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Effect of covered calls on portfolio performance

Bachelor's thesis

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Prague, July 27, 2023

Tomas Jezo

Abstract

This thesis aims to evaluate the performance of a covered call strategy written on Exchange-traded funds compared to a buy-and-hold strategy of the Exchange-traded fund in the US stock market. The strategy is constructed using at-the-money, two-percent and five-percent out-of-the-money call options. The premium for the former is taken from historical market data and for the latter two calculated using the Black-Scholes-Merton formula adjusted for dividends. The results further provide a two-period distinction to better account for different market periods, namely Covid-19 and the geopolitical conflict in Ukraine. The results fail to show evidence of a significant difference between a covered call strategy and the buy-and-hold strategy. However, we provide possible applications of the strategy in certain market settings. The performance is evaluated on the basis of annualized returns and standard deviation, as ratios based on the mean-variance framework are omitted due to possible bias of negatively skewed distribution of returns of the covered call strategy.

JEL Classification	G10, G11, G12, G13, C02
Keywords	Covered calls, ETF, Black-Scholes model, Options pricing, Portfolio performance
Title	Effect of covered calls on portfolio performance

Abstrakt

Cieľom tejto práce je zhodnotiť výkonnosť stratégie krytých call opcií vypísaných na fondy obchodované na burze v porovnaní so stratégiou nákupu a držania daných fondov na americkom akciovom trhu. Stratégia je zostavená s použitím kúpnych opcií at-the-money, dvojpercentných a päťpercentných out-of-the-money. Prémia pre prvú z nich je prevzatá z historických trhových údajov a pre druhé dve je vypočítaná pomocou Black-Scholesovho-Mertonovho vzorca upraveného o dividendy. Výsledky ďalej poskytujú rozlíšenie na dve obdobia, aby sa lepšie zohľadnili fluktuácie na trhu, konkrétne Covid-19 a geopolitický konflikt na Ukrajine. Výsledky nepreukazujú významný rozdiel medzi stratégiou krytých kúpnych opcií a stratégiou nákupu a držania. Uvádzame však, že stratégiu je možné využiť v určitých trhových podmienkach. Výkonnosť sa hodnotí na základe anualizovaných výnosov a štandardnej odchýlky. Metriky založené na rámci strednej odchýlky sa vynechávajú z dôvodu možného skreslenia kvôli tomu, že výnosy stratégie krytých call opcií majú negatívne zošikmenie.

Klasifikace JEL	G10, G11, G12, G13, C02
Klíčová slova	Kryté call opcie, ETF, Blackov-Scholesov model, Oceňovanie opcií, Výkonnosť portfólia
Název práce	Vliv krytých call opcí na výkonnost portfolia

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Contents

List of Tables

List of Figures

Acronyms

ATM At-the-money

CBOE Chicago Board of Options Exchange

CC Covered call

ETFs Exchange-traded funds

ITM In-the-money

IV Implied volatility

MPT Modern portfolio theory

OTM Out-of-the-money

QYLD Global X NASDAQ 100 Covered Call ETF

RV Realized volatility

SPY SPDR S&P 500 ETF Trust

Chapter 1

Introduction

Financial derivatives are complex financial instruments whose value depends on the performance of another asset. Among the financial derivatives, options have been gaining popularity in recent years. As options are becoming more available on broker platforms, the awareness of investors about the risks and benefits of the derivative should also be increased. Due to the complexity of the financial derivative, to make informed investment decisions using options, investors need to be wary of many outside factors influencing the price of the options and the market anticipation of the price movements. Options present a variety of benefits, including leverage to significantly magnify the profits from a trade. Moreover, they offer the possibility of decreasing a risk of a position by hedging. However, negatives include a contractual obligation for a trader as well as possible unlimited losses with certain trading strategies. Therefore, the thesis presents definitions of option contracts and an overview of option trading strategies.

This thesis evaluates the covered call (CC) strategy applied to Exchange-traded funds (ETFs), which according to some scholars, should outperform the underlying ETF on a risk-adjusted basis (Whaley 2002; Figelman 2008; Hill *et al.* 2006). The thesis extends the findings of previous research on newer data and evaluates the performance using three levels of moneyness of options, i.e. at-the-money and two and five percent out-of-the-money. The aim of the thesis is to find whether there is a statistically significant effect of covered calls on portfolio performance. However, the thesis refrains from using ratios based on the mean-variance framework, contrary to a variety of scholars (Whaley 2002; Figelman 2008; Hill *et al.* 2006; Foltice 2021). This is done due to existing evidence suggesting that such measures are not appropriate and overvalue the covered call strategy (Brooks *et al.* 2019; Leggio & Lien 2004; Plantinga *et al.* 2001; Rendleman 2001).

The approach taken to examine the performance of the strategy consists of using real-life historical data as well as utilising the Black-Scholes-Merton formula and drawing comparisons to the benchmark, namely the SPDR S&P 500 ETF Trust (SPY). Further, to better grasp the effect of covered calls on portfolio performance, the data is divided into two periods based on market performance, and the covered calls strategy is compared to the benchmark during both rising and falling markets.

The thesis is structured as follows. Chapter 2 is concerned with an overview of options, beginning with a brief history and evolution of options trading followed by an overview of popular option trading strategies. Chapter 2 further introduces the Black-Scholes-Merton model together with assumptions of the model and greeks that provide additional information about option contracts. Chapter 3 covers a literature review concerned with the covered call strategy. Moreover, the chapter covers the motivation for selecting a covered call strategy, the process of constructing the strategy, a summary of the performance noted by other scholars, and metrics used to evaluate the performance. Chapter 4 is dedicated to the description of the data used, the transformations applied to the data and the methodologies used to analyse the covered call strategy. Chapter 5 reports and interprets the analysis results and draws implications for the strategy's performance. Chapter 6 states the limitations of the analysis and concludes the thesis.

Chapter 2

Defining options

2.1 Evolution of options trading

The history of options trading can be traced back to ancient Greece, where a philosopher Thales of Miletus, made a prediction about great olive harvest and purchased rights for the use of olive presses from other farmers. Once his prediction came to be correct, he resold the rights back to the olive makers (Abraham 2022). Throughout history, similar events occurred, which led to the creation of standardized option contracts by the Chicago Board of Options Exchange (CBOE) in 1973 (Chicago Board Options Exchange 2023b). Since then, the number of exchanges trading options has vastly increased and brought the attention of investors seeking to use it for hedging or speculation. The market has been on the rise in recent years, and it experienced the biggest rise during Covid-19 outbreak which can partially be attributed to the removal of commission on options trading by major brokers (Ungarino 2019). Moreover, Barnert (2022) on Bloomberg reported that the number of contracts surpassed 10 billion for the first time in history. It is more than double the number of contracts in 2019, as seen in figure 2.1.

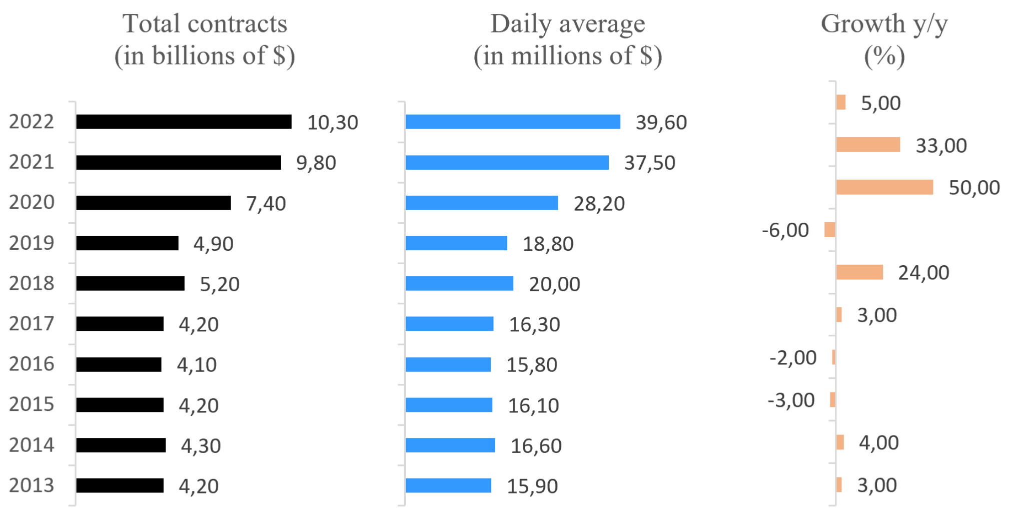

Figure 2.1: Development of option volumes
Source: Barnert (2022).

Together with the increase in ordinary option contracts, there has been an increase in covered call ETFs. Covered call ETFs are often portrayed as an equally performing instrument to stock ETFs with lower volatility. Among the first to create a covered call ETF was CBOE in 2002 when they commissioned Robert Whaley to create a theoretical index BXM [1] which created the basis for future covered call ETFs (Chicago Board Options Exchange 2023a). Since then, there has been an increased interest in covered call ETFs, and as of June 2023, ETF.com reports 190 covered call ETFs with total assets of around 41.19 billion dollars (Chicago Board Options Exchange 2023a). The biggest covered call ETF is Global X NASDAQ 100 Covered Call ETF (QYLD) with 8.08 billion dollars in assets (etf 2023).

During the period between 2009-2023 covered in the article, BXM, one of the most widely used benchmark for covered calls, has been performing relatively close to S&P 500, however, with lower volatility (Chicago Board Options Exchange 2023a).

In recent years, especially after the Covid-19 crisis, the topic of covered calls does not seem to be thoroughly covered. There was a spur of research into covered calls in the past, and they have been evaluated often through metrics such as the Sharpe ratio and others based on the mean-variance framework (Whaley 2002; Figelman 2008; Feldman & Roy 2005). However, some scholars argue this approach is not appropriate due to the high negative skewness of

[1] Cboe S&P 500 BuyWrite Index

returns and propose that the performance of the strategy is not as straightforward as others would argue (Brooks *et al.* 2019; Leggio & Lien 2004; Plantinga *et al.* 2001; Rendleman 2001). Consequently, the interest comes to examine the theoretical results and results using real-life data from the market in the recent period to evaluate the performance of the strategy and create a longer time frame that would help solidify the investment strategy or show that in the long run, the strategy would underperform the buy-and-hold of an ETF. This work does not consider tax implications and commissions, which could substantially affect the performance of the strategy as they pose a difficulty to incorporate into the calculations.

2.2 Defining option contracts

Options are a type of financial derivative that behaves based on an underlying on which it is written. Meaning, it is based on a contract between two parties, the buyer and the seller, where the buyer has the right but not an obligation to exercise the contract i.e. to purchase or to sell the underlying. On the other hand, the seller, once assigned, has an obligation to fulfil the contract. Each option contract has as aforementioned an underlying asset, time to maturity which denotes the life of the contract, a strike price, the price which gives the buyer the option to exercise their right to the contract, and a premium which is paid by the buyer. The literature distinguishes between two types of options, call and put. Both types can be bought or shorted and each has a different payoff diagram. Finally, there are many types of options where European, American or Asian are among the most popular ones. The work considers European options, which cannot be exercised before their time of maturity, contrary to American options. These can be exercised anytime during their lifetime, and because of that are priced higher.

- Purchased call option
  Figure 2.2 shows the payoff diagram for a long call option with premium c, strike price K and price of the underlying S_T.

- Written call option
  Figure 2.2 shows the payoff diagram for a long call option with premium c, strike price K and price of the underlying S_T.

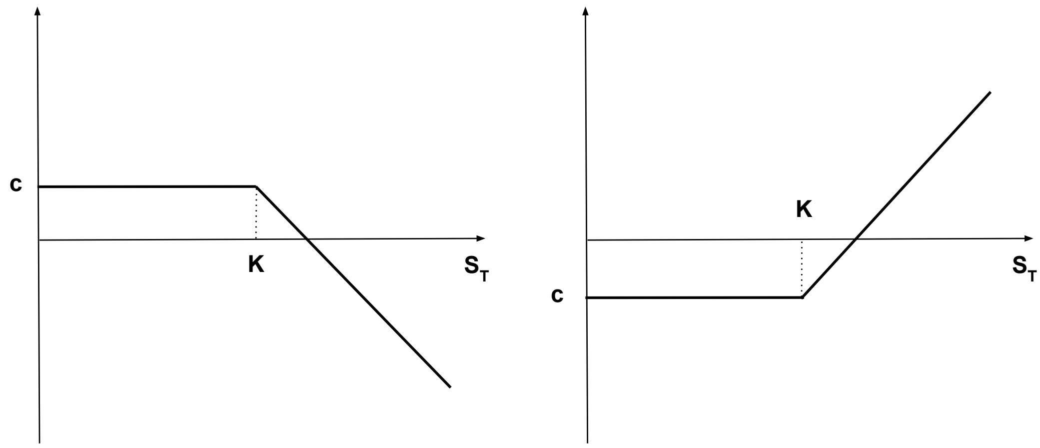

Figure 2.2: Call payoff diagrams
Source: Hull (2021).

- Purchased put option
  Figure 2 shows the payoff diagram for a long call option with premium c, strike price K and price of the underlying S_T.

- Written put option
  Figure 2 shows the payoff diagram for a long call option with premium c, strike price K and price of the underlying S_T.

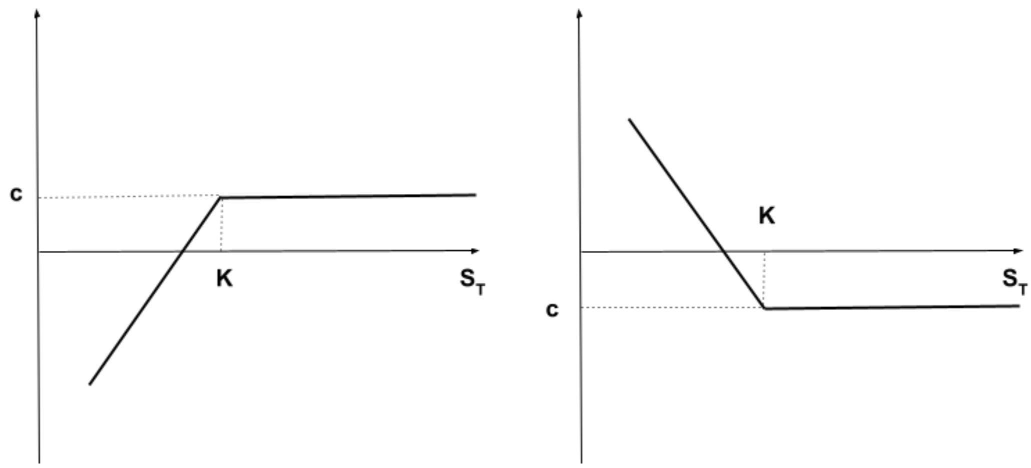

Figure 2.3: Put payoff diagrams
Source: Hull (2021).

From the diagrams and equations, we can build on the moneyness of the options. The theory distinguishes between options that are in-the-money (ITM), at-the-money (ATM) and out-of-the-money (OTM).

(i) At-the-money means the option strike price equals the current price of the underlying

(ii) In-the-money means the option strike price is below the current price of the underlying for a call option and above the strike price for a put option i.e. the option can be exercised

(iii) Out-of-the-money means the option strike price is above the current price of the underlying for a call option and below the strike price for a put option

2.3 Trading strategies using options

Before further exploring the profitability of the covered call strategy, a selection of strategies popular among investors that can provide abnormal profits is introduced. While there is an abundance of trading strategies using options, only covered call strategies were reperformed and evaluated in later chapters of the paper.

- Covered call
  Covered calls are an interesting options strategy that involves holding enough shares to cover the calls sold on the underlying. By covering each call option sold with shares, the investor is protected against unexpected upward price movements that would otherwise pose an unlimited risk. Consequently, the strategy allows investors to collect the premium from selling options. The performance of the strategy is mainly driven by two factors:

  (i) call premium

  (ii) volatility premium

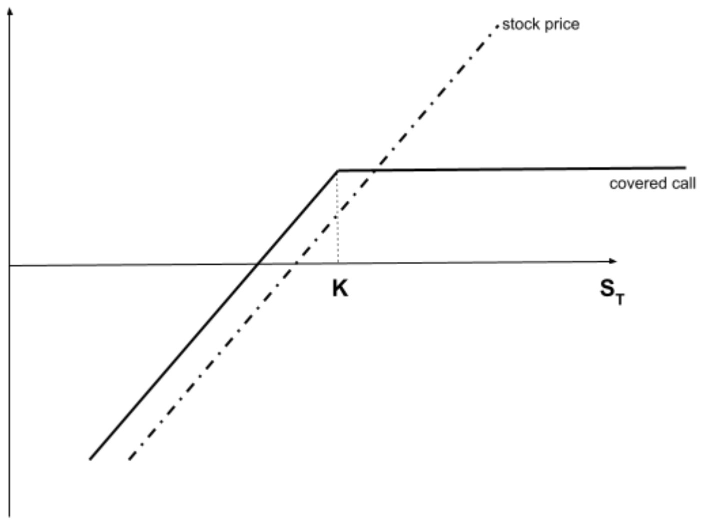

Figure 2.4: Payoff diagram of covered call strategy
Note: The maximal payoff is the amount of call option premium plus the difference between the strike price and stock price
Source: Fidelity (2023a)

- Naked call
  Similar to covered calls, the strategy consists of selling naked options on an underlying. As the investors are not holding the underlying on which the options are written, the strategy introduces unlimited risk. The unlimited potential loss is depicted in figure 2.2, where in case the underlying sharply increases, the call option should go down in value. On the other hand, the maximum gain is the amount of premium, making the strategy high risk. Therefore it is often the case that the brokers require investors to hold collateral in the amount of the shares covered by the option plus a variable premium of around 10% (Chicago Board Options Exchange 2021).

- Cash secured put
  Cash-secured puts provide an opportunity for the investor to gain access to low-value high-quality shares while also providing a premium for the time the share has a higher price. However, it requires quite high collateral and might block the possible gains from upward stock movements while holding the put. It can be combined with covered calls after the puts are assigned to improve the payoff further.

- Straddle
  Straddle is a popular trading strategy involving European options. It

is constructed by purchasing a European call and a put with the same strike price and expiration date. The strategy is most profitable when a strong stock movement is recorded. The investor does not consider the direction of the movement, only magnitude. Hull (2021) notes that for the straddle to be an effective strategy, the direction of the movement cannot be anticipated by a large number of investors. Otherwise, the movements would already be priced in the option premium, making the strategy less profitable.

- Strangle
  Strangle is realized by holding both call and put options with different strike prices but the same expiration date. Importantly, in a long strangle, the call option strike price is higher than the put strike price. Meaning, the call strike is above the price of the underlying and the put strike is below. The strategy capitalizes on strong price movements in the underlying, similar to straddle. Strangle has a smaller downside risk compared to straddle, but at the same time, higher price movements need to occur for investors to profit from the strategy, compared to straddle (Hull 2021).

2.4 Pricing of options

One of the most widely used approaches to pricing options is using the Black-Scholes-Merton formula. The formula was first introduced in two separate papers written by Black-Scholes and Merton, respectively. The paper published by Black & Scholes (1973) derives the formula using both stochastic calculus and the capital asset pricing model and arrives at the same conclusion with both approaches.

$$c = S_0 N(d_1) - Ke^{-rT} N(d_2) \tag{2.1}$$

$$p = Ke^{-rT} N(-d_2) - S_0 N(-d_1) \tag{2.2}$$

$$d_1 = \frac{\ln\left(\frac{S_0}{K}\right) + \left(r + \frac{\sigma^2}{2}\right) T}{\sigma\sqrt{T}} \tag{2.3}$$

$$d_2 = \frac{\ln\left(\frac{S_0}{K}\right) + \left(r - \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}} = d_1 - \sigma\sqrt{T} \tag{2.4}$$

Furthermore, the model requires a number of assumptions, out of which especially the assumption of constant volatility is questioned.

2.4.1 Assumptions of the model

- Stock Prices Behave Randomly and Evolve According to a Lognormal Distribution
  The assumption of lognormal distribution in stocks assures that the stock values cannot be negative. Moreover, the theory shows that stocks are randomly distributed. The lognormal distribution is essential for the derivation of the Black-Scholes formula. However, the theory suggests that the distribution is very closely related to lognormal, and therefore, the assumption seems reasonable.

- Risk-Free Rate and Volatility of the Log Return on the Stock Are Constant Throughout the Option's Life
  The assumption of constant interest rates and volatility is often questioned in theory. As there are various times to maturity of the options, in real life, it is highly unlikely that during the duration of one year, neither the risk-free rate nor volatility would be constant. However, theory suggests that the assumption of constant interest rates is reasonable as it allows for better simplicity of the formula, and research shows that interest rates do not play a strong role in option or stock prices. On the other hand, the assumption of constant volatility is very unrealistic and frequently broken. We dive more into the concept of implied volatility later in this paper. Still, models that assume changing volatility do not seem to be strictly better and are significantly more difficult to grasp and apply. Hence the assumption of constant volatility is assumed.

- No Taxes or Transaction Costs
  While both taxes and transaction costs are associated with trading, especially when dealing with covered calls, which are recognized as capital gains, the model assumes neither due to simplicity.

- Stock Pays No Dividends

The assumption can be relaxed, and we introduce a relaxed version in the later stages of the paper in case of analysis of dividend-yielding ETFs.

- Options Are European
  Early exercise cannot be implemented into the model, hence the model can be only used to calculate the price of European options, not American ones.

To further build on the formula, there are indicators known as Greeks, which can be derived from it and give more insight into how individual parts of the formula affect the options price.

2.5 Greeks

- Delta
  Delta gives information about the change of the option price with respect to the underlying and can give the investor insight into how likely the option is to end in the money. The delta of the option can be expressed as

$$\Delta = \frac{\partial \sqcap}{\partial S} \tag{2.5}$$

  Consequently, the higher the delta, the higher the premium of the option.

- Theta
  Theta is a very important indicator showing how time decay affects option price. The value of theta is usually negative and increases as the option approaches maturity, as the price of the option decays faster.

$$\Theta = -\frac{\partial \sqcap}{\partial T} \tag{2.6}$$

- Gamma
  Gamma shows the rate of change of delta with respect to the price of the underlying and is the greatest for options close to the money.

$$\Gamma = \frac{\partial \Delta}{\partial S} = \frac{\partial^2 \sqcap}{\partial S^2} \tag{2.7}$$

- Vega
  Vega shows the rate of change of the value of option with respect to volatility.

- Rho
  Rho shows the rate of change of the value of the option with respect to the interest rate.

Chapter 3

Literature review

3.1 Motivation for selecting covered call strategy

The modern portfolio theory (MPT) introduced by Markowitz (1952) shows that investors can create a portfolio with various levels of risk and return to create an optimal portfolio which either maximizes return for their acceptable level of risk or allows for the lowest risk given investors desired return. The MPT shows that diversification should be employed, and investing in only one stock is not enough. The argument is that with various stocks that do not have related risks, the risk of the entire portfolio is lowered compared to the risk of each individual stock. Hence, the investor can choose to purchase a variety of stocks on the market to make it more diverse. Another option is to purchase ETFs, which provide a diversified basket of stocks or other securities and track a given sector or index.

ETFs have been on the rise in recent years, gaining popularity among investors and can be considered to be one of the fastest-growing financial products (Liebi 2020). As such, investors can be interested in increasing the favourability of buy-and-hold of an ETF by writing a call on the ETF to generate additional gain from the call premium. The idea for a variety of investors in using covered calls lies in the benefit of collecting the option premium while holding the underlying stock which the investor is interested in holding for a longer term, and ETFs are a great example of such a financial product. As such, there has been an increase in covered call ETFs, as introduced in chapter 2. There is a variety of papers and a number of scholars writing on the topic of covered calls, either as a way to improve the performance of portfolios such as Whaley (2002); Figelman (2008); Diaz & Kwon (2017) or to improve the performance of asset managers through covered call writing such as Satchell (2016).

The sentiment for the covered call strategy is not met by every researcher. While brokers and exchanges often advertise the strategy through strong positive income, the upside potential is strongly capped with the option strike price. One of the strongest indicators towards investor selection of covered calls can be found in hedonic framing and mental accounting bias (Shefrin & Statman 1993). The mental accounting bias causes investors to have a blurred distinction between income and capital and consequently allows for a favourable view of covered calls (Shefrin & Statman 1993). Apart from the possible cognitive errors that could affect investors' decision to opt for covered calls, they are marketed favourably by brokers and exchanges as means to earn income from option premiums while holding onto the stocks that the investor owns (Shefrin & Statman 1993). Over the years, the advertisement of the strategy has been improved, and authors such as Israelov & Nielsen (2018) provide a balanced overview of the positives and negatives together with misconceptions of the strategy. Moreover, exchanges have increased the learning materials provided for the strategy and offer videos and articles that explain the pros and cons such as Fidelity (2023b).

3.2 Construction of covered call strategy

The literature mainly considers two approaches to constructing and testing the covered call strategy. First approach utilized by Whaley (2002), Figelman (2008) and Feldman & Roy (2005) is to analyze real-life option data while the second one is to use simulations to compute the option price and subsequently analyze the strategy based on theoretical prices as done by Diaz & Kwon (2017), Diaz & Kwon (2019) or Foltice (2021).

The strategy is first introduced using ATM option contracts (Figelman 2008; Whaley 2002; Feldman & Roy 2005; Hill *et al.* 2006). The frameworks of ATM options were extended by, for example, Diaz & Kwon (2019) where they analyzed portfolios with ATM, 5% OTM and 10% OTM money options. On the other hand, while they do not provide a methodology for ITM call options, their work mentions the possibility of including ITM options by investors who wish to maximize the call premium yield or those who have bearish views. The next step in constructing the strategy is deciding on the timing of the investment, and length of option contracts chosen. Authors generally agree on using contracts which have one month until expiration and are written every third Friday of the month, i.e., following the standard time of the month when new option contracts are written. Lastly, scholars consider passive and active overwriting (Figelman 2008; Whaley 2002; Feldman & Roy 2005; Diaz & Kwon 2017). Passive covered call strategy considers selling the call with a given constant moneyness and holding it until expiration while claiming the premium. However, in more volatile markets, there is a higher likelihood of exercise and hence triggering tax implications. Dynamic overwriting takes advantage of the volatility in the market and sets the moneyness based on the implied probability that the option will be exercised (Δ). Meaning the higher the implied volatility is in the market, the higher the call strike price is set, to limit exercise costs and vice versa (Hill *et al.* 2006; Che & Fung 2011).

3.3 Performance of the strategy

Among the first to analyze the covered call strategy (buy-write strategy) were Merton *et al.* (1978). They analyzed the strategy from July 1963 to December 1975 for 136 stocks and 30 Dow index stocks. They provided evidence that the strategy had similar returns but lower volatility of returns and superior performance in low volatility environment.

Whaley (2002) found that calls written on S&P 500 can have a similar performance to S&P 500 itself with returns being 1.106% vs 1.187% in favour of the index, however, at two thirds of the volatility 2.663% and 4.103% respectively. Consequently, Whaley employs the Sharpe ratio to conclude that on a risk-adjusted basis, covered calls have superior performance. As the paper became widely used due to its impact and the creation of the BXM index by CBOE, research replicated and improved the approach.

Whalye's work was extended by Feldman & Roy (2005), who verified Whale's findings on a larger dataset and drew similar conclusions finding similar performance and using the Sharpe ratio, concluding on superior risk-adjusted performance. However, Feldman & Roy (2005) also look at time periods of over and under-performance to test the strategy during different market conditions.

They conclude that falling markets allow for better performance of the strategy relative to the benchmark (-1.4% vs -2.3% annual) while during rising markets, the strategy limits the upside potential of the index and has lower performance relative to the benchmark (2.25% vs 2.5%). A similar approach was seen by Figelman (2008), who draws similar conclusions to the previous papers.

Even more detail into the performance of covered call strategy during different market conditions is provided by Hill *et al.* (2006). In the paper, there are three five-year-long periods, with rising, falling and relatively stable market behaviour. The S&P 500 recorded annualized returns of 27.71%, -1.01% and 10.02% respectively. On the other hand, these results were compared to the BXM index, ATM, 2% OTM and 5% OTM options. In the case of the declining market, the buy-write strategy recorded positive annual returns in all of the tested strategies. In the case of a slightly increasing market, the strategy also performed better, with ATM call options having the best performance. Finally, in a sharply increasing market, the strategy underperformed relative to the benchmark, with 5% OTM call options having the closest return of 26.75%. Hill *et al.* (2006) also consider options with 3-month maturities. In the return aspect, the one-month-dated options have superior returns.

3.3.1 Strategy performance measures

The performance of the strategy has been evaluated based on many metrics by scholars over the years. The most notable metrics utilized are Sharpe ratio, Treynor ratio or Jensen's alpha. The metrics in question are based on the mean-variance capital asset pricing model framework introduced by Sharpe (1964); Lintner (1965), which has a basis in the mean-variance framework introduced by Markowitz (1952). Sharpe ratio measures the ratio of excess returns over the standard deviation of excess returns. It is a powerful ratio considering financial data that are not skewed. However, there is evidence that suggests that the Sharpe ratio does not provide adequate measure due to high levels of skewness and kurtosis occurring with calls, making the distribution of returns negatively skewed. As such, there is a risk that the Sharpe ratio would return better results due to the skewness of the data (Brooks *et al.* 2019; Leggio & Lien 2004; Plantinga *et al.* 2001). Moreover, there also exists evidence that asset managers using financial derivatives with a highly negatively skewed distribution of returns can utilize the Sharpe ratio to artificially boost the performance of their portfolios on a risk-adjusted basis (Goetzmann *et al.* 2007). Due to the negative skew of the returns of covered calls, the thesis does not utilize mean-variance-based metrics. We argue that, as in the MPT, the most important measure for an investor is to either minimize the variance or maximize returns, and in the case of buy-and-hold, with a long holding duration, the return seems to be of most interest to investors.

3.3.2 Different holding periods

The exchange markets offer a wide variety of options and allow investors to choose a variety of holding periods. Academic papers focusing on covered call strategies most often quote the use of one-month-to-maturity options, i.e. around 27-35 days or three months-to-maturity, around 87-93 days (Whaley 2002; Figelman 2008; Hill *et al.* 2006). To maximize profit from the strategy and not allow theta to decrease the option's value too strongly.

3.3.3 Implied - Realized volatility spread

Implied volatility (IV) is an important measure that is used to determine the option premium. As the name implies, implied volatility is implied by the market and can be calculated from the Black-Scholes formula when solving for volatility with real-life market prices. It is considered mean-reverting, meaning both high and low volatilities are expected to return to their mean (Hull 2021). On the other hand, realized volatility is the volatility realized by the market. Hence when evaluating the volatility of options, IV is known, while realized volatility is only estimated (Hull 2021).

The spread of implied volatility (IV) and realized volatility is an important factor, as it can stand behind the success of the covered call strategy. Authors conclude that the spread is usually positive, driving the prices of call options up and allowing for better performance of the covered call strategy (Stux & Fanelli 1990; Whaley 2002; Hill *et al.* 2006; Figelman 2008).

3.4 Disadvantages of Covered call writing

3.4.1 Upside limitation

When working with covered calls, the seller needs to take into account the upside limitation in case of a sharp price increase of the underlying. When utilizing a passive covered call approach, the increases of the underlying are forgone by the call, and the upside potential is capped at the strike price of the sold call option. There can be cases when the investor expects sharp price increases of the underlying to either buy call options further out of the money to limit the forgone increases in the price of the underlying or to employ active overwriting, where the strike price of the option is determined by the volatility of the underlying asset to keep the constant likelihood of exercise in different market conditions.

3.4.2 Capital gains and tax realization

The covered call strategy is subject to capital gains. Each country has its complex set of tax rules for the sale of market instruments. In the Czech Republic, only proceeds below 100 000 CZK are exempt from tax or the security must be held for more than three years (Portál veřejné správy 2021). Due to high costs associated with covered call strategy, i.e. if assigned, the investor needs to sell the underlying stocks. Therefore, the limit for tax exemption can be broken which in turn can lead to a decrease in the overall profit from the strategy.

3.4.3 Contractual obligation

Any option contract poses a contractual obligation to the seller to deliver the asset in case the seller is assigned. Israelov & Nielsen (2018) mention, that there is a difference between selling the security at a desired price and time and being contractually obliged to do so. While the covered call provides a premium to the seller of the option, the contract still obliges the seller to sell the contract even in case the price is not favourable for the sale.

3.4.4 Covered calls embody selling volatility

With many option contracts, the difference between implied and realized volatility drives the demand for that contract. With covered calls, the seller essentially sells volatility and apart from other, bets, the implied volatility is higher than the realized one. Israelov & Nielsen (2018) advise investors who do not have any opinion on the movement of volatility to stay away from covered calls. Generally, one of the benefits of the strategy is capitalizing on volatility premium, however, in case the implied volatility would be below-realized volatility, the attractiveness of the strategy could be hindered (Hill *et al.* 2006; Whaley 2002; Figelman 2008).

Chapter 4

Data and Methodology

4.1 Data description

To analyse the performance of covered calls, data from two sources, Yahoo Finance and Refinitiv Eikon Datastream was utilized. The focus is put on ETF tracking the S&P 500, namely SPDR S&P 500 ETF Trust (SPY). SPY is one of the most popular ETF tracking S&P 500 index, with a price target of 10% of S&P 500.We downloaded the daily data for SPY from Yahoo Finance directly to R to ensure direct reproducibility of code for any time frame. While the data is in the form of OHLC [2], for the purposes of our calculation, only closing prices were used. Similarly, the data for option prices was downloaded from Refinitiv Eikon Datastream with the strike price, time to maturity, option premium and price of the underlying asset. On both datasets, we performed a transformation to monthly prices. This transformation is done to test the covered call strategy with options that have a month to maturity, following the approach of Whaley (2002); Hill *et al.* (2006) where the options are written on the third Friday of each month to simulate real-life exchange practices. Therefore, the number of observations decreased from 720 to 165, with the removal of the last observation, as the call is not written, and our strategy ends on that date. Moreover, to account for the possibility of missing data, only trading days were used, therefore, the dataset is without any missing data. The data was selected from 17.7.2009 until the present time, namely 21.4.2023, which is the third Friday of April. However, the calculations could be extended for any data range necessary. The first date is set to 17.7.2009 as that is the first third Friday since the option data on the SPY in Refinitiv

[2] Open, high, low, close price

Eikon Datastream has been available. For calculating the option premium using the Black-Scholes formula, we utilize realized volatility of the SPY index acquired from Refinitiv Eikon Datastream together with time to maturity, the SPY closing price, and the risk-free rate represented by the one-month Libor rate. Finally, the dividend yield was calculated from yahoo finance and merged with the previous data to allow for our calculations.

Below, the descriptive statistics of our data utilized are presented. The three datasets are utilized for the calculation of returns of ATM, 2% OTM and 5% OTM are in Tables 4.1,4.2 and 4.3 respectively. It can be noticed from the statistics that the SPY index recorded substantial growth between 2009 and 2023, with its minimum being 94.13 and maximum of 468.89. Moreover, the time to maturity is between 28 and 35 days only due to the nature of writing the option contracts on the third Friday of each month. Finally, the strike prices are moving according to the moneyness of the call option and are increasing accordingly. Finally, the dividend yield of the SPY index has been relatively stable, increasing due to the increasing price of SPY.

	Premium	Strike price	Maturity	Underlying asset	Dividend yield
Minimum	0.03	94.00	28.00	94.13	0.01
Quartile 1	2.38	146.00	28.00	145.87	0.02
Median	3.05	212.00	28.00	212.44	0.02
Mean	4.65	237.28	30.46	237.42	0.02
Quartile 3	5.24	294.00	35.00	294.00	0.02
Maximum	42.20	460.00	35.00	468.89	0.03

Table 4.1: Descriptive statistics for ATM call options
Note: The number of observations for each variable is 165, without any gaps due to missing data.

	Premium	Strike price	Maturity	Underlying asset	Dividend yield
Minimum	1.16	96.01	28.00	94.13	0.01
Quartile 1	1.63	148.79	28.00	145.87	0.02
Median	2.09	216.69	28.00	212.44	0.02
Mean	2.73	242.17	30.46	237.42	0.02
Quartile 3	2.98	299.88	35.00	294.00	0.02
Maximum	7.64	478.27	35.00	468.89	0.03

Table 4.2: Descriptive statistics for 2% OTM call options
Note: The number of observations for each variable is 165, without any gaps due to missing data.

	Premium	Strike price	Maturity	Underlying asset	Dividend yield
Minimum	0.16	98.84	28.00	94.13	0.01
Quartile 1	0.40	153.16	28.00	145.87	0.02
Median	0.87	223.06	28.00	212.44	0.02
Mean	1.10	249.29	30.46	237.42	0.02
Quartile 3	1.55	308.70	35.00	294.00	0.02
Maximum	3.96	492.33	35.00	468.89	0.03

Table 4.3: Descriptive statistics for 5% OTM call options
Note: The number of observations for each variable is 165, without any gaps due to missing data.

Finally, in Figure 4.1, we present the development of one-month SPY call option premiums for ATM, two percent OTM and five percent for better visualization. These premiums had average monetary values of 4.65, 2.73 and 1.1 over the course of the examined period. The most significant difference can be noticed between the maximal recorded premium, which can be attributed to the difference in real-life and theoretically computed values as well as the moneyness, which can both contribute to the spike.

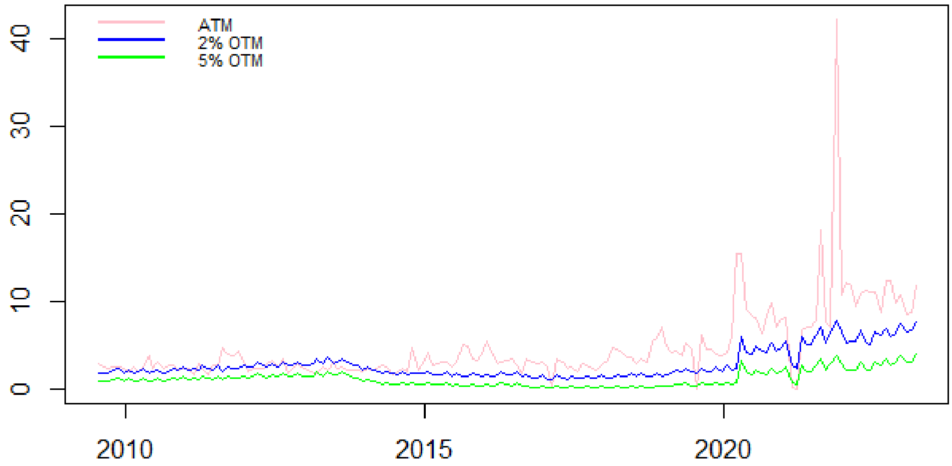

Figure 4.1: Development of option premium based on moneyness from 17.7.2009 until 17.3.2009

Source: Author

4.2 Construction of the strategy

This section introduces the approach taken to calculate returns of the covered call strategy as well as the return of the SPY benchmark. We follow by calculating annualized returns and the standard deviation of the returns. The approach utilized by the author is in line with known literature and follows similar approaches of Whaley (2002); Feldman & Roy (2005); Hill *et al.* (2006); Figelman (2008).

Firstly, let us define the return of the SPY benchmark as follows:

$$R_{(S,t)} = \frac{(S_t e^{qt} - S_0)}{S_0} \tag{4.1}$$

Where S_t is the stock closing price at time t S_0 is the stock closing price at time $t-1$, and q is the continuous dividend yield. The return of the covered call strategy is defined as:

$$R_{(CC,t)} = \frac{(S_t e^{qt} - S_0 - C_t + C_0)}{(S_0 - C_0)} \tag{4.2}$$

Where S_t is the underlying stock price of at time t, C_t is the call option premium at time t, S_0 is the price of the underlying at time $t-1$, C_0 is the call premium at time $t-1$, q is the continuous dividend yield of the underlying and t is the time to maturity of the call option in years. Importantly, C_t is the value of the call option at expiration, defined as:

$$\max(0, K - S_t) \tag{4.3}$$

where K is the strike price of the call option at time $t-1$ and S_t is the underlying stock price at time t giving us the value faced by the option seller at the time of expiration t. The data are adjusted for the third Friday of each month, and the values on expiration and purchase of the option, ranging with maturities from 28 up to 35 days are used as outlined in chapter 4.1.

Moreover, the Black-Scholes formula introduced in Chapter 2 is adjusted for a dividend-paying financial instrument, as SPY pays out quarterly dividends. The equations 2.1, 2.3, and 2.4 are adjusted for the known dividend yield:

$$c = S_0 e^{-qT} N(d_1) - K e^{-rT} N(d_2) \tag{4.4}$$

$$d_1 = \frac{\ln\left(\frac{S_0}{K}\right) + \left(r - q + \frac{\sigma^2}{2}\right) T}{\sigma\sqrt{T}} \tag{4.5}$$

$$d_2 = \frac{\ln\left(\frac{S_0}{K}\right) + \left(r - q - \frac{\sigma^2}{2}\right) T}{\sigma\sqrt{T}} = d_1 - \sigma\sqrt{T} \tag{4.6}$$

where c stands for the call option premium, S_0 is the closing price of the underlying at time $t-1$, q is the dividend yield, r is the risk-free rate and K is the strike price. N denotes the normal distribution, σ is the volatility of the underlying stock, and T shows the time period for which the premium is calculated. In the setting of our work, T is set to 28 or 35 days, equivalently to the data extracted for ATM call options, σ is taken from the historical volatility of SPY, r is set as the one-month LIBOR rate and since SPY is a dividend-yielding ETF, q is extracted and transformed from historical data. Moreover, S_0 is set as the closing price of SPY and K is adjusted from the closing price to be either two or five percent above the closing price.

The returns of both benchmark and covered call strategy were subsequently transformed into annualized returns using

$$\text{AR} = \left(\prod_{t=1}^{T} (1 + R_t) \right)^{\frac{12}{T}} - 1 \tag{4.7}$$

where AR stands for annualized return, T stands for the duration of examined time period in days. Therefore, the value of T varies based on the time frame picked during the analysis. As the analysis was conducted on monthly basis over 165 months, T was set to 165 in the case of ATM and two and five percent OTM options. For the analysis of the two time periods, from 2009 until 2020 and the second one from 2020 until 17.3.2023, T was set to 125 and 38, respectively.

To measure volatility, the annualized standard deviation wa employed. As explained in chapter 3, mean-variance ratios may be sub-optimal for evaluating covered call strategy. The performance of the covered call strategy is evaluated relative to the annualized returns and annualized standard deviation.

$$\text{ASD} = \sqrt{\frac{\sum_{t=1}^{T} (R_t - \overline{R})}{n - 1}} \sqrt{12} \tag{4.8}$$

where ASD stands for annualized standard deviation, R_t is the return of either the benchmark or a covered call strategy, $\overline{R}$ is the average return of the strategy, and n is the number of observations available. To annualize data with monthly frequency, the constant 12 is used.

To test whether the difference in performance of the trading strategies is statistically significant a two-tailed t-test is performed. We test the results at a 5% significance level.

4.3 Calculation of realized volatility

The calculation of realized volatility from the closing price of the selected SPY ETF is performed using the following formula:

$$R_t = \ln\left(\frac{P_t}{P_{t-1}}\right) \tag{4.9}$$

$$RV = 100 \times \sqrt{\frac{252}{n} \sum_{t=1}^{n} R_t^2} \tag{4.10}$$

Where P_t is the SPY closing price at time t and P_{t-1} represents the preceding day. The realized volatility (RV) is then calculated using the duality returns (R_t) using n as the number of trading days for the period and 252 represents the standardized number of trading days in a year. We calculated the realized volatility for a month-long period and compared the results to the implied volatility of options with one month to maturity.

Chapter 5

Results

The work evaluates the performance of the CC strategy with respect to return and annualized standard deviation and compares the strategy to the buy-and-hold strategy using the underlying SPY ETF on which the calls are written. The results are divided into three categories. First, the widely used ATM call options are compared to the buy-and-hold strategy using real-life data. Second, the two period comparison is presented, to better capture the impact of Covid-19 and geopolitical conflict in Ukraine on the return of the covered call strategy relative to the SPY ETF. Last, the results acquired from utilizing the Black-Scholes option pricing model to calculate the theoretical price of the 2% and 5% OTM call options are presented and compared to the ATM strategy as well as to the underlying ETF.

The percentage changes between respective analyzed strategies outlined in Table A.2 are used from the non-rounded values displayed in the appendix in Table A.1. We also provide tables containing percentage changes in the two examined periods between 2009 and 2019 and 2020 and 2023. The changes can be found in the appendix in Tables A.3 and A.4, respectively. The non-rounded values were used for the calculation of percentage changes, as the rounding would significantly alter the percentage changes, amounting to around a three percentage points difference in some cases.

5.1 ATM Covered call

Table 5.1 shows results for both a buy and hold of SPY and writing ATM call on SPY. From the results, the Annualized return of the simple buy and hold strategy outperforms the covered call strategy by 30.28%. Such a result is in line with our understanding of the market, as the covered call strategy conducted with ATM calls limits returns when a strong upward movement of the stock market occurs, which was the case most of the time during the period from 2009 until 2023 when the data was analyzed. The second metric, annualized standard deviation, came to be lower for the covered call strategy by 36.92%. The result is consistent with Whaley (2002) and Figelman (2008) in the fact that the covered call strategy has a lower annual return, however, the difference recorded for the period between 2009 and 2023 is higher than the results published by the respective authors. The worse annualized return can be attributed to the strong market performance during the years analyzed, and the gains the covered call strategy lost compared to an increasing market. Consequently, the upwards limitation caused by ATM call options is more pronounced and leads to a bigger difference in returns of the two strategies as the abnormal returns of the market are ignored by the CC strategy completely. By having stronger annualized returns, the preference for buy-and-hold of SPY can increase for individual investors, as for long time periods, investors become more interested in the return rather than the volatility. The lower standard deviation can be deemed essential by investors considering the covered call strategy. When investors would like to lower volatility in their portfolio, the strategy above can help them achieve the result, as it consistently provides lower volatility than a simple buy and hold period. Moreover, Table 5.1 shows that the distribution of returns related to covered calls is more negatively skewed compared to the buy-and-hold strategy. The negative skew of the distribution is to be expected, due to the limitation of upward price movement caused by selling call options. Finally, we do not find statistical significance that the covered call strategy constructed on SPY outperformed the buy-and-hold of SPY on the analyzed data.

	SPY	ATM
Annualized Return	0.13	0.08
Annualized Std Dev	0.18	0.12
Skewness	-1.27	-4.73
Excess Kurtosis	12.05	34.07

Table 5.1: Performance metrics for SPY and ATM covered call

5.2 Two period comparison

In this section, the results of a two-period comparison are presented to account for different market performances. Since the global financial crisis, the market has been relatively stable for a period of almost 11 years, during which it experienced continuous growth. The first major crash was experienced during the COVID-19 crisis, which brought a 25.1% plummet in the value of the S&P 500, according to Vanguard Asset Management (2023). As SPY tracks S&P 500, the decision was made to evaluate the performance of the investment strategies during a strong market and during a crisis to better understand which market conditions are the most adequate for the covered call strategy.

The calculated results are for periods between 2009 and 2019 and 2020 until 2023. The selection is supported by Vanguard Asset Management (2023) who reports a strong upward movement between 2009 and 2020 followed by the Covid-19 crisis and geopolitical conflict in Ukraine.

5.2.1 Period between 2009-2019

The performance of the covered call strategy during our first period performed in accordance with our expectations. From Table 5.2, we note the stronger annual performance of the SPY ETF relative to the covered call strategy. The result is expected due to the limitation that the strategy poses during strong market increases by capping the upward movement of the underlying price. On the other hand, the standard deviation for the strategy is lower than for the benchmark. Hence, even for investors wishing to keep low volatility of their portfolio, they can decrease it even further by applying a covered call strategy on the ETF. Consequently, during a period when the markets are rising, the individual investor can alter between the two strategies. In case the investor is more risk-averse and wishes to decrease the volatility of their portfolio, they can employ the CC strategy. At the same time, if the wish is to increase performance, the buy-and-hold strategy should be employed. However, we do not find statistical differences between the two strategies during the first time period.

	SPY	ATM
Annualized Return	0.15	0.10
Annualized Std Dev	0.13	0.09
Skewness	-0.87	-2.51
Excess Kurtosis	2.36	8.13

Table 5.2: Performance metrics for SPY and ATM covered call between 2009 and 2019

5.2.2 Period between 2020-2023

Table 5.3 shows the performance of SPY and covered call strategy between 2020 and 2023. We find, that during turbulent times, the relative performance of the covered call strategy worsens. Firstly, the return is 65.51% lower compared to the benchmark ETF. While the price decreases are cushioned by the premium from the options, the relatively quick recovery seems to be missed by the covered call strategy resulting in a fairly low annualized return for the three-year period. Furthermore, the standard deviation is lower by 26.94% which is slightly lower than for the full 14-year long period and also lower than the difference for the period between 2009 and 2019. Even in the setting of higher volatility in the market, we do not find one strategy to be statistically significant from the other one. However, the volatility of both approaches is relatively high which can lead to the statistical insignificance noted by the t-test. However, from a standpoint of an investor, the buy-and-hold strategy can be seen as a clear choice during highly volatile markets. The buy-and-hold has almost 66% better annualized returns without considering tax implications and fees,hence, the final difference in annualized returns could be even more pronounced in favour of the buy-and-hold.

	SPY	ATM
Annualized Return	0.07	0.02
Annualized Std Dev	0.28	0.20
Skewness	-1.04	-3.90
Excess Kurtosis	7.02	17.59

Table 5.3: Performance metrics for SPY and ATM covered call between 2020 and 2023

Interestingly, while both of the time periods are vastly different in terms of market performance, we fail to find a statistical difference between the performance of the CC and the benchmark in either of the periods. This suggests that CC could rival the benchmark in both market conditions. However, during the 2020-2023 period, the CC realized only a 2% annualized return which might not be considered enough by the majority of investors, even at lower volatility.

5.3 Black-Scholes estimations of option premium

We employed the Black-Scholes formula for the calculation of the option premium and subsequent two and five percent OTM options. Further OTM options were chosen to examine the performance of the strategy where the upward movement of the underlying is not as restricted as with ATM options. From Table 5.4, it can be concluded that the strategy utilizing OTM options achieves superior annualized returns based on the period from 2009 until 2023 compared to both the benchmark and CC strategy with ATM options. Both 2% and 5% OTM options have higher annualized returns than SPY and also have lower annualized standard deviations than the underlying. The results comply with the expectations and the understanding of the past market evolution. While a simple buy and hold strategy is subject to price increases and decreases, movement of the written option further OTM is seemingly achieving lower standard deviation and higher returns. Hence, there is a case where the strategy can be included in the portfolio of an investor and serve as a great strategy for boosting the portfolio. Based on our results, we can conclude, that theoretically, the strategy is more favourable in case of options that are further out of the money. The 2% OTM calls achieve 16.86% better annualized returns with 22.01% lower volatility. Whereas the 5% OTM calls achieve even superior annualized returns compared to the benchmark, with a 22.04% increase with 12% lower annualized volatility.

The results can be theoretically expected due to the fact, that since the option is further out of the money, the likelihood of exercise decreases, and the foregone gains from increases of the underlying are slightly decreased. However, by moving further out of the money with the options, the premium for the option sold decreases, hence it depends on the market and the investor what strike price to choose. Nevertheless, the covered call strategy with OTM options provides higher returns than a simple buy and hold strategy and lower standard deviation and seems superior to a simple buy and hold. The results would imply the strategy is a clear winner in comparison to the ETF. However, even with the improved performance of both covered call strategies, we fail to find statistically significant results that would favour the covered call strategy to a buy-and-hold. That is even before considering tax implications, fees and high costs to enter the strategy which were not included in the analysis and could alter the results for worse for the covered call strategy.

	SPY	ATM	2% OTM	5% OTM
Annualized Return	0.13	0.08	0.15	0.16
Annualized Std Dev	0.18	0.12	0.14	0.16
Skewness	-1.27	-4.73	-4.04	-2.95
Excess Kurtosis	12.05	34.07	25.61	16.15

Table 5.4: Performance metrics for SPY ATM 2% and 5% OTM options

5.4 Distribution of returns

To depict the occurrences of returns, a histogram of returns containing a distribution of returns of the benchmark, ATM, 2% and 5% OTM options was plotted. The histogram allows us to see how concentrated the returns are and helps us visualize the effect of the covered call strategy on the returns. At first, we notice the improved left tail by the amount of option premium, with the five percent OTM option being the closes to simple buy-and-hold due to the lowest premium associated with the call. Moreover, the negative skew associated with the strategy is portrayed. The visualisation allows us to see how the returns of the CC strategy are capped by the moneyness of the call option and how the CC strategy omits the abnormal returns of the benchmark.

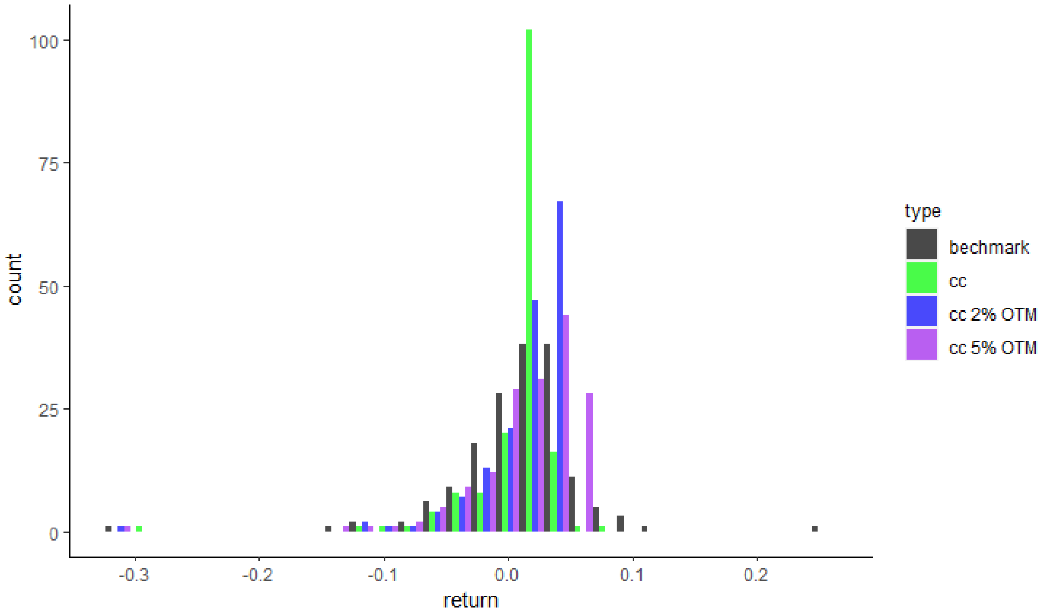

Figure 5.1: Histogram with the distribution of returns for analyzed strategies

Source: Author

Finally, we find the percentage number of trading days that the covered call strategy was above the buy-and-hold. Our results report that the returns of ATM call options outperformed the benchmark on 53.04% of the trading days, while the two and five percent OTM call options outperformed the benchmark on 72.56% and 91.46% of trading days, respectively. However, due to the importance of the missed right tail of the returns distribution, even when the covered call strategy outperforms the benchmark on most of the trading days, the difference in annualized returns is not as pronounced as this metric would suggest.

5.5 Implied vs realized volatility spread

One of the factors quoted by scholars to drive the attractiveness of the covered call strategy is the difference between the volatility realized by the market and the volatility implied by the market (Whaley 2002; Hill *et al.* 2006; Figelman 2008). The implied and realized volatility of the ATM SPY option with one month to maturity is depicted in Figure 5.2. The calculation of RV is performed from the closing prices of SPY, while the IV is taken from Refinitiv Eikon Datastream. We notice that the IV is almost constantly above RV, suggesting that the market is anticipating higher volatility than it is realizing. This means that the option premiums were priced higher during the period examined in the thesis, which could have helped boost the performance of the CC strategy. Consequently, in case the market continues in such a trend even in the future, the attractiveness of the CC strategy can still have a strong basis. However, in case the trend changes, the attractiveness of the strategy can severely be hindered as the investors could no longer capitalize on the volatility premium.

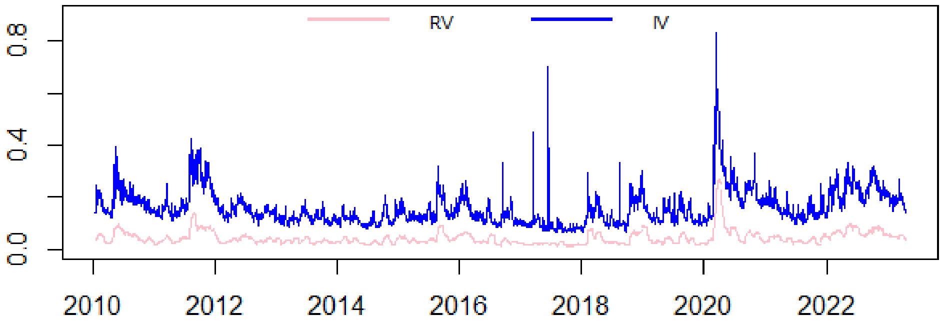

Figure 5.2: SPY ATM One-Month Option: Implied and Realized Volatility between 15.1.2010 - 21.4.2023
Source: Author

Chapter 6

Conclusion

This thesis analyses the performance of the covered call strategy and compares it to a benchmark ETF SPY in terms of annualized returns and annualized standard deviation. The analysis is conducted on a period from 17.7.2009 until 21.4.2023. During the period, annualized returns and standard deviation are calculated for covered call strategy constructed using ATM, two percent OTM, and five percent OTM call options. Moreover, to provide a deeper analysis of the performance of ATM covered calls, two sub-periods were constructed for the years 2009-2019 and 2020-2023.

Results suggest no statistically significant difference between the performance of any of the covered call strategies examined in the thesis compared to the benchmark (SPY). In terms of annualized returns, the best performance was achieved by the CC constructed using five percent OTM call options followed by the two percent OTM call options. Both of the approaches managed to outperform the benchmark, having an annualized return of 16% and 15%, respectively, while the benchmark achieved only a 13% return during the examined period. However, we note that the investor should remain cautious when selecting the CC strategy. Based on these results, it may seem attractive to use this strategy, however, one should also pay attention to the fact that the calculation does not include tax implications, transaction fees and higher costs to enter the strategy, which could hinder the returns of the CC and make it less favourable.

Further, the lowest annualized standard deviation was recorded by CC constructed using the ATM call options. The annualized standard deviation was 30.28% lower for the CC, having a 12% annualized standard deviation compared to the benchmark's 18%. Therefore, for an investor wishing to decrease the volatility in their portfolio, CC can be a valid strategy. Interestingly, the volatility achieved by ATM CC seems to be consistently at two-thirds of the benchmark volatility, which is in line with previous research. In both time periods, between 2009-2019 as well as between 2020-2023, this was the case. While we note that we fail to find a statistical difference between the performance of the CC and the benchmark in either of the periods, during the 2020-2023 period, the CC realized only a 2% annualized return which might not be considered enough by the majority of investors, even at lower annualized volatility. Therefore, there can be an argument made that the constraints that the CC strategy poses are even more pronounced during volatile and negative market conditions, which makes it an unfavourable strategy compared to a buy-and-hold in such a setting.

Moreover, while the annualized returns jumped rapidly for both CC strategies with OTM calls, compared to the ATM strategy and the benchmark the annualized standard deviation also increased significantly. The results show that when a more significant margin is allowed for the growth of the stock, the volatility impact is also increased. While the strategy can help investors outperform the market, it should be incorporated by investors who wish to mainly boost the performance of their returns rather than drastically diminishing the annualized deviation. Still, the investor needs to bear in mind that we fail to find statistically significant results that would favour the covered call strategy to a buy-and-hold. That is even before considering tax implications, fees and high costs to enter the strategy, which were not included in the analysis and could hinder the results of the covered call strategy.

This thesis contributes to the several streams of research done on trading, options, as well as trading strategies, specifically CC. By analysing the CC strategy from the point of view of annualized returns and standard deviation, we omit the potential bias that could occur when using mean-variance-based metrics. By making this change, we do not find a statistical difference between the performance of CC compared to a buy-and-hold of SPY, contrary to some of the previous research. Moreover, by having data on options divided into two time periods from 2009 to 2019 and from 2020 to 2023, we investigate important events that negatively affected the market (Covid-19 and geopolitical conflict in Ukraine). The results allow us to see how CCs perform during highly volatile market conditions and if it is a viable trading strategy during such times. Our results can have an impact on investors who are considering implementing covered calls or covered call ETFs into their portfolios to achieve superior performance. To maximize returns, applying CC strategy using 2% and 5% OTM seems to improve returns relative to the benchmark ETF. To minimize annualized standard deviation, applying the CC strategy using ATM call options seems to yield the best results.

However, two major limitations which can alter the results of the work are noted. The first one is the inclusion of tax impact on capital gains recognized from the sale of the stock once the seller of the call is assigned. As with the strategy, a sale of hundred shares of stock multiple times per year can trigger tax implications which could hinder the overall return of the strategy. The second one is transaction fees. While selling the call options on a monthly basis, the investor needs to pay a fee for the transaction, which can diminish the gain achieved from the option premium and consequently decrease the return of the strategy. Moreover, the covered call strategy has quite high costs to enter, considering the investor ought to buy a hundred shares of the underlying to cover the whole position of one call option.

The analysis performed in this thesis could further be extended by including dynamic overwriting that could help the investor achieve better results by adjusting the moneyness of the option based on the volatility in the market. This approach could help in achieving better results in favour of the covered call strategy and, in case tax implications are included, lower those as well. Moreover, a bigger pool of options could be explored using both historical and simulated option premiums. Such an approach could help show the theoretical and real performance of the strategy and dive deeper into the favourability of CC strategy in the real market setting.

Bibliography

Abraham, S. (2022): "The history of options contracts." Retrieved from https://www.investopedia.com/articles/optioninvestor/10/history-options-futures.asp.

Barnert, J. P. (2022): "Us stock options smash record, surpassing 10 billion contracts." Retrieved from https://www.bloomberg.com/news/articles/2022-12-30/us-stock-options-smash-record-surpassing-10-billion-contracts?leadSource=uverify%20wall.

Black, F. & M. Scholes (1973): "The pricing of options and corporate liabilities." *Journal of political economy* **81(3)**: pp. 637–654.

Brooks, R., D. Chance, & M. Hemler (2019): "The "superior performance" of covered calls on the s&p 500: Rethinking an anomaly." *The Journal of Derivatives* **27(2)**: pp. 50–61.

Che, S. Y. & J. K. Fung (2011): "The performance of alternative futures buy-write strategies." *Journal of futures markets* **31(12)**: pp. 1202–1227.

Chicago Board Options Exchange (2021): "Cboe Margin Manual." Available at: https://cdn.cboe.com/resources/membership/Margin_Manual.pdf.

Chicago Board Options Exchange (2023a): "Cboe S&P 500 BuyWrite Index." Retrieved from https://www.cboe.com/us/indices/dashboard/bxm/.

Chicago Board Options Exchange (2023b): "Stock Options." Retrieved from https://www.cboe.com/exchange_traded_stock/.

Diaz, M. & R. H. Kwon (2017): "Optimization of covered call strategies." *Optimization Letters* **11(7)**: pp. 1303–1317.

Diaz, M. & R. H. Kwon (2019): "Portfolio optimization with covered calls." *Journal of Asset Management* **20(1)**: pp. 38–53.

etf (2023): "Covered Calls Overview." Retrieved from https://www.etf.com/topics/covered-calls.

Feldman, B. E. & D. Roy (2005): "Passive options-based investment strategies." *The Journal of Investing* **14(2)**: pp. 66–83.

Fidelity (2023a): "Anatomy of a covered call." Retrieved from https://www.fidelity.com/learning-center/investment-products/options/anatomy-of-a-covered-call.

Fidelity (2023b): "Why use a covered call?" Retrieved from https://www.fidelity.com/learning-center/investment-products/options/why-use-a-covered-call.

Figelman, I. (2008): "Expected return and risk of covered call strategies." *The Journal of Portfolio Management* **34(4)**: pp. 81–97.

Foltice, B. (2021): "Revisiting covered calls and protective puts: A tale of two strategies." *Social Science Research Network* .

Goetzmann, W., J. Ingersoll, M. Spiegel, & I. Welch (2007): "Portfolio Performance Manipulation and Manipulation-proof Performance Measures." *The Review of Financial Studies* **20(5)**: pp. 1503–1546.

Hill, J. M., V. Balasubramanian, K. Gregory, & I. Tierens (2006): "Finding Alpha via Covered Index Writing." *Financial Analysts Journal* **62(5)**: pp. 29–46.

Hull, J. C. (2021): *Options futures and other derivatives.* Pearson.

Israelov, R. & L. N. Nielsen (2018): "Covered call strategies." *Financial Analysts Journal* **70(6)**: pp. 23–31.

Leggio, K. B. & D. Lien (2004): "Is covered call investing wise? evaluating the strategy using risk-adjusted performance measures." *Advances in Quantitative Analysis of Finance and Accounting* pp. 187–204.

Liebi, L. J. (2020): "The effect of etfs on financial markets: a literature review." *Financial Markets and Portfolio Management* **34(2)**: pp. 165–178.

LINTNER, J. (1965): "The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets." *The Review of Economics and Statistics* **47(1)**: pp. 13–37.

MARKOWITZ, H. (1952): "Portfolio selection." *The Journal of Finance* **7(1)**: pp. 77–91.

MERTON, R. C., M. S. SCHOLES, & M. L. GLADSTEIN (1978): "The returns and risk of alternative call option portfolio investment strategies." *Journal of Business* pp. 183–242.

PLANTINGA, A., R. VAN DER MEER, & F. SORTINO (2001): "The impact of downside risk on risk-adjusted performance of mutual funds in the euronext markets." *SSRN Electronic Journal* .

PORTÁL VEŘEJNÉ SPRÁVY (2021): "Zdanění příjmů z investic do cenných papírů." Retrieved from `https://portal.gov.cz/rozcestniky/zdaneni-prijmu-z-investic-do-cennych-papiru-RZC-91`.

RENDLEMAN, R. J. (2001): "Covered call writing from an expected utility perspective." *Journal of Derivatives - J DERIV* **8**: pp. 63–75.

SATCHELL, S. (2016): *Derivatives and Hedge Funds*. London: Palgrave Macmillan UK.

SHARPE, W. (1964): "Capital asset prices: A theory of market equilibrium under conditions of risk." *Journal of Finance* **19(3)**: pp. 425–442.

SHEFRIN, H. & M. STATMAN (1993): "Behavioral aspects of the design and marketing of financial products." *Financial Management* **22(2)**.

STUX, I. E. & P. R. FANELLI (1990): "Hedged equities as an asset class." *Morgan Stanley Equities Analytical Research* .

UNGARINO, R. (2019): "Wells fargo just eliminated online commissions. here's everything we know about brokerages' latest moves in the race to zero." Retrieved from `https://www.businessinsider.com/charles-schwab-td-ameritrade-interactive-brokers-e-trade-cut-fees-2019-10`.

VANGUARD ASSET MANAGEMENT (2023): "Bull and bear markets over time." Available at: `https://www.vanguard.co.uk/content/dam/intl/europe/documents/en/bear-and-bull-chart-uk-en.pdf`.

Whaley, R. E. (2002): “Return and risk of cboe buy write monthly index.” *The Journal of Derivatives* **10(2)**: pp. 35–42.

Appendix A

Tables for overall performance and percentage changes between strategies

	SPY	ATM	2% OTM	5% OTM
Annualized Return	0.131100	0.082700	0.153200	0.160000
Annualized Std Dev	0.176700	0.123200	0.137800	0.155500
Skewness	-1.268483	-4.726632	-4.038194	-2.948902
Excess Kurtosis	12.046499	34.070502	25.613333	16.147778

Table A.1: Non-rounded overall performance metrics

	% change SPY vs ATM	% change SPY vs 2% OTM	% change SPY vs 5% OTM
Annualized Return	-36.92%	16.86%	22.04%
Annualized Std Dev	-30.28%	-22.01%	-12%
Skewness	272.62%	218.35%	132.47%
Excess Kurtosis	182.82%	112.62%	34.05%

Table A.2: The % change in performance metrics between covered call strategies and the benchmark

	% change SPY vs ATM (2009-2019)
Annualized Return	-32.07%
Annualized Std Dev	-34.87%
Skewness	189.77%
Excess Kurtosis	244.09%

Table A.3: The % change in performance metrics between covered call strategies and the benchmark between 2009 and 2019

	% change SPY vs ATM (2020-2023)
Annualized Return	-65.51%
Annualized Std Dev	-26.94%
Skewness	273.44%
Excess Kurtosis	150.66%

Table A.4: The % change in performance metrics between covered call strategies and the benchmark between 2020 and 2023