed the hypothetical investor a minimum and only initial cash out, what would have happened if in the first months both options had expired without value? Surely to continue with the strategy the investor would have had to keep his nerves, his cool and believe in his own bull market projections, which is not easy because then the uncertainties and doubts of the individual agents that form the world of behavioral finance come into play.

7.3 Bearish strategies

Let us now turn to the implementation of the **bear put spread** strategy. To do this, ATM puts were bought and at the same time OTM puts were shorted with a monthly maturity. This strategy showed very different results between the two stocks, reflecting not only the technical structure of the strategy but also the interaction with the reference market environment. In the case of SPY, the strategy allowed the investor to generate a net profit of about $22.000 on a total cash out of $50.000, reflecting a total return of 43% over the 5 years considered. However, the performance was accompanied by an extremely high monthly standard deviation (205%), explained by highly unstable behavior. However, this figure can be interpreted in the light of the US macroeconomic environment: despite the fact that the period analyzed included moments of high stress such as the market crash due to the 2020 pandemic, the S&P 500 showed an overall bullish underlying trend, thanks to accommodative monetary policies, expansive fiscal interventions and a robust post-pandemic recovery. In this market environment, the implementation of a bearish strategy such as the bear put spread is structurally disadvantaged, as the absence of prolonged downtrends reduces the probability of positive payoffs. The annualized sharpe ratio in fact signals a moderate inefficiency despite a positive end result as it is 0.30. It must be said, however, that even more critical was the implementation of the same strategy on the AMZN stock, where a loss of $798 was recorded on a cash out of USD 23400 and thus a negative total return of -3%, not to mention the strongly negative annualized sharpe ratio (-6%). This is because the period analyzed for Amazon was characterized by an aggressive initial expansion until 2021, followed however by a major correction between the end of 2021 and the whole of 2022, linked to macroeconomic tensions and rate hikes. In this context, the average monthly volatility was 117%. Sold options often did not adequately compensate for the costs of purchased options, leading to erratic or zero payoffs.

To summarize, the implementation of this strategy in the US market during the period from 2018 to 2023 proved ineffective due to the absence of sustained bearish phases. The historical context analyzed was characterized by short shocks and quick rebounds, conditions in which the strategy cannot be exploited to the full. While SPY closed with a profit due to its greater predictability, Amazon proved unsuitable for a strategy so sensitive to directional consistency. The comparison made of these two strategies still demonstrates the importance of a careful reading and forecasting of the market environment to implement the right strategy.

7.4 Non-directional strategies

The **straddle** strategy is based, as mentioned in chapter 3, on the simultaneous purchase of a call and a put at the money, with equal maturity date. The success of the strategy depends on the ability of the underlying to register large and sudden changes regardless of direction. The effectiveness of the straddle is linked to the realized volatility compared to the implied volatility of the options, and the unpredictable nature of the movements of the underlying. In the case of the SPY ETF, the strategy performed well: with a total cash out of $5.600, the strategy generated a net profit of $110.000 and the return was therefore 1976%, accompanied by an annualized sharpe ratio of 1.08.

However, these results should be seen in the context of the US macroeconomic environment of the period analyzed, which saw alternating phases of growth, crisis and major upturns. These events created systemic shocks and large price movements as well as sudden movements in the index. This is an ideal behavior for the strategy mentioned above, as the sudden movements allow one of the two options to generate significant payoffs, which are higher than the cost of the strategy and thus the cost of the long positions on the call and put options. Another factor that plays a crucial role in the case of SPY is that since it is a widely traded and therefore very liquid ETF, option premiums are relatively low. This made it possible to implement the strategy with affordable costs and with frequent breakeven points. The favorable

combination of strong movements and relatively low option prices made the strategy very effective on SPY in this specific time frame.

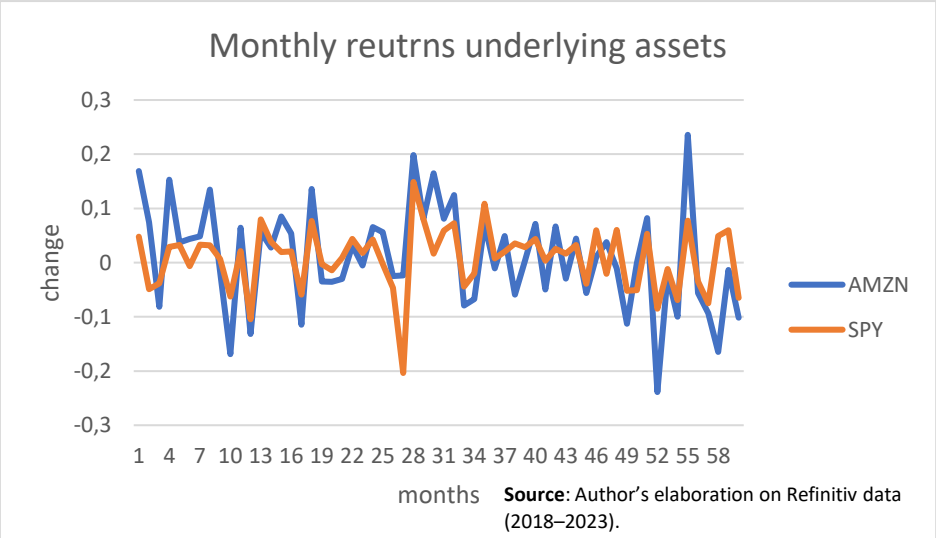
On the other hand, the performance of the strategy on Amazon did not prove to be as successful, quite the contrary. With a total cash out of $35,000 and a net loss of about $17.000, there was a negative return of -48%, with an annualized sharpe ratio of 0.52, a positive value that may seem a paradox, but can be explained: the strategy still generated positive returns in a significant number of months, interspersed with episodes of large losses. These drawdowns did not generate an excessive standard deviation in relation to the average monthly return. The sharpe ratio in fact does not fully capture the asymmetry or the time sequence of returns but only their statistical distribution around the mean. In practice, the strategy as a whole was inefficient in absolute terms but not excessively volatile in relative terms, which allowed the sharpe ratio to remain above zero.

We now continue with the analysis regarding the strategy; although Amazon is a highly volatile stock, its price has been characterized by prolonged directional movements rather than sudden shocks. In particular, the bullish phase between 2020 and 2021 rendered put options worthless, while the subsequent correction wiped out the value of call options, making the payoffs often insufficient to cover the cost of the two types of options purchased. In addition, the stock's volatility increased the strategy's break-even, limiting its effectiveness.

The comparison of the two cases underlines the structural delicacy of the straddle: although it is a neutral strategy, its success is linked to the frequency and intensity of the movements of the underlying with respect to the expectations implicit in the option premiums. SPY although less volatile had violent events that dislodged the market and rewarded the straddle strategy. Amazon on the other hand has been more consistent in its behavior over time making the strategy expensive and inefficient. Thus the straddle on SPY proved surprisingly effective because it was able to capture unexpected phases of discontinuity well, while on Amazon it

suffered from an excess of forecasting implicit in the premiums, without sufficient movements in the underlying to justify the cost of the monthly investment.

In the graph above we can confirm the structural characteristics of the selected and analyzed stocks. Amazon represented by the blue line shows significantly higher volatility than SPY (orange line), with more frequent



Source: Author's elaboration on Refinitiv data (2018–2023).

and wide oscillations. Despite this, this volatility often occurs in a directional as well as continuous form, limiting the effectiveness of non-directional strategies such as the straddle, in which one of the two options tends to completely lose value. On the other hand, SPY shows a more regular dynamism with more symmetrical movements compared to the average and with frequent reversal events, which pave the way for the payoffs of the double side of the straddle contract. This explains why the strategy, despite the greater volatility of AMZN, is more profitable for SPY: the quality of volatility has proven to be more relevant than the absolute quantity.

Let us now discuss the **calendar spread** strategy in which one sells an option with a short expiry time and simultaneously buys an option with the

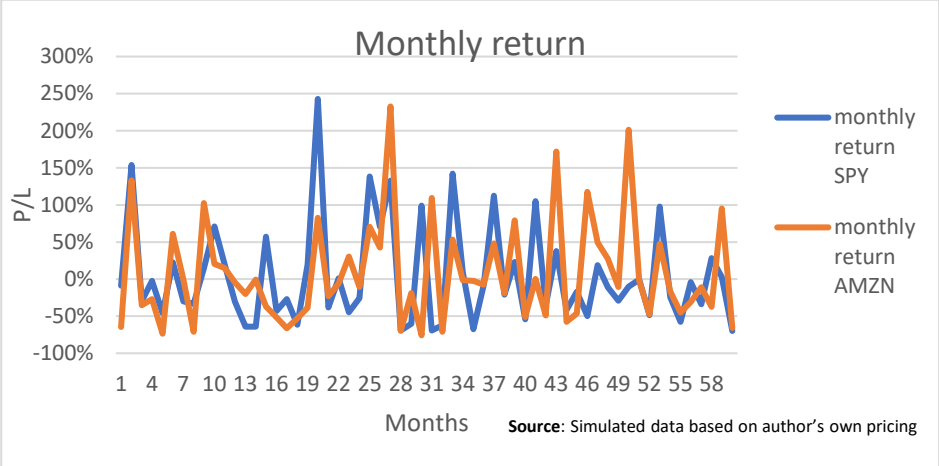
same strike but a longer expiry time. The strategy implemented involved selling ATM call with a 1-month maturity and buying ATM call with a 3-month maturity; when the first call expires, the call with a longer maturity is divested. This strategy is based on a bet on the difference in time value between the two options. The calendar spread tends to benefit from moderately directional markets in which the implied volatility of the long maturity remains high and the short maturity suffers a rapid loss in time value (time value decay).

In the case of the SPY ETF, the calendar spread proved to be inefficient, with a loss of about $26,000 against a cash out of $30,000, realizing a negative return of 85% and an annualized sharpe ratio of 0.18. This result is attributed to the nature of the underlying and the market environment of the period under analysis. In fact, SPY faced phases of turbulence and exogenous shocks that produced large and sudden movements, dynamics that damage a strategy such as the calendar spread. The short-dated options sold often suffered rapid losses because the underlying moved away from the strike, while the long-dated options failed to appreciate sufficiently to compensate the loss. In addition, implied volatility tended to rise over all expiry dates, reducing the difference that should assist a strategy such as this.

On the other hand, at Amazon, the strategy was relatively successful, generating a net profit of $8200 on a cash out of $9500, for a return of 86% and a sharpe ratio of 0.37. Although AMZN is a more volatile stock than SPY, it experienced sideways ranges and consolidation phases, in which case the short expiry tended to decay rapidly with the price close to the strike, while the long expiry option retained residual value. In addition, AMZN often presented an increasing volatility structure with maturity, a condition that favored calendar spreads.

The difference in performance between the two attest underlines the contextual nature of the strategy: it works best in moderately directional

markets, time implied volatility and the absence of breakout events. SPY reacted differently to macroeconomic shocks and this penalized the strategy, while AMZN repeatedly provided ideal conditions for the strategy to perform well. These results highlight the importance of adapting certain strategies not only to the type of underlying, but also to the pattern of implied volatility and expected price dynamics in the short term.



Source: Simulated data based on author's own pricing

As we can see from the graph, SPY (blue line) generated discontinuous returns with strong spikes and deep drawdowns, which highlights how the strategy suffered from sensitivity to market shocks. AMZN (red line), despite being a volatile stock, has produced multiple months with small but positive returns, helping the short position decay in range bound conditions.

The graph therefore explains why SPY closed with a very negative return while AMZN the opposite, despite the same strategic structure.

7.5 Hedging strategies

Performing a comparative analysis of the implementation of the protective put, a hedging strategy, on the two selected underlyings, a remarkable divergence in efficiency and return was found. Although the structure of the strategy is identical in both cases (long position on 1000 shares and 1000 OTM puts on a monthly basis), the impact of the intrinsic

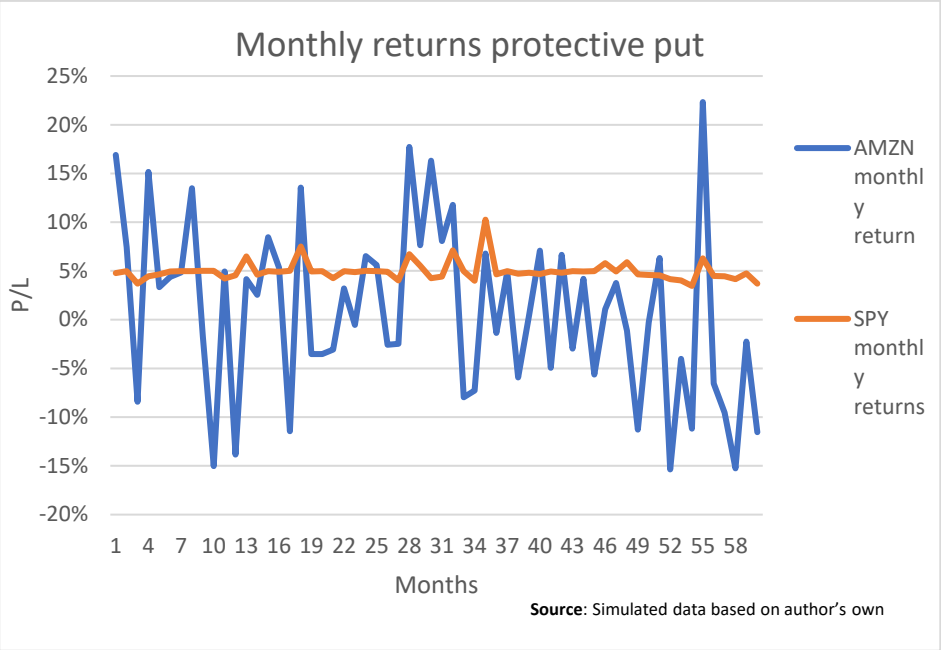
characteristics of the two instruments generated very different performances.

In the case of the SPY ETF, the strategy generated a positive cumulative return of about 380% over 5 years, starting with a total cash out of about $269,000 and ending with a final cash fund of about $1,300,000. This result was possible thanks to the nature of the underlying asset: SPY is in fact an ETF that replicates the S&P 500 index and has a relatively low volatility, behaving more stably over the long term than equities taken individually. This allowed the put options purchased to provide effective protection during market drawdowns, while the index's subsequent rebounds favored the rebuilding and accumulation of the cash fund, with which the strategies were financed during the period considered. In addition, the lower volatility of the stock resulted in less onerous put premiums, improving the ratio of cost of protection to potential return.

On the other hand, the same strategy applied in this case to the Amazon stock produced a much lower return of 15% on a total cash out of $100.000. The main reason for this is the high volatility of Amazon's stock, which is typical for growth companies and the technology sector. This volatility resulted in more expensive option premiums, increasing the cost of hedging month-to-month. In addition, Amazon has shown larger and less predictable price movements than SPY, leading to more frequent top-ups to support the strategy during periods of underperformance of the underlying. In terms of capital efficiency, therefore, SPY showed a clear superiority: the return was achieved with a lower level of risk, lower protection costs and a steadily increasing cash fund performance. On the other hand, the implementation on Amazon required a higher capital injection to cover losses, as the initial cash out was $59,000 but subsequently the cash fund was not enough to finance all the monthly strategies and thus slowly the total cash out came to the $100,000 mentioned above, all against a much lower return.

This comparison underlines the importance of selecting the underlying in hedging strategies, as well as the need to carefully balance the cost of protection against the potential return, especially when it comes to high-volatility financial instruments. The protective put strategy, while offering a valid hedge in theoretical terms, turns out to be highly sensitive to the structure of the underlying and the efficiency of the option premiums, elements that significantly influence its practical effectiveness.

From the point of view of the risk-return profile, a key indicator used is the Sharpe Ratio, calculated on the basis of the monthly returns obtained during the entire backtest period and subsequently annualized by multiplying them by the square root of 12. The results show a marked difference between the two underlyings: the Protective Put strategy applied on SPY shows an annualized Sharpe Ratio of 4.64, an exceptionally high value reflecting a stable average return that is well above the assumed volatility. In contrast, the same strategy on Amazon returned an annualized Sharpe Ratio of 0.26, indicating a marginal return relative to risk. This contrast confirms that, in addition to absolute return, the quality of return - understood as efficiency per unit of risk - is strongly influenced by the nature of the underlying asset and the cost of protection derived from its implied and historical volatility.



Source: Simulated data based on author's own

The graph above represents the monthly returns of the strategy applied to the two selected securities. An important difference in the stability and dispersion of the results between the two underlyings immediately jumps out at you (also confirmed by the difference in the relative volatility of the monthly returns of the two securities: 1% for SPY and 9% for AMZN). While SPY shows moderate monthly returns, AMZN shows greater variability, with recurring peaks and troughs. This confirms the different effectiveness of the same strategy implemented on two very different securities: in the case of SPY, lower volatility allowed for more efficient risk management, while for AMZN, high option premiums and less predictable movements undermined the benefits of hedging. The graph therefore visually shows the greater regularity and reliability of the strategy on a security like SPY instead of AMZN.

8. Conclusions

8.1 Summary of findings

In this paper, we investigated the effectiveness of the main trading and hedging strategies with options, through a quantitative analysis applied to two separate securities: Amazon (AMZN) a high volatility technology stock, and SPY, an Exchange Traded Fund that replicates the main US S&P 500 index, which is more diversified and therefore stable.

The analysis showed that:

- Directional strategies such as covered call and bull call spreads were effective in a moderately bullish market environment such as that of the period analyzed. In particular, SPY offered greater stability and management sustainability, while AMZN returned higher returns but with greater operational complexity
- Strategies based on implied volatility such as straddles and calendar spreads, i.e. non-directional strategies, have emphasized that the "quality" of volatility, i.e. the nature and frequency of movements of the underlying is more decisive than its absolute magnitude.
- The hedging strategy implemented, the protective put, proves to be a valid instrument in theory, but the actual effectiveness depends on the cost of the options as well as the predictability of the underlying.

SPY offered excellent results in terms of protection and capital growth, while on AMZN high costs limited its efficiency.

The analysis carried out has highlighted some important operational implications:

There is no such thing as a good or bad strategy universally, but each must be chosen according to the nature of the asset, but above all according to the expected market environment.

Furthermore, with regard to strategies offering hedging, these must also be evaluated on the basis of the trade-off between protection and cost, as their impact on the expected return must be fully understood.

Last but not least, the role of volatility must be mentioned: long volatility strategies such as the straddle or short volatility must be used when the

environment is consistent with expected future volatility. In addition, volatility is very important in order to better understand which strategy you want to use and the implicit costs involved with a high volatility stock, because as we said in the first chapters, a highly volatile stock will have call and put options that are more likely to end up in the money and consequently will be more expensive, which goes to influence the cost of implementing the strategies.
The use of options proves to be an extraordinarily flexible instrument, capable of offering both important hedging and speculative opportunities. However, an informed and contextual approach is essential: one must consider the characteristics of the underlying reference asset, the operating costs, and the volatility regime.
Technical mastery of derivatives in conjunction with a careful reading of the market in advance is the key to implementing effective, sustainable strategies that are consistent with the investor's objectives.

In this paper, we explored the use of options as tools to implement trading and hedging strategies, emphasizing through a quantitative analysis on two underlyings how different strategies perform in different market and volatility contexts.
The numerical results showed that directional strategies perform better in favorable market conditions, whereas strategies such as protective puts are more suitable in low volatility contexts or for risk-averse investors.
Neutral strategies such as the straddle were effective, again according to the results obtained, in the presence of high volatility, but still involve a high initial cost and consequently a high break-even threshold, which is not easy to achieve.

Sometimes, however, one should not dwell only on numbers because we know that the investor's financial behavior is important, because it is fundamental to be able to reason with a clear head in any situation in order not to run into avoidable problems.

Options by their very nature are not linear and the multiple strategic configurations that can be used require a high level of awareness and self-control.

The investor who decides to trade with options interacts not only with objective variables such as those discussed in this analysis, but also with subjective components such as risk perception, return expectations and psychological factors.

Many behavioral finance studies have established that complex financial instruments such as options are often subject to distorted interpretations by retail investors.

For example, loss aversion can lead to the overuse of strategies such as protective puts, even in cases where the risk is limited.

This is a psychological mechanism theorized by Kahneman and Tversky that leads the investor to prefer reassuring but also more costly strategies, accepting a safe loss (the put premium) to avoid a potential, though unlikely, future loss.

On the other hand, however, we find the overconfidence bias, i.e. the tendency to overestimate one's analytical and forecasting capabilities.

This bias drives many investors towards high-risk speculative strategies such as the long straddle, based on a scenario of a strong price movement of the underlying asset.

These are strategies that, however sophisticated they may be, also require to a commensurate degree important emotional control: in fact, the investor could easily abandon them early if the price moves slowly or if the hoped-for results are not achieved quickly, thus undermining the effectiveness of the strategy itself.

Investor behavior is also influenced by market phases.

In contexts of high volatility, such as in 2020 or in times of crisis, the increased demand for defensive options reflects the search for emotional protection more than technical evaluation.

Just as in other market contexts such as sideways, many investors implement strategies such as the covered call not because they have a real

expectation of return but to seek limited rewards as long as they do not stay put.

These behaviors are visible in the results obtained in the thesis just discussed.

The covered call on SPY is a strategy that stands out not only for its numerical soundness, but also for its psychological sustainability: it is simple to implement, produces a steady stream of monthly premiums that helps reduce the feeling of uncertainty in the investor.

These are elements that make this strategy attractive even to less experienced investors.

In contrast, the Amazon straddle has not performed as well as expected, and its behavior requires stress tolerance, discipline, and significantly bullish or bearish expectations.

In the absence of significant movements, this strategy quickly erodes capital, testing the investor's emotional resilience.

So to conclude, in addition to the quantitative assessment of strategies, which plays a crucial role in their implementation, it is essential that investors also take into account their behavioral profile, risk tolerance, and ability not to disinvest even in times of difficulty and uncertainty.

Options, if well understood and managed, can be incredibly effective tools for protection but also for speculation, yet on the other hand they can magnify decision-making errors and losses if used impulsively or too emotionally, without a critical character.

Although the thesis focuses on the effectiveness of strategies in terms of return and risk, it implicitly emphasizes a broader message addressed to the reader: the choice and success of a strategy with options depends not only on numbers, but also on the human component, on the decisions, whether they are rational or irrational, that inevitably accompany every transaction.

A good strategy is such not only if it works in the backtest, but if it can be maintained after applying it by a real investor under real conditions.

8.2 Limitations

In the development of this study, some limitations emerged that it is important to recognize in order to contextualize the results obtained and outline room for improvement for future studies:

- In the study, historical volatility (calculated internally) was used instead of implied volatility to price options using the Black-Scholes method. Academic literature points out that implied volatility is more reliable than future market expectations (Hull,2009), thus potentially making the simulated premiums less accurate.
- We have not included transaction costs in the simulation. In the real world, especially in very dynamic strategies such as delta hedging, these factors have a clear impact on performance, which is one reason for the existence of static delta hedging.
- Furthermore, the analysis focuses on only two assets, limiting the generalizability of the results.

  The only performance indicator used, i.e. the sharpe ratio, assumes a normal distribution of returns, and this does not adequately capture extreme events.
- The adoption of languages such as Python or R is preferred to Excel in advanced professional and academic contexts.
- Dividend payments were not included and a risk free rate of 3% was assumed for simplicity.

Despite these limitations, the analysis provides a clear, consistent and didactically useful framework for understanding which strategies work best under different market conditions, and thus answer the research question that characterizes this thesis work.

8.3 Academic Literature Background

This paper is part of a large academic strand analyzing trading and hedging strategies with options.

The study by Driessen, Maenhout and Vilkov (2009) analyses portfolios

consisting of long and short positions on equity options, evaluating performance through average monthly returns, sharpe ratios and alpha against asset pricing models.

This thesis was inspired by this methodological backtest approach, albeit more advanced and complex.

Similarly, Christoffersen, Goyenko, Jacobs and Karoui (2018) propose a dynamic portfolio allocation methodology, which is based on signals derived from implied option volatility.

The intent to assess the effectiveness of strategies in different market contexts is akin to that of the aforementioned research, although a simpler approach characterized by historical volatility and Excel simulations is adopted.

Also important is the reference to John Hull's (2009) classic text, ‘Options, Futures and other derivatives’, which is one of the fundamental pillars for understanding financial derivatives, especially pricing and risk management strategies.

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Appendix A – Black-Scholes model formula

The following formula represents the Black-Scholes model used in order to comute the theoretical price of a European call option:

$$C = C = S0 \cdot N(d1) - K \cdot e - rT \cdot N(d2)$$

Where: $$d1 = \frac{\ln(S0/K)+(r+\sigma 2/2)T}{\sigma\sqrt{T}}$$

And: $$d2 = d1 - \sigma\sqrt{T}$$

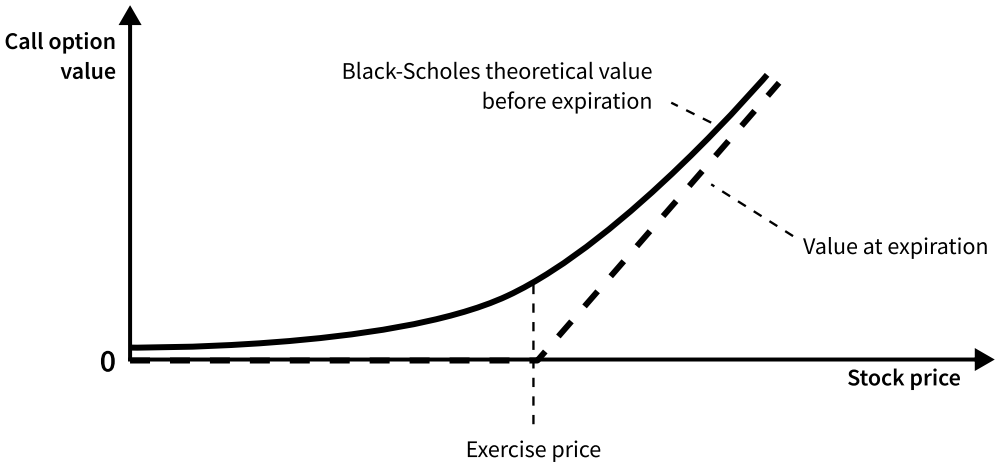
- C : Call option price;
- S0 : Current underlying's price;
- K : Strike price;
- T : Time to maturity;
- R : Risk free rate;
- σ : Underyilng's volatility
- N(·) : Cumulative distribution function of the standardized normal

In the following figure it is represented the value of a European call option according to the Black-Scholes model as a function of the price of the underlying asset.

The solid curve represents the value of the option calculated with Black-Scholes before expiration, while the dashed line shows the value at expiration.

We can see how the theoretical value includes a time premium that cancels out at expiration, when the option assumes only its intrinsic value.

The exercise of the option, being a call option, occurs only if the price of the underlying exceeds the strike.



Source : https://osquant.com/papers/intro-to-black-scholes-and-hedging/

The following figure shows a European options calculator, used to calculate the price of 3-month expiration options one month after purchase in relation to the calendar spread strategy.

This calculator shows all relevant intermediate values: d1, d2, the cumulative functions N(d1), N(d2), the theoretical option price, and the main greeks.

Options on non-dividend paying stocks

Call Option	
Type	Call
Risk-free rate	3%
Time to maturity (in years)	0,25
Volatility (per year)	15%
Underlying asset price	59,45
Strike	59,45
d1	0,136508
d2	0,062049
N(d1)	0,554290
N(d2)	0,524738
N(-d1)	0,445710
N(-d2)	0,475262
N'(d1)	0,395242
Call price	1,99
Delta (for long position)	0,554290
Gamma (for long position)	0,089288
Vega (for long position)	11,664

Put Option	
Type	Put
Risk-free rate	3%
Time to maturity (in years)	0,25
Volatility (per year)	15%
Underlying asset price	59,45
Strike	49,45
d1	2,609997
d2	2,535538
N(d1)	0,995473
N(d2)	0,994386
N(-d1)	0,004527
N(-d2)	0,005614
N'(d1)	0,013234
Put price	0,006416
Delta (for long position)	-0,004527
Gamma (for long position)	0,002990
Vega (for long position)	0,391

Academic calculator provided by a foreign lecturer in advanced derivatives valuation and risk management;

Appendix B – Structure of Excel files used for analysis

The Excel file used to analyze the strategies on Amazon(AMZN) and SPY stocks contains 15 worksheets each, each dedicated to certain components of the simulation model. The structure is as follows:

- AMZN.O/SPY : Historical data of the daily price of the stock;
- Volatility : calculation of historical annualized volatility on a monthly basis;
- Option_data : general summary of data used in option pricing such as strikes, risk free rate- maturity date and time to maturity;
- Call_ATM, Call_OTM, Call_ITM: calculation of the theoretical price of ATM,OTM and ITM call options using BS model;
- Put_ATM, Put_ITM, Put_OTM: Same calculation for put options;
- Covered call: Simulation of covered call strategy;
- Protective put: Simulation of protective put strategy;
- Bull call spread: Construction and payoff of the bull call spread strategy;
- Bear put spread: Construction and payoff of the bear put strategy;
- Straddle: Analysis of the volatility based strategy;
- Calendar spread: Simulation of the strategy based on expiration time differences.

The following figure represents an example of the call option at the money calculation in the Excel file above mentioned.

CALL 30 DAYS ATM	D1	D2	Price
02-gen-2018	0,081262	0,040932	1,030217
01-feb-2018	0,075176	0,032433	1,265214
01-mar-2018	0,079799	-0,03333	3,462935
02-apr-2018	0,072328	-0,02162	2,649504
01-mag-2018	0,080319	-0,03686	3,793014
01-giu-2018	0,093964	0,061129	1,181301
02-lug-2018	0,071484	0,013486	2,087183
01-ago-2018	0,075536	0,010975	2,438224
04-set-2018	0,071794	0,026816	1,94281
01-ott-2018	0,071365	-0,00072	3,006906
01-nov-2018	0,100748	-0,06995	5,76678
03-dic-2018	0,08829	-0,05354	5,113725
02-gen-2019	0,100961	-0,07256	5,409342
01-feb-2019	0,074632	-0,03115	3,520107
01-mar-2019	0,071649	-0,00641	2,706807
01-apr-2019	0,070226	0,001885	2,582806
01-mag-2019	0,082421	0,037043	1,860144

CALL 90DAYS ATM	D1	D2	Price
02-gen-2018	0,140751	0,070897	1,878461
01-feb-2018	0,134028	0,057823	2,367475
01-mar-2018	0,135306	-0,05652	5,96976
02-apr-2018	0,128123	-0,0383	4,792247
01-mag-2018	0,138366	-0,0635	6,638691
01-giu-2018	0,164491	0,107012	2,210739
02-lug-2018	0,1245	0,023488	3,767239
01-ago-2018	0,124253	0,018054	4,138782
04-set-2018	0,131078	0,048959	3,716533
01-ott-2018	0,123607	-0,00124	5,360095
01-nov-2018	0,170826	-0,11861	9,863018
03-dic-2018	0,151213	-0,0917	8,858912
02-gen-2019	0,173896	-0,12498	9,391437
01-feb-2019	0,133058	-0,05554	6,387137
01-mar-2019	0,124765	-0,01117	4,840697
01-apr-2019	0,122309	0,003283	4,634885
01-mag-2019	0,137617	0,061851	3,251383

Exchange Date	Close	Price call ATM	Price put ATM	Strike ATM	Stock price in 30 days	Payoff	Profit/loss	Investment cost (net)	Real cost of investment	Cash fund	Cash out	Annualized volatility	Monthly returns
02-gen-2018	59,45	1,030217091	0,883907484	59,45	69,50			-1914,124575	-1914,124575		-1914,125	14%	
01-feb-2018	69,50	1,265214193	1,105562118	69,50	74,67	10049,5	8135,375	-2370,776311	0	7678,724		15%	425%
01-mar-2018	74,67	3,46293474	3,266927962	74,67	68,60	5172,5	2801,724	-6729,862702	-1557,362702	6121,361		38%	118%
02-apr-2018	68,60	2,649503887	2,486299116	68,60	79,11	6073	-656,8627	-5135,803003	0	7058,558		33%	-10%
01-mag-2018	79,11	3,793014138	3,591832773	79,11	82,08	10513,5	5377,697	-7384,84693	0	10187,21		40%	105%
01-giu-2018	82,08	1,181301334	0,972682608	82,08	85,69	2964	-4420,847	-2153,883942	0	10997,33		11%	-60%
02-lug-2018	85,69	2,087183394	1,876299989	85,69	89,86	3612	1458,116	-3963,483383	-351,4833827	10645,84		20%	68%
01-ago-2018	89,86	2,438224048	2,187634561	89,86	101,98	4169,5	206,0166	-4625,858609	-456,3586091	10189,49		21%	5%
04-set-2018	101,98	1,942810267	1,716913941	101,98	100,22	12117	7491,141	-3659,724208	0	18646,76		17%	162%
01-ott-2018	100,22	3,006905636	2,75205503	100,22	83,28	1757,5	-1902,224	-5758,960666	-4001,460666	14645,3		25%	-52%
01-nov-2018	83,28	5,766779598	5,548188304	83,28	88,62	16941,5	11182,54	-11314,9679	0	20271,83		58%	194%
03-dic-2018	88,62	5,1137246	4,895632831	88,62	76,96	5341,5	-5973,468	-10009,35743	-4667,857431	15603,97		49%	-53%
02-gen-2019	76,96	5,409342299	5,21994986	76,96	81,31	11661,5	1652,143	-10629,29216	0	16636,18		61%	17%
01-feb-2019	81,31	3,520107064	3,333322176	81,31	83,59	4355	-6274,292	-6853,429241	-2498,429241	14137,75		38%	-59%
01-mar-2019	83,59	2,706807003	2,494249675	83,59	90,71	2275	-4578,429	-5201,056678	-2926,056678	11211,7		27%	-67%
01-apr-2019	90,71	2,582806491	2,359567473	90,71	95,58	7123	1921,943	-4942,373964	0	13392,32		24%	37%

Part of implementation of the straddle strategy on Amazon stock where there is the exchange date, the close price at the exchange date, the prices of call and put options at the money, the stock price in 30 days, the payoffs after one-month strategy, the monthly p/l, the investment cost and the real cost of investment (the ones which decrease the cash fund), the effective cash out, the annualized volatility on a monthly basis of the underlying stock and the monthly return of the strategy.

Note: The files were used to implement simulation logic for the strategies

on a monthly basis, with premiums calculated using the Black-Scholes model, based on historical volatility and constant risk-free interest rate (3%).