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**Performance of leveraged ETFs during market  
volatility**

School of Accounting and Finance  
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Master's degree Programme in Finance

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**UNIVERSITY OF VAASA****School of Accounting and Finance**

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**ABSTRACT:**

ETFs have been gathering more and more attention and popularity amongst various types of investors. During the last years, LETFs have been growing in popularity as well, and the total AUM of these products has been growing significantly. However, research on the subject has casted doubts on the performance of these funds. These findings, and significant losses endured by investors during the 2008 financial crisis led to multiple warnings against these products by the financial regulators.

The purpose of this study is to analyze the performance of LETFs during a period of market volatility stemming from the Covid19 pandemic (1.1.2020 - 30.6.2020). The empirical research of this paper utilizes a set of popular LETFs following the most common U.S. indices. The separate LETFs are formed into portfolios of similar funds for the analysis and comparison of different fund types and characteristics.

The empirical research of this thesis is designed to provide insights on the effects of market conditions to these products for investors considering LETFs. The performance of these products is analyzed based on the absolute returns as well as their risk-adjusted metrics. The LETFs systematically underperform and underleverage using the absolute metrics, this underperformance is accentuated on higher leverage ratios, inverse leveraged LETFs and longer holding periods. Risk-adjusted; the funds provided returns greater than their underlying indices during the most volatile market conditions, this effect was significantly stronger on the positively leveraged funds. This suggests that these funds can be a valid choice for an investor in the right market conditions when the mechanics of these funds are understood.

This thesis provides a new outlook on the performance of the LETFs. The findings of the study are mostly in-line with earlier finding on their performance and the reasons behind the undesired characteristics of these funds, but it also provides a new investor-centric outlook on the validity of these funds utilizing the risk-adjusted performance metrics on the LETFs.

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**KEY WORDS:** Exchange-traded fund (ETF), Leverage, Performance, Volatility



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**TIIVISTELMÄ:**

Viimeisen vuosikymmenen aikana ETF-rahastot ovat kasvaneet suuresti niin suosiossa kuin markkinaosuudessa. Vuonna 2006 markkinoille tulleet vivutetut ETF:t ovat erityisesti viime vuosien aikana kasvattaneet suosiotaan sijoittajien keskuudessa. Kuitenkin niiden tuottoja ja ominaisuuksia on kritisoitu laajasti niin tieteen kuin sijoittajienkin keskuudessa. Varhainen tieteellinen tutkimus, sekä 2008 finanssikriisin aikana vivutettujen tuotteiden käyttäjien kokemat merkittävät tappiot johtivat lopulta varoituksiin useilta rahoitusalaan sääteleviltä laitoksilta. Viimeisimpien vuosien tutkimus on kuitenkin osoittanut, että vivutetuissa ETF rahastoissa voi olla tarjolla myös abnormaaleja positiivisia tuottoja.

Tämän tutkielman tarkoituksena on jatkaa aikaisempaa tutkimusta vivutettujen ETF-rahastojen tuotoista, keskittyen analysoimaan niiden tuottoja Covid19 pandemian aiheuttamassa korkean volatilitiitin markkinassa (1.1.2020-30.6.2020). Tutkimukseen valikoitiin yleisimpiä vivutettuja ETF-rahastoja, jotka seuraavat suurimpia Yhdysvaltojen pörssimarkkinoiden indeksejä. Valituista ETF-rahastoista muodostettiin rahastotyypeittäin portfolioita empiiristä tutkimusta varten.

Tämän tutkielman empiirisen osuuden on tarkoitus kontribuoida aikaisempaan tutkimukseen sijoittajalähtöinen näkökulma. Vivutettujen ETF-rahastojen tuottoja arvioidaan niin perustuen niiden absoluuttisten tuottojen ja vastaavien indeksituottojen suhteeseen, kuin molempien riskikorjattujen tuottojen vertailuun. Absoluuttisten tuottojen vertailussa vivutetut ETF-rahastot tuottivat systemaattisesti negatiivista alfaa, mutta riskikorjattuna pärjäsivät vertailuindeksejään paremmin.

Tämä tutkielman tulokset indikoivat, että vaikka vivutettuihin ETF-rahastoihin liittyy systemaattisia ja rakenteellisia haasteita, jotka ovat sijoittajan kokemalle tuotolle haitallisia, ja joihin markkinaolosuhteet vaikuttavat, oikein käytettynä niillä voidaan saavuttaa puhdasta indeksisijoittamista korkeampia tuottoja riskikorjatuilla mittareilla arvioituna.

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**AVAINSANAT:** Exchange-traded fund (ETF), Leverage, Performance, Volatility



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**Abbreviations**

|      |                                |
|------|--------------------------------|
| AP   | Authorized Participant         |
| AUM  | Assets under management        |
| ETF  | Exchange-traded fund           |
| CAPM | Capital asset pricing model    |
| CAR  | Cumulative average returns     |
| HPR  | Holding period returns         |
| LEFT | Leveraged exchange-traded fund |
| NAV  | Net Asset Value                |
| OTC  | Over the counter trade         |
| PCF  | Portfolio composition file     |



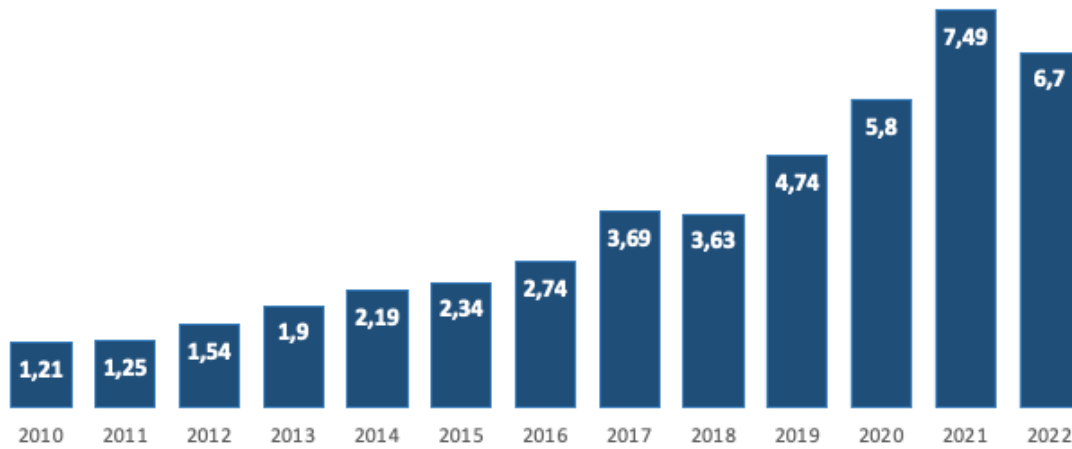
# 1. Introduction

## 1.1. Motivation for the study

Index-based passive fund investing has grown significantly in the last few decades. The main benefits of indexing can be interpreted to be broad diversification, effective asset allocation and cost efficiency. (Kaartinen 2012: 8–9.) Additionally, the poor performance of asset management, and its high costs have pushed more investors toward passive investment vehicles. This has led to the emergence of various new investment innovations to the financial markets. Most recently there has been a variety of exchange-traded products to come out in the markets, most significant of which are the exchange traded funds.

Exchange-traded funds are one of the most spoken about financial phenomenon in the most recent decades and additionally, they have been stated to one of the most influential financial innovations of the time period in question. (Lettau & Madhavan 2018.) The market for exchange traded products, especially for exchange-traded funds is already considerable, and has been constantly growing at an accelerating pace. The ETF market was valued 4.3 trillion in 2018, when the whole mutual fund market was valued at 6 trillion in 2016. (Lettau et al. 2018; Blitz, Huij & Swinkels 2012.) In addition to the considerable size, the ETF markets are quite diverse, a large variety of underlying assets can function as the basis for an exchange traded fund. Thus, an investor can follow a large number of differing proxies, the most common being the large geographical stock indices such as the S&P500 (Kaartinen 2012: 31–33).

Figure 1 presents the growth of the ETF market over the last decade based on information provided by Morningstar analysis of 2023. The growing ETF-market accounted for 70% of all newly launched funds in the U.S markets, with 5 697 separate funds in total. (Morningstar, 2023)



**Figure 1. AUM of ETF-market in US & Europe (\$UStr) (Morningstar, 2023)**

These traditional ETFs however, similarly to traditional index based mutual funds, only seek to replicate their underlying indices. This does not facilitate any opportunities for investors to take a position with regards to the future development of the benchmark index or the market at large. For this purpose, the first leveraged and inverse leveraged exchange traded funds were introduced in 2006 to the U.S. markets. Leveraged and inverse-leveraged ETFs (LETFs from now on), try to typically provide the daily index returns with a set multiplier. These multipliers, or leverage ratios, range from  $-1x$  to  $\pm 3x$  for most of the popular LETFs, but much higher ratios are also readily available. These desired returns are achieved using derivatives structures, most commonly via futures and swaps. (Charupat & Miu, 2014)

The LETFs gained popularity rapidly after their inception in 2006 due to multiple factors stemming from the nature of these products. As explained, they are leveraged products, which usually require a margin account and at least some knowledge in derivatives and trading with them (Shum & Kang, 2013). Inverse-leveraged ETFs can also act as an alternative for short selling the constituent stocks of the underlying index, which can be a quite complicated and cost intensive operation. These inverse leveraged ETFs are also able to target underlying indices that have restricted short selling opportunities (Lovicsek, Tang & Xu, 2013).

At the end of the year 2006 when these ETFs were introduced, only 12 funds existed, and they held under \$2 billion in assets (Guasoni & Mayerhofer, 2023) But already in 2012, after 6 years from their inception, there were over 200 ETFs. These instruments were tracking a large variety of different types of indices, and combined they held around 30 billion U.S. Dollars in assets under management (Charupat & Miu, 2014). From 2012 to the end of 2022, the number of ETFs had not changed that dramatically, as there were around 240 at the end of the year 2022. The AUM however has grown from \$30 to over \$65 Billion during this time. (Guasoni & Mayerhofer, 2023)

The emergency of the ETFs coincided significantly with the financial crisis of 2008, and during the volatile market conditions that followed the crash, a lot of investors were encouraged to utilize these products for speculating the market developments. During these years the ETFs experienced significant tracking errors especially for multi-day holding periods. This led to many investors incurring heavy losses on their investments, ultimately resulting in SEC issuing warnings against the use of ETFs, and the Financial Regulatory Industry Authority (FINRA) issuing fines to investment institutions for selling and encouraging the use of ETFs without necessary understanding of the functionalities of these products. (Jiang & Peterburgsky 2017) In 2015, the SEC even considered a limit of 150% to the leverage ratio on the ETFs on the U.S. markets, but this was never put in place. Later in 2017, the SEC approved ETFs with a leverage ratio of 4x, but later withdrew this approval. (Guasoni & Mayerhofer, 2023)

The experience for the ETFs from the first years of their history raised concerns on the performance of the ETFs, and the corresponding sanctions by the financial regulators prompted most of the investment management firms to issue new guides for the use of the ETFs, and advice against these products without the full knowledge of what they entail. Both main ETF management firms, Profunds and Direxion have also issued warnings on the problems investors may face when using these products with holding periods of over a day. Direxion advises any investors to seek professional financial counselling before investing in ETFs, and the Proshares fact sheet warns investors on possible deviations of returns:

*“Holding periods of greater than one day can result in returns that are significantly different than the target return. These effects may be more pronounced in funds with larger or inverse multiples and in funds with volatile benchmarks.”* (Proshares, 2020)

Early research on the matter further solidified the sentiment that the ETFs were underperforming in comparison to their targets and were not suitable for investors looking to buy and hold assets (Cheng & Madhavan, 2009). This underperformance was mainly attributed to a phenomenon called the constant leverage trap, arising from the structure of these products (Bansal & Marshall, 2015).

More recently, there have been studies that contradict this first assessment of the performance of the ETFs. Jiang and Peterburgsky (2017), and further on Peterburgsky (2021) suggests that the poor performance of ETFs during the years following their inception, could be attributed to the financial crisis of 2008, and expanded the timeframe of the analysis first by simulation, and later using real market data. Their findings suggest that when used correctly, these products can be useful and profitable for the investors.

These types of market speculative instruments are commonly used when investors forecast clear and sudden movements in the markets. These sudden movements are usually encountered when the markets are already volatile, suggesting that these products are most utilized when they are underperforming the most. This study will aim to analyze whether the performance of ETFs during the market crash caused by the Covid-19 pandemic follows the early findings of underperformance during the 2008 financial crisis, or whether they perform closer to the model suggested by Jiang and Peterburgsky (2017).

## **1.2. Structure of the study**

The study will begin with an overview of the investment products being analyzed, the inception and background of these products, and an explanation on the construction and structure of a traditional exchange traded fund. Followed by an overview on the

differences of traditional ETFs to funds with synthetic return replication such as leveraged and inverse-leveraged ETFs.

The theoretical background is followed by a literature review. Most relevant earlier studies are introduced, and the effects of their findings are explained. Based on the literature review, an overview of the most prevalent explanatory variables for the performance of LETFs is also conducted.

After the literature review, a theoretical background on the portfolio performance metrics is provided. The chapter explains the background for the efficient market hypothesis, consequent capital asset pricing model, and provides an overview on the metrics that are used in this study to evaluate the performance of the LETFs.

Subsequent to the theoretical framework, the next chapter goes over the data selection of this study and provides an explanation on the choices made with regards to the data selected, as well as an explanation on any inefficiencies in the data, and provides methods that are used to correct for those challenges. The examination of the data is followed by a chapter that presents the methodology used in this study to extract the empirical results from the data examined. This includes an overview of the risk adjusted return metrics, and their interpretation as well as presentation of the regression model used in this study.

Finally, the results of the empirical research are presented and explained, and the findings of the study are concluded. Furthermore, the impact of this study, its limitations are explained, and suggestions on research going further are presented.

### **1.3. Purpose of the study**

The purpose of the study is to analyze the performance of the LETFs during a timeframe of high market volatility, both in comparison to their benchmark indices and to each other, to determine the impact of the market conditions to the performance and utility of these products. Findings of Loviscek, Tang and Xu (2014) suggest that the LETFs could

provide performance significantly greater than the earlier studies have implicated. These findings are also supported by Bansal and Marshall (2015). To contribute to this existing literature, the framework of this study is made to provide a realistic approach on the use of the LETFs by an average investor, to study the performance of these products in conditions they are most likely to be utilized (high volatility markets) in comparison to earlier studies that have been done with data from low volatility markets, and with strategies most utilized by the investors (holding periods longer than a day), as explained by Dulaney, Husson, and McCann (2012).

Using the data gathered with this framework, the performance of the products and portfolios analyzed in this study are evaluated using multiple risk-adjusted portfolio metrics, as well as an OLS-regression analysis of the returns of LETFs compared to the returns of their underlying indices. The approach of this paper contributes to the research on the subject by giving an investor-centric outlook on the matter and using a new selection of funds to analyze their performance.

Most of especially the earlier research on the matter has been conducted on the funds available in the U.S. markets, but this thesis will include a selection of European funds as well. As these fully synthetic funds are relatively more prevalent in European markets, this is a vital addition for the understanding of these products and provides a needed cross-sectional analysis on the matter. The selected period of time is also a new outlook on these products, as this thesis focuses on the performance of these leveraged products solely during market volatilities, rather than trying to gauge the performance of LETFs through steadily rising markets as many of the studies before having done.

#### **1.4. Hypotheses**

This thesis is motivated to investigate a total of two different hypotheses. The first hypothesis is the base hypothesis of the thesis, and the following hypothesis is derived from the findings of the first hypothesis. The first hypothesis is motivated by earlier research by Jiang and Peterburgsky (2017) as well as Charupat and Miu (2011), it seeks to provide an outlook on the performance of the LETFs broadly. The hypothesis is based on the

expectation, that the construction and mechanics of LETFs create undesired effects for the investor, and can be expressed as follows:

*H1: The LETFs underperform their underlying indices with extended holding periods.*

Continuing with the findings of for example Charupat and Miu (2011) as well as Avellaneda and Zhang (2010), if the experienced underperformance of LETFs is based on the characteristics of the products, this deviation from desired returns is expected to be more significant in funds with higher leverage-ratios, and funds with negative leverage-ratios. It is also expected to be significantly more prevalent the longer the holding period (Rompotis, 2014).

The second hypothesis is motivated by the research of Avellaneda and Zhang (2010) and Charupat and Miu (2011), as they implicate that the mechanics of the funds are not the sole explanatory factors on their performance. The discrepancies are noted to be path dependent, signifying that with LETFs, the experienced performance is conditional to the return path of the benchmark index. Thus, the relative performances of the LETFs are expected to differ based on the market conditions being observed. This hypothesis is focused on the main purpose of the study: The performance of the LETFs in volatile markets.

Charupat and Miu (2011) find that a “sideways” market is detrimental to the performance of these funds, especially with high market volatility, while LETFs at a trending market could provide performances greater than the underlying index, if the volatility in the markets is low. Avellaneda and Zhang (2010) also find the inverse correlation between market volatility and the performance of the LETFs, due to the mechanic of daily rebalancing of these funds. The paper points to realized volatility being the main explanatory factor on the experienced underperformance of the LETFs.

*H2: The underperformance of LETFs is significantly higher in volatile markets.*

## **2. Exchange traded funds**

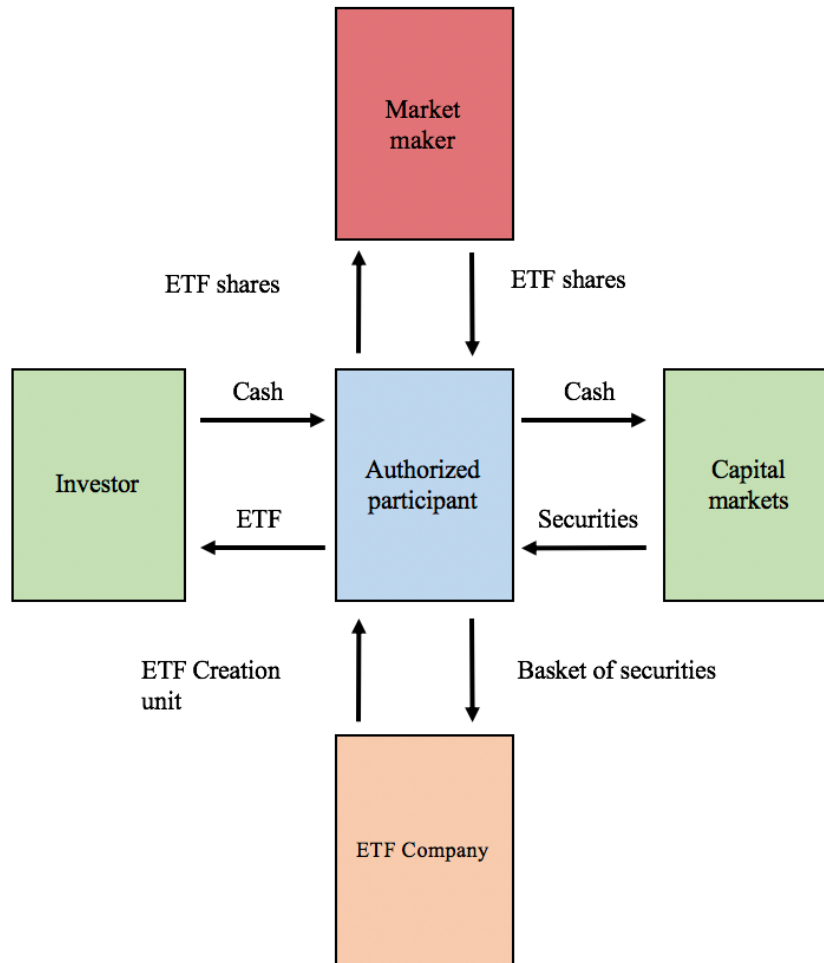
Exchange traded funds, similarly to traditional mutual funds, are a pool of assets invested in a portfolio of the underlying securities defined by the strategy of the fund. Unlike mutual funds, ETF issuers do not operate directly in the capital markets, instead the shares of the fund are traded in stock exchanges between investors similarly to regular stocks. ETF shares are created and distributed by Authorized Participants, who gather the portfolio of assets and deliver it to the fund company in exchange for ETF creation units, which are then split into ETF shares for the market. (Lettau & Madhavan 2018.)

The authorized participants are responsible for the distribution of ETF shares to the market. In the ETF markets, in addition to the authorized participants, there are market makers who operate to secure the liquidity of the market. The market makers constantly make put and call offers for the shares to ensure the market liquidity. (Kaartinen 2012: 39–40.)

Due to the shares being exchanged in the markets, the fund portfolio is unaffected by the selling and buying of the shares. The trading between investors is occurs in the secondary exchange, and in this type of exchange, all of the shares sold and bought in the markets already exist, and no additional shares are created when an ETF share is being bought, thus the basket of underlying securities does not get affected by the ETF share exchanges. (Ferri & Phillips 2009) Primary exchange occurs between the authorized participants and the fund company, and it is the only trade by which the fund portfolio holdings are affected. (Kaartinen 2012: 40–41.)

### **2.1. Construction of an ETF**

The Basket of securities corresponding to the underlying securities can be constructed either physically or synthetically. A physical ETF is constructed by acquiring directly the securities of the benchmark index, the holdings of the portfolio are made to replicate the holdings of the benchmark as closely as possible. The holdings being identical, the returns of the fund follow the benchmark index. (Lettau et al 2018.)



**Figure 2. The structure of an ETF (Ferri et al. 2009)**

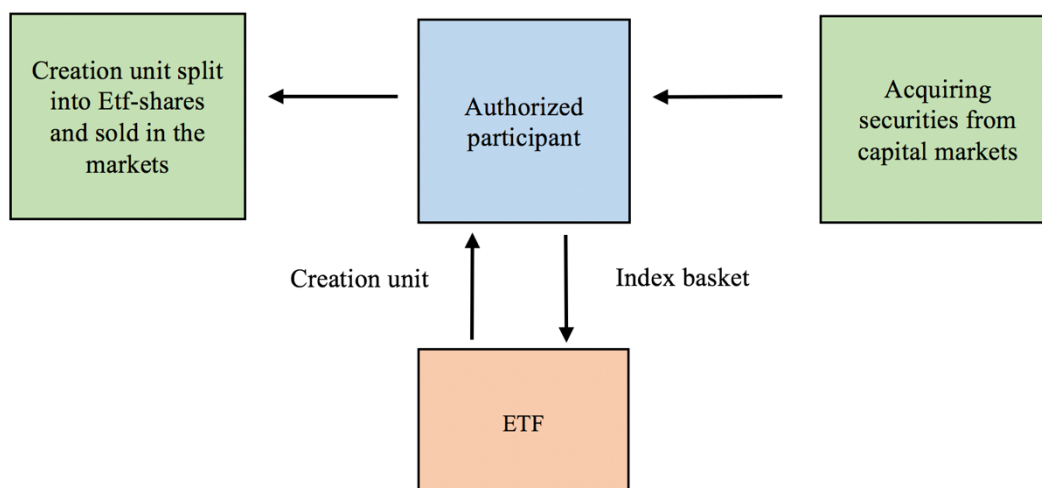
## 2.2. Creation and redemption of shares

Arbitrage is a fundamental principle in finance, as it proposes an efficient pricing of securities in the markets. In principle, arbitrage opportunities arise, when the same security is priced differently in two different markets. For the ETF markets, arbitrage occurs when the price of the underlying security and the price of the ETF share differ. This arbitrage opportunity, however, is only available for the authorized participant as they are the only

ones able to convert the securities between the two types of markets and thus profit from the price differences. (Petajisto 2017)

When the demand of ETF shares significantly diverges from the demand of the securities of the underlying index, the price of the ETF share differs from the price of the underlying securities. This leaves the authorized participant with an arbitrage opportunity, since the price of the ETF shares trade at a premium or discount from their fundamental value. For example, in the case of grown demand of the ETF shares, the authorized participant is able to notice the premium on the market prices compared to the daily NAVs, and is able to create new shares, releasing them to the ETF market. This arbitrage opportunity keeps the market efficient, since the growth in supply brings the price down to its fundamental value. Thus, the price of the shares does not significantly diverge from their value, and stabilizes the market prices of these funds (Kaartinen 2012: 40–41., Petajisto 2017)

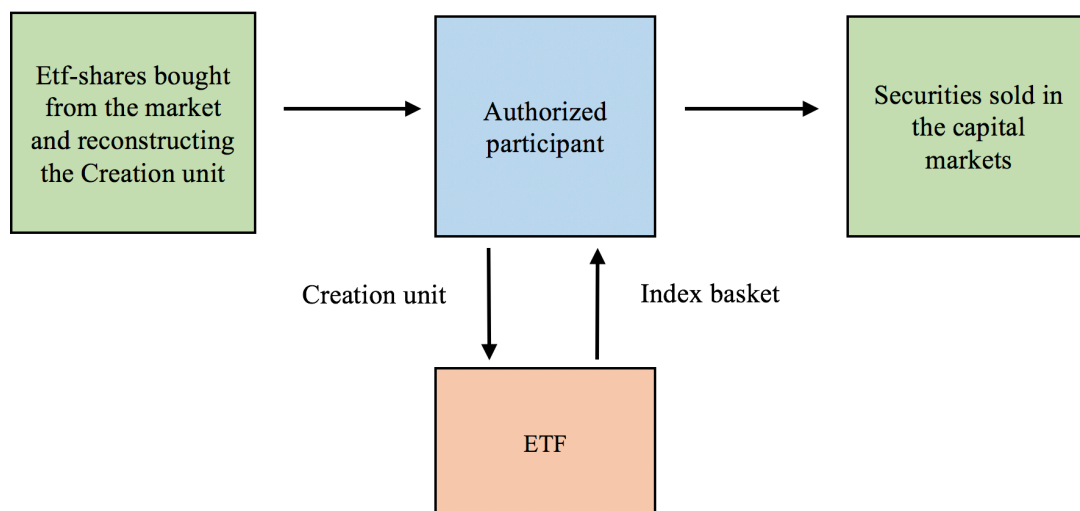
The creation of new ETF shares is a similar process to the original launch of the fund. The authorized participant gathers the basket of securities and liquid assets defined in the contract with the fund company. These baskets are typically quite large and are exchanged for tens of thousands of ETF shares. The fund company delivers an ETF creation unit for the authorized participant, who then splits the unit into ETF shares and sells them to the investors through the markets. (Ferri et al. 2009: 30–33; Lettau et al. 2018.)



**Figure 3. The creation of ETF shares (Ferri et al. 2009)**

The redemption of the shares is an inverted process of the creation, the authorized participant reconstructs the Creation unit by acquiring ETF shares and receives a basket of securities in turn for the creation unit from the fund company. There are some limits to the arbitrage opportunities of the authorized participants, since the fund companies charge for the creation and redemption of the shares. These charges are typically marginal in comparison to the value of the creation unit. (Ferri et al. 2009. 32-33)

The basket of securities corresponding to an ETF creation unit is defined in a portfolio composition file published at the end of each day. PCF is the net asset value-based basket of underlying securities that correspond to an ETF share. It defines the securities and other liquid assets as well as the amount of cash the portfolio is required to hold. The cash in the portfolio corresponds to the cumulative dividends that have not been paid to the investors, as well as the proportion of the fund that might be invested in illiquid assets. (Ferri et al. 2009: 33–34.)



**Figure 4. The redemption of ETF shares (Ferri et al. 2009)**

### 2.3. Trading of the ETF shares

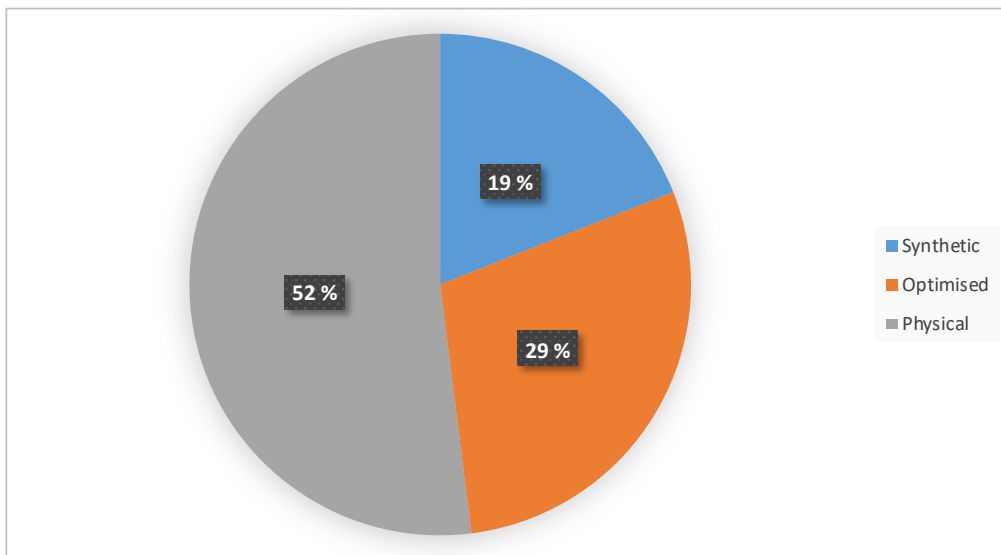
ETF shares are traded in secondary exchange, which can be divided into two classes. These are the stock exchange trade, and over the counter trade (OTC). The stock exchange trade takes place similarly to any shares, put and call bids are placed into the system, and the trades happen at the market price. (Kaartinen 2012: 38–39.) The market makers engaged in the exchange are of great significance for the efficiency and liquidity of the ETF markets. Especially in the European markets the liquidity of the ETF shares would be substantially lower than that of the underlying assets. (Kaartinen 2012: 40–41.)

The largest ETF trades are made in the adaptive over the counter markets. The liquidity of the stock market exchange is not usually sufficient for the trades of large quantities. For these exchanges, the potential buyers inquire the price from the market makers, who often simultaneously act as the authorized participant. When trading directly with the authorized participant, it is possible to utilize the liquidity of the underlying asset by creation or redemption of ETF shares. (Kaartinen 2012: 40–41.) The process of especially large OTC-market trades can also be carried out by the investor gathering the portfolio of

assets required for the creation of ETF shares and then delivering the basket of securities to the authorized participant to be converted into ETF shares. (Kostovetsky 2003.)

## 2.4. Synthetic ETFs

If acquiring the underlying securities to replicate the underlying index of the fund is not possible or feasible, the fund can be constructed by using derivatives contracts. These are called synthetic ETFs, and in addition to availability problems, the motivation behind constructing the fund synthetically can also be their typically higher liquidity and cost efficiencies. Purely synthetic ETFs without any form of physical components are especially common in the case of European markets due to regulatory constraints in the U.S. markets. (Naumenko & Chystiakova, 2015) Figure 5 shows the distribution of three different methods of replication used by ETFs. Physical ETFs have at least 90% of their assets in the constituents of the benchmark, while synthetic ETFs are using purely derivatives structures. The optimized portfolios use less than 90% of their assets in physical replication. (ECB, 2017)

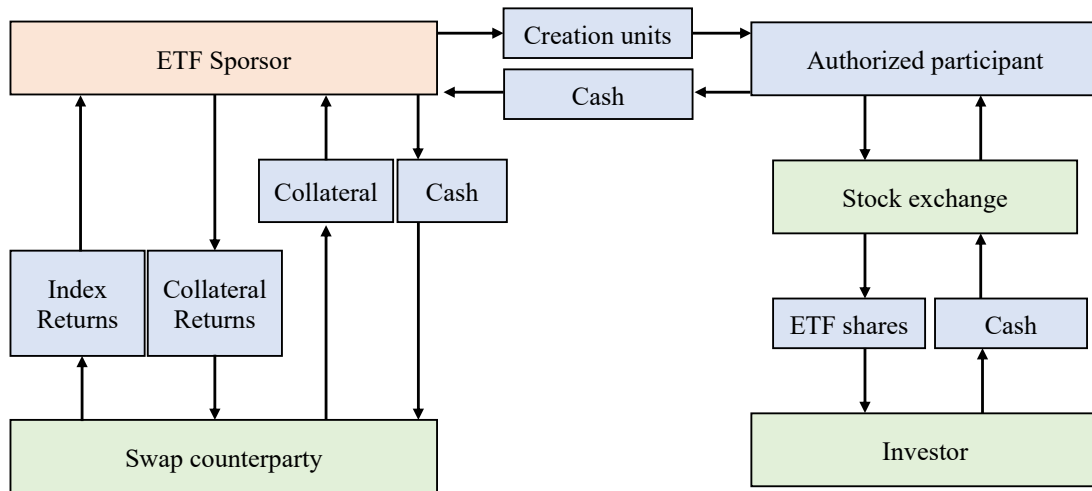


**Figure 5. The portfolio replication of European ETFs. (ECB, 2017)**

The objective of synthetic ETF's is not to identically reconstruct the benchmark portfolio, but rather follow the returns of the benchmark as closely as possible. Synthetic ETF construction is usually done with swap-contracts, thus the fund is able to follow the returns of the index portfolio without possessing the underlying securities. (Kaartinen 2012: 31-33.) One method to use these swap contracts for the creation of the fund with a structure is called a total return swap, also referred as the unfunded swap structure (Naumenko & Chystiakova, 2015). When constructing a synthetic ETF, the authorized participant will use an ETF sponsor, rather than acquiring the portfolio of securities himself. The AP will receive the creation units for cash from the ETF sponsor, who in turn will enter a SWAP with a financial institution, in order to receive a return targeting the benchmark of the fund (Naumenko & Chystiakova, 2015).

The completion of the swap deal between the ETF sponsor and the financial institution involves a two-step process. First part of the process is a swap of assets between the two parties. The ETF sponsor will exchange the cash from the AP in exchange for portfolio of collateral assets from the financial institution. These collateral assets and securities can vary significantly from the benchmark index of the fund. The second part of the process involves a swap of returns. The ETF sponsor will swap the return of this acquired collateral portfolio for the returns of the benchmark index.

These two counterparts of the swap deal for the creation of a synthetic ETF are typically closely related as financial institutions. Due to this close nature of the relationship between the participants, it has been proposed that another reason for the use of synthetic, rather than physical ETFs, is the opportunity for the financial institution to acquire funding by benefiting from the synergy effect in the transaction. (Ramaswamy, 2011) This synergy effect can be found for example when a larger bank has its subsidiary investment bank acting as the ETF sponsor, and the parent bank can ship off illiquid bonds and stocks as the collateral assets to its investment bank subsidiary, saving money in reduced warehousing costs of these assets, while simultaneously acquiring liquid cash in return. (Naumenko & Chystiakova, 2015)



**Figure 6. The creation of a synthetic ETF using swap exchange (Ramaswamy, 2011)**

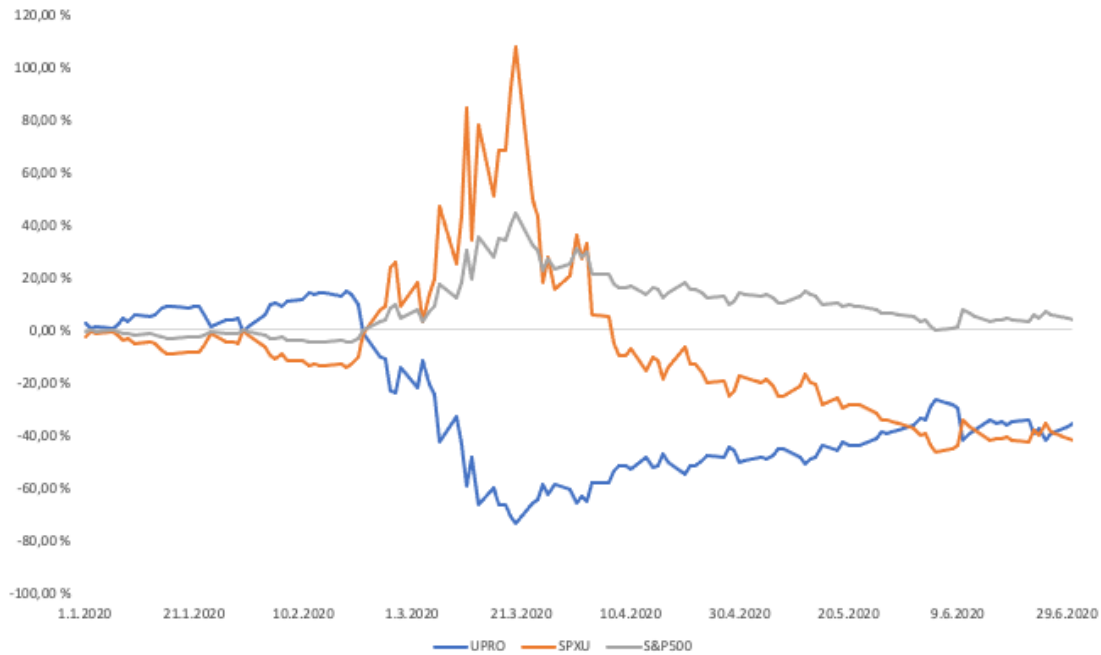
The consensus in the academic financial community suggests that the synthetic ETFs should provide a return identical to the benchmark index without tracking error, as the returns acquired from the swap deal should be equal to the index. This lack of tracking error risk is however replaced by the risk of insolvency by the swap counterparty. This is something that tends to be under evaluated by the ETF sponsors when marketing synthetic ETFs as investment vehicles. (Naumenko & Chystiakova, 2015)

## 2.5. Leveraged ETFs

Unlike most common ETFs, both physical and synthetic, leveraged ETFs thrive to track the daily returns of the benchmark index, rather than the value of the underlying assets. This replication of returns is achieved with a synthetic replication scheme, and in most cases, by utilizing the total return swaps as explained above. Alternatively, it could be achieved by using future contracts or other derivatives structures. (Shum & Kang, 2013)

Traditional ETFs, both physical and synthetic, try to match the benchmark index identically, but Leveraged ETFs thrive to offer returns of the underlying assets multiplied by the funds desired leverage ratio (Shum & Kang, 2013). This stated leverage ratio can be both positive or negative, allowing investors to bet against the index or other underlying security. As traditional inverse ETFs target their underlying assets with a multiplier of -1, the inverse LETFs typically have leverage ratios of -2 or -3. As with all leveraged products, with LETFs as well, multiplying the desired returns, will also multiply the risks involved in the investments, this is something that the investors should be aware when trading with LEFTs (Rompotis, 2014).

LETFs try to achieve the returns of the underlying asset using the stated leverage ratio daily, and in order to achieve that, the fund portfolio needs to be rebalanced every day to match the changes in the values of the underlying assets and to balance the acquired leverage to match to the promised leverage ratio and the invested assets. This daily rebalancing influences the performance experienced by an investor holding these products for more than a day. Thus, using these products for longer holding periods is highly advised against. (Jiang & Peterburgsky 2017) Figure 7 presents the cumulative returns of S&P 500 index and UPRO and SPXU LETFs when holding the ETFs for multiple months while the markets are volatile. The graph represents the undesired effects of daily rebalancing and the constant leverage trap to the performance of these product when utilizing a long term buy and hold strategy.



**Figure 7. Returns of S&P 500, UPRO and SPXU from 1.1.2020 to 30.6.2020. (Datastream, 2023)**

Due to these factors in the construction of the fund, as well as costs and fees associated with transactions on the derivatives contracts on which these LETFs are based, these products are typically used to hedge positions, profit from short term momentums or for market speculations rather than long term investments (Shum & Kang, 2013). Rompotis (2014) further acknowledges that due to the exposure on market volatility, the returns of these products can deviate from their target returns, as they fail to track their underlying indices if the volatility in the markets are high, especially when the holding periods are longer than suggested.

### **3. Literature Review**

Despite the stark rise in popularity of the leveraged ETF's, most of the conducted research so far casts doubts on the performance and tracking ability of these funds. This chapter provides an overview on the findings of those studies and explains their implications on further research and the LETF market in general. Based on the literature reviewed, most prevalent explanatory variables for the results found in the conducted empirical research are also explained in this chapter.

#### **3.1. Prior research on the matter**

Just couple years after the inception of the LETFs, Cheng and Madhavan (2009) presented that based on the mechanics and the functionality of these products, investors are over-exposed to the volatility of the underlying index, and experience underperformance compared to their non-leveraged counterparts. These undesired characteristics were deemed to be especially strong in funds with high leverage, in long holding periods, and when the market volatility was high. Based on these observations they determined these products to be unfit for investors with long investment horizons, or any other "buy and hold" - strategies. Cheng and Madhavan (2009) also cast doubts on the validity of these products for regular retail investors as their understanding of the products does not seem adequate. Furthermore, based on the market activity and general use of LETFs at the time of their study, they also determine most financial advisors to be underinformed on the functionality of these products, and the implications of their mechanics to the expected returns for the investor.

This sentiment that due to the complex structure of these leveraged funds the implications and effects of the mechanics are not sufficiently understood by the average investor, thus making LETFs unfit for any investors not well-versed in the characteristics of these products is also shared by Jiang & Peterburgsky (2017). However, they note that financial advisors have been more aware of the issues considering these funds and have been

advising their clientele not to partake in the LETF markets without clear understanding on its functionality. This is partly due to the Financial Regulatory Industry Authority (FINRA) issuing fines to multiple large investment institutions (Wells Fargo, Citigroup, Morgan Stanley and UBS) in 2012, totaling \$9.1 Million “for selling leveraged and inverse ETFs without reasonable supervision and for not having a reasonable basis for recommending the securities”. (Jiang & Peterburgsky 2017)

Dulaney, Husson, and McCann (2012) note that for the LETFs they examined, the average holding periods exceeded the suggested daily investment horizons, and that a considerable portion of investors were holding these products for longer than a quarter of a year. This indicates that despite the warnings and the information on these funds not being suitable for longer holding periods, many investors are still unaware of the effects of the LETF mechanics on long term returns.

### **3.2. Constant leverage trap**

Generally, LETFs are determined to achieve returns close to what they promise when measuring on daily examination, even though deviations in the market prices compared to their benchmarks also occur relatively frequently (Charupat & Miu, 2011). However, comparative deviations on the returns of these products start to appear when the investment horizon is longer than one day (Rompotis, 2014). This growth on the deviation in longer holding periods can be mainly attributed to the constant leverage trap, this phenomenon is especially prevalent in extended holding periods, mainly when examining periods of more than a few months or when the holding period is determined to be years. (Jiang & Peterburgsky, 2017). The impact of the constant leverage trap to leveraged ETFs was reported early on the lifespan of these products, for example by Cheng and Madhavan (2009).

The constant leverage trap can be demonstrated through a hypothetical scenario, following the example used by Jiang & Peterburgsky (2017). Consider three different portfolios that

replicate the returns of the S&P 500 index. Portfolio one invests in the index without a leverage, portfolio two has a leverage ratio of 3x using a LETF, UPRO for example, and portfolio three replicates the returns of the index with a leverage ratio of -3x using SPXU for example. For the purposes of simplicity, all of the three portfolios invest \$1 in their respective instruments for one week. During this hypothetical week, the S&P 500 index returns are 25% on half of the days, and -20% on the other half. If all of the portfolios track the index perfectly with their respective leverage ratios, after the investment period of this one week, portfolio one has a value of \$1, while portfolio two has a value of \$0.17, and portfolio three is valued only at \$0.01. (Jiang & Peterburgsky, 2017)

This constant leverage trap on the LETFs is mainly due to the structure and the mechanics of these products, specifically due to a process called daily rebalancing (Bansal & Marshall, 2015). This means that the leverage of the fund is balanced daily to correspond to the marketed leverage ratio. In a static LETF, without this process of daily rebalancing, the exact leverage ratio of the fund will vary based on the returns of the benchmark. In the case of the example triple leveraged LETFs, in theory, the fund will loan \$2 of capital for leverage on every \$1 of invested capital. Without constant rebalancing, the weight of this loaned capital in the LETF portfolio will be either smaller or larger than intended based on the performance of the index. This difference is also detrimental for the investor, as the leverage ratio decreases on the days when the returns are positive and increases when the returns on the index are negative. (Bansal & Marshall, 2015)

To combat this variance in the leverage ratio, the mechanic of daily rebalancing is introduced to LETFs. To achieve a constant leverage ratio, the loaned capital is adjusted to correspond to the value of the invested capital each day, rather than only at the inception of the fund. This way, the amount of foreign capital in the fund if the LETF is the fluctuating variable, rather than the leverage experienced by the investor (Bansal & Marshall, 2015). This rebalancing of the fund means that in order to maintain the desired constant leverage, the fund manager has to invest more capital into the fund when the prices have risen, and inversely get rid of some of the loaned capital when the value of the fund has gone down. This frequent buying high and selling low -effect generates negative alpha compared to the index and to a static leverage fund. (Avellaneda & Zhang, 2010)

Due to this rebalancing of the leverage, the investor is over-exposed to the volatility of the benchmark index, causing underperformance in the long term compared to static leveraged portfolios. This effect is exasperated if the leverage ratio of the fund or the volatility of the market is high, and moreover worsened if the holding period is extensively long (Avellaneda & Zhang, 2010). The adverse effect of the rebalancing on the performance of the LETF is also determined to be greater in inversely leveraged funds, compared to their positively leveraged counterparts. In the analysis conducted by Avellaneda & Zhang (2010), the daily rebalanced LETFs overperformed their static leverage counterparts only in market conditions where the returns were substantially high, while simultaneously volatility was low or non-existent, while they underperformed comparatively worse when volatility was high, especially in sideways markets.

The ETF counterparts have tried to mitigate these undesired attributes of the LETFs by offering options and variety in the ways and the frequency this rebalancing is being conducted. Rather than the rebalancing occurring daily, there are products available with weekly or monthly rebalancing of the leverage ratio. These products with less frequent rebalances have been noted to carry comparatively smaller tracking errors to the benchmark. However, most of the investors involved in leveraged products, are not aware enough of the effects of the rebalancing to seek out or understand the alternative leverage products. (Dulaney et al, 2012)

### **3.3. Management effects**

Investors that trade or hold leveraged exchange traded funds are exposed to similar management and other administrative fees to investors that have shares of traditional ETFs. The management fees that are usually charged by the fund issuers and calculated as annualized percentage rates from the net asset values of the funds form most of the fees experienced by the investor. The total experienced expenses are typically expressed as the expense ratio of the fund. As a result of the passive nature of these funds, they are

expected to underperform their benchmark more, if this expense ratio is higher, and less, if it's lower. (Charupat & Miu, 2014)

These expressed expense ratio does not however usually include all of the various fees and costs experienced by the funds management with the LETFs. As the leveraged funds are targeting returns synthetically, there are various transaction costs in setting up and changing the derivatives contracts these desired returns are coming from. These hidden costs from the management of the derivatives are typically higher for funds that have higher leverage ratios, or if the creation or redemption process of the ETF shares are more frequent. These unaccounted costs can also occur in funds that track either less liquid or more volatile indices. (Charupat & Miu, 2014)

Because of these inefficiencies on tracking the returns of smaller or less liquid indices with derivatives, it is fairly common for bull LETFs tracking these indices to include the constituent stocks as a part of their portfolio (Charupat & Miu, 2014). This, however, means that the fund management has to match the varying weights of these stocks in the underlying index, which is known to be a source of tracking error in traditional and unleveraged ETFs (Frino, Gallagher & Neubert 2004). This traditional fund creation process involving the stocks of the underlying indices, also exposes the investor to an opportunity costs from the dividend yield of these stock in comparison to holding the index portfolio directly, as there is a delay on the delivery of the accrued dividends to the investor (Frino et al. 2004). This effect however is unlikely to be highly significant with the LETFs as the portfolios only include a portion of the constituent stock (Charupat & Miu, 2014).

The method of replicating the returns chosen by the fund management can have an impact on the tracking error between different fully synthetic ETFs as well. All different derivatives hold specific risks to the type of contract chosen, for example basis- and correlation risks, and those can have an impact on the tracking ability if the fund. Furthermore, if the fund wants to mitigate the ETF counterparty risks, and use a large variety of derivatives, it will run into increased risks of those derivatives deviating from the objective returns. (Charupat & Miu, 2014).

### **3.4. Financing effect**

As explained in the previous chapter, ETFs mainly use derivatives structures to achieve leveraged returns. In rare cases actual financial leverage might be used as well. Regardless of the chosen method of leverage, the fund will have to finance the desired leverage ratio, and the costs associated with that will have an impact on the performance and the tracking ability of the fund. (Charupat & Miu, 2014)

Funds with a positive leverage ratio (bull ETFs) are required to collect outside financing to achieve the stated leverage for their holdings and have to bear the costs included in those transactions. This negative effect on the bull ETFs is stronger the higher the leverage ratio is, as the weight of the financing on the total value of the portfolio is greater. However, this financing effect works the opposite way on funds that have a negative leverage ratio (bear ETFs) as their portfolio is made by holding short positions. Similarly to bull ETFs, the financing effect is also stronger with funds that have higher leverage ratios, but the effect is beneficial to the fund and its investors. (Bansal & Marshall, 2015)

### **3.5. Findings from previous research**

Charupat and Miu (2011) analyzed the characteristics, performance, market transactions and investment strategies on Canadian ETFs after a few years of their inception using market data from years 2007 to 2009. They conclude that even though the ETFs have been a successful innovation, the market pricing of these products tend to be more volatile compared to their non-leveraged counterparts. The paper also notes that these pricing inefficiencies tend to differ between bull and bear funds, as the bull ETFs analyzed in their study were trading at a discount more often than at a premium, and vice-versa for the bear ETFs. The paper also points out that this effects the end of the day performance of both types of funds, as they are rebalanced to represent the desired leverage ratio. Due to this phenomenon, they conclude that these products are not suitable for long term

investing, as the tracking errors grow significantly when the holding period increases. (Charupat & Miu, 2011)

Lovicek Tang And Xu (2014) provide an analysis on the validity of the critical consensus within the previous research and the financial institutions on the performance of LETFs. They suggest that the issues of the performance of these products might be due to the coinciding of the financial crisis of 2008 to the inception and the early performance of these products. To combat this problem, in the paper Lovicek et al. simulate the long term returns of LETFs targeting Dow Jones Industrial Average from historical data, and use other large indices (S&P 500 and the Nasdaq Composite) to measure the robustness of their simulation. Using this historical data they simulate various types of LETFs, with varying frequencies of fund rebalancing. While the effects of the constant leverage trap are visible, their empirical results suggest that these simulated LETFs did not significantly underperform their comparative indices in the long run, even with holding periods of a year or more. Their findings contradicted the previous early studies and the negative sentiment towards these products for long term investing. (Lovicek et al. 2014)

Bansal and Marshall (2015) continue to further analyze the performance of these products in the long term. They suggest that while the characteristic of the LETFs cause undesired effects such as the compounding effects and the volatility drag, the same characteristic and forces create effects beneficial for the investors, thus negating the impact of these adverse effects. In the paper they propose a framework for decomposing the tracking error of LETFs in order to more delinquent analyze their performance. The research conducted implicates that in contradiction to the general consensus, but similarly to Lovicek et al. (2012) the tracking error of LETFs studies were in fact positive. From their model, the authors were able to distinguish the effects of the different components on the performance of the LETFs. They noticed that the management effect for the funds was actually positive, meaning that professional fund management was able contribute positively to the performance of the LETFs even when accounted for the fees experienced by the investor. The paper notes that the timeframe studied (2011-2014) is relatively short, and the markets were in a strong and robust uptrend throughout the whole sample, furthermore the interest rates were historically low for the whole period. Both of these characteristics

might have an impact on the performance of the studied LETFs. (Bansal & Marshall, 2015)

Similarly, Charupat and Miu (2014) analyze the significance of different factors on the performance and the tracking error of the LETFs. They propose a new regression model that includes an additional variable for the compounding effect, in order to offset the effects of the constant leverage trap on the LETFs. The authors propose, that using this model will enable them to accurately analyze the performance and efficiency of the managements of different ETF-products. Using this model, they analyze the performance of the most popular LETFs targeting the largest indices in the U.S. markets (S&P 500, NASDAQ 100, Russell 2000, and the Dow Jones Industrial Average). Their empirical analysis finds that the compounding effect has a significant impact both on the performance and the tracking ability of the LETFs inspected. This impact also varied depending on the market return paths and the volatility of the markets during the timeframe studied. When analyzing the performance of these funds after controlling for the compounding effect, the study finds that there were significant variations on the tracking errors between funds, even if their expense ratios were similar. Some of these variations were explainable by other financing effects, but the study found some discrepancies between the efficiencies of management between the funds as well. According to the study, the funds with the higher leverage ratios were underperforming compared to their less leveraged counterparts, and this was due to the inefficiencies and higher costs of management included in the higher leveraged portfolios. (Charupat & Miu, 2014)

Jiang & Peterburgsky (2017) consider a different approach to investing using the LETFs. If these products are generating consistent negative alpha in the long run as most of the literature and public sentiment suggests, a strategy based on short selling these products should, in theory, yield consistent positive alpha for the investor. To test this hypothesis, the authors propose a model where they pair together ETF counterparts that track the S&P 500 index in order to determine whether shorting these ETF pairs could provide a return that outperforms the underlying index. The empirical research is conducted via a simulation using historical data from 48 years in total. The authors find that many of the tested investment strategies involving the shorted ETF pairings were able to outperform

the S&P 500 index, and provided risk adjusted returns significantly higher than the benchmark. Using the Sharpe ratio to determine the performance of these LETF pairings, some of the studied strategies were able to yield risk adjusted returns that were multiple times higher than the one of the benchmark index (Jiang & Peterburgsky 2017).

To continue his earlier studies, Peterbursky (2021) uses the same framework as earlier. Risk adjusted returns of investment strategies using shorted leveraged and inverse leveraged ETF pairings targeting the S&P 500 index are analyzed in comparison to their benchmark. Contrary to the first study, the empirical research is not conducted via simulation, and rather uses real market data on the studied LETFs from the years 2010-2016. Similarly to the findings of the earlier study, the risk-adjusted returns of these created shorted LETF pairings outperformed their relative benchmark. This positive alpha was however noticed to diminish when the thresholds for rebalancing of portfolios were tightened. Moreover, the research suggests a positive relation between the market volatility and the outperformance of the shorted pairings, and an inverse correlation between the positive market returns and the outperformance of the studied strategies. (Peterbursky, 2021) This suggest that the proposed strategies would be most profitable in high volatility markets, and least profitable in steady rising market conditions. This in in line with the early studies on the performance of LETFs on different market conditions. See for example (Avellaneda & Zhang, 2010).

## **4. Portfolio performance**

This chapter will go over the efficient market hypothesis, and the relationship between risks and returns. Moreover, this chapter includes an explanation of the Capital asset pricing model (CAPM) that describes this relationship. This provides a theoretical background on the portfolio performance measurements and the regression model presented later in the paper.

### **4.1. Market efficiency**

Most of the commonly used risk-adjusted portfolio performance metrics are based on the relationship between the systematic risk and the corresponding returns of an investment security. This assumption relies heavily on the expectation that the financial markets are at least somewhat efficient. Efficiency in the financial markets signifies that the prices of securities are affected by all relevant information. Competitive and effective financial markets should signify that securities are priced correctly, and achieving abnormal excess returns should not be expected with any kind of investment strategy, and any excess returns should come with a high degree of risk. (Dimson & Mussavian, 1998)

Market efficiency relies on the market participants being rational, or that occasional irrational actions are corrected by opposing rational actors. In reality, it is far-fetched to assume that all of the individuals operating in the broad financial markets are acting purely rationally, but the efficient market hypothesis suggest that rather than irrational actions generating other correlated irrational behaviors, the markets will generally correct themselves with opposite actions if momentary irrationality appears. Furthermore, if irrational behavior prevails in the markets, arbitrage opportunities will become available, and actors using these opportunities will eventually correct the irrational market pricing. This irrational price correction method functioning in efficient markets can also be presented as

the law of supply and demand, where the relationship between the supply and demand of a market commodity will have an impact on the price of the commodity, and the price changes will have an impact on the former. This way the markets will find the rational price for the security. (Villalta, 2012, p. 53-62)

## **4.2. Efficient market hypothesis.**

Fama (1970) introduced an efficient market hypothesis, that introduces three forms of market efficiency, weak-form, semi-strong form, and strong form. The different forms describe how well and what kind of information the market prices follow, and how this information should be interpreted when predicting price movements of securities. The weak form of market efficiency implies that all of the meaningful public past information is already included in the price of the securities, and the past price changes are not relevant in predicting movements in the future. This means that future price changes should only happen when new information comes to light. In this weak form, because the historical price changes do not hold relevancy for predicting future movement, technical analysis or investment strategies based on historical price data should not be able to provide excess returns for investors in the market. Fundamental analysis, in the other hand, might be able to provide investors excess returns in the markets, by allowing investors to benefit from new information that has not yet been reflected in the pricing. (Fama, 1970)

The semi-strong form of market efficiency suggested by Fama (1970) implies that in addition to the past public information being included in the prices, new available information will be absorbed into the prices quickly and effectively, making it impossible to gain excess abnormal returns by using that new information in investing strategies. The semi-strong form of efficiency suggests that both fundamental and technical analysis will be void in trying to provide excess abnormal returns for the investors. The only way to achieve these excess returns is through private information possessed before the rest of the market participants. (Fama, 1970)

Finally, the strong form of market efficiency implies that also all of the private information in addition to the public information is already reflected on the prices of securities in the markets. Thus, making it impossible to gain an advantage in the markets by possessing any kind of information regarding the security or the markets at large. It is widely accepted that weak and semi-strong forms of market efficiencies can be accomplished, but strong form of efficiency is unachievable. In the real-world markets, private information and using that for investment purposes, insider trading in other words, will provide excess returns, and is considered illicit activity, and there are broad legislations to prevent that in the markets. (Fama, 1970)

### **4.3. Expected returns**

For explaining the relationship between the risk taken on, and returns expected on a security, the Capital asset pricing model was developed by finance academics in the 1960s (Sharpe, 1967). CAPM is the most widely used framework for understanding the expected returns of a security. The model is able to measure and quantify expected risk with simplicity, which makes it a popular tool, but also attracts a fair bit of criticism (Brentani, 2003).

A major shortfall of the CAPM model is that it requires certain conditions, assumptions and simplifications in order to function as a way to quantify the relationship between the expected returns and the risk of the security as intended (Severini, 2017, p. 194-215). The model assumes that all of the investors are rational and risk-averse, use the same inputs for creating expectations, and use the same, single investment horizon. The model also assumes certain conditions from the market; all assets are publicly held, and publicly traded, shorting securities is possible and allowed, lending at a risk free rate is unlimited, and there is no taxes or transaction costs. (Bodie et al. 2009).

The CAPM-model can be described with the following formula:

$$E(r_i) = r_f + \beta_i [E(r_m) - r_f] \quad (1)$$

Where:  $E(r_i)$  = Expected return of the security  $i$

$E(r_m)$  = Expected market return

$r_f$  = Risk-free rate

$\beta_i$  = Beta of the security

The equation in question describes how the expected returns of a security are a sum of the accrued market risk in relation to the volatility of the security and the additional risk-free returns achieved. This equation forms the security market line, and according to the CAPM when markets are in balance, all portfolios and securities should fall into this line. If a security would fall over this line, it would be providing returns greater than the risks would suggest, and vice versa, a security that falls under this line, would be providing returns less than what the accrued risks would indicate. By comparing the returns of a investments to the security market line, investors are able to compare portfolios to the general risk/reward ratio. (Severini, 2017, p. 194-215).

The beta coefficient in the equation describes the sensitivity of the security to the market changes. It measures the volatility of the portfolio in comparison to the systematic risk of the market at large. Mathematically, it is the slope coefficient of the regression between the market and portfolio returns. This can be expressed as (Brentani, 2003):

$$\beta_i = \frac{COV(r_p, r_m)}{VAR_{r_m}} \quad (2)$$

where:  $COV_{(rp,rm)}$  = Covariance of the return of the portfolio with the market returns

$VAR_{rm}$  = Variance of market returns

The beta describes the volatility of the security to the changes in the markets and can be interpreted as the implied risk of the security. A beta of 1 implies the returns of the security are perfectly correlated to those of the markets. Moreover, a beta less than one implies that the returns of the security are less volatile, and thus less risky than the market. Similarly, a security with a beta over 1 is more volatile, and riskier, than the market returns. For example, a fund that targets twice the market returns, would have a theoretical beta of 2. The beta of a portfolio can also be negative, in this instance, the returns of the security are negatively correlated to the market returns. An inverse leveraged ETF that targets -2x the market returns for example, would have a theoretical beta of -2. (Pratt, et. al., 2014, p. 189-300)

## 5. Risk-adjusted portfolio performance

Considering the relationship between the portfolio risks and corresponding returns suggested by efficient market theories, when assessing the performance of a fund, it is imperative not to evaluate only the experienced returns, but the risk profile of the portfolio as well. Comparing the returns of two portfolios is possible only if the risk levels are highly similar, unless the returns are adjusted for the risk of the portfolio. There have been multiple measurements created for adjusting the returns for the risk of the portfolio, these measures allow for the comparison of the performance of portfolios with different risk structures. (Bodie, Kane & Marcus 2011: 849–850.)

### 5.1. Jensen's alpha

If the portfolio returns are compared against the general market risk, the used measurement is usually Jensen's alpha. To form the Jensen's alpha, the real portfolio returns are compared to the expected returns based on the market risk of the portfolio. The expected returns are calculated with the Beta-multiple of the Capital asset pricing model. Alpha is the excess return of the portfolio in comparison to its expected returns based on its market risk. (Jensen 1967)

$$\text{Jensen's Alpha} = r_i - [r_f + B_i(r_{bm} - r_f)] \quad (3)$$

Where:

- $r_i$  = Return of the portfolio
- $r_f$  = Risk-free rate
- $B_i$  = Beta-multiple of portfolio i
- $r_{bm}$  = returns of the benchmark index

If the alpha of the portfolio is positive, the returns of the portfolio have been higher than the returns of a market portfolio with a similar risk level, meaning that the risk adjusted returns of the portfolio are stronger than those of the comparison index. In contrast, a negative alpha signifies risk adjusted returns lower than those of the comparison index. (Jensen 1967)

## 5.2. Sharpe Ratio

William F. Sharpe developed a way to measure the risk adjusted returns of a portfolio based on the Capital asset pricing model, this measurement has become known as the Sharpe ratio (Sharpe 1966). Sharpe researched the subject further, publishing additional papers in 1994 and 2007. The Sharpe ratio is the most commonly used and well-established way of measuring the performance of portfolio returns. Sharpe ratio is measured by comparing the portfolio returns in excess to the risk-free rate to the excess volatility of the portfolio. (Sharpe 1966)

$$\text{Sharpe Ratio} = \frac{r_i - r_f}{\sigma_i} \quad (4)$$

Where:

- $r_i$  = Portfolio returns
- $r_f$  = Risk free returns
- $\sigma_i$  = Standard deviation of the portfolio

Sharpe ratio measures how well the portfolio excess returns cover the additional risk compared to the risk-free rate. A large Sharpe ratio can be interpreted as robust risk adjusted

returns, while a negative result signifies returns lower than the risk-free rate. The risk-free rate used can be determined by the person calculating the ratio. (Sharpe 1966)

### 5.3. Sortino Ratio

The Sharpe ratio accounts for any volatility experienced in the returns of the portfolio, but generally for an investor, only excessive downwards volatility is considered unwanted, while additional upward movements are considered beneficial. A drawback from using the Sharpe Ratio is that high upside volatility affects the measurement negatively, and punishes the measured fund on something that is desirable for most investors (Longin, 2016). To combat this issue, the Sortino Ratio was created to measure the performance of a fund specifically in relation to its unwanted downward volatility (Sortino & Price, 1994).

$$\text{Sortino Ratio} = \frac{r_i - r_f}{\sigma_i} \quad (5)$$

Where:

$r_i$  = Portfolio returns

$r_f$  = Risk free returns

$\sigma_i$  = Downside deviation of the portfolio

Similarly to the Sharpe ratio, a higher Sortino ratio implies a more robust risk adjusted performance for the portfolio in question. In practice, when measuring two comparable portfolios, the one with higher returns for the incurred risks will have the higher Sortino Ratio.

## 5.4. Treynor ratio

Another way of comparing the portfolio returns to the market risk is the Treynor ratio. Similarly to the Sharpe ratio, it calculates the ratio between the portfolio excess returns and the excess risk, but instead of portfolio volatility, the measure of risk used in the ratio is the Beta of the portfolio. Treynor ratio is thus calculated by dividing the portfolio returns in excess to the risk-free rate with the Beta of the portfolio. Beta measures the volatility of the portfolio in regard to the changes in the market, thus the Treynor ratio adjusts the returns only for the systematic risk of the portfolio.

$$\text{Treynor ratio} = \frac{r_p - r_f}{\beta_p} \quad (6)$$

Where:

$r_p$  = Portfolio return

$r_f$  = Risk-free rate

$\beta_p$  = Beta of the portfolio

## 5.5. Information Ratio

The Information Ratio (IR) measures the performance of a fund relative to its benchmark index and the excess risk of the fund. Information ratio measures the excess returns compared to the benchmark returns against the experienced excess risk, expressed by the standard deviation (Tracking Error) of the fund. Excess returns are compared to the tracking error in order to measure if the additional returns are due to superior performance or higher volatility (Darbyshire & Hampton, 2012). The information Ratio can be calculated with the following formula (Treynor & Black, 1973):

$$IR = \frac{r_p - r_{bm}}{TE} \quad (7)$$

Where:

IR = Information Ratio

$r_p$  = Return of the portfolio

$r_{bm}$  = Return of the benchmark index

TE = Tracking Error of the portfolio

## 6. Tracking Error

Tracking error is a fundamental measurement of tracking the performance of index-based funds, especially for passive investors. Additionally, it has gathered popularity as a metric for the performance of funds especially with the rise of ETFs. The specific definitions of the tracking error vary, but the metric is designed to measure how closely the portfolio returns of the fund are able to follow the returns of the benchmark index. The tracking error measures the differences between the returns of the benchmark index and the portfolio, and signifies the excess risk of the portfolio in comparison to its benchmark. There have been multiple methods created for estimating the tracking error, but generally calculating tracking error can be expressed as the deviation between the returns of the portfolio and its benchmark. (Cremers et al. 2009)

This chapter will go over the most commonly used, and for the purposes of this study, most relevant methods for estimating the tracking error of ETFs and ETF portfolios. In existing literature, there are a few differences between what data is used, and how the measurement is calculated. Papers like Wong and Shum (2010) and Rompotis (2011) use the price data of the funds to calculate the returns, while Charupat & Miu (2014) for example propose the usage of Net Asset Value (NAV) for the calculations in order to combat inefficiencies in the market prices.

The methods for the estimation of the tracking error that will be explained in this chapter include, the average differences of returns (Frino & Gallagher, 2001), Standard deviation of return differences (Cremers et al. 2009), and the residual standard deviation of an OLS-regression between the returns of the fund and the benchmark index (Frino & Gallagher, 2001).

## 6.1. Average of the differences of returns

The simplest way to express the tracking error is by calculating the absolute differences between the returns of the portfolio and the index, and can be expressed mathematically as (Wong & Shum, 2010) :

$$TE = \text{Return of the fund} - \text{Return of the index} \quad (8)$$

For the purposes of this study, when analyzing inverse-leveraged funds, it is not useful to distinguish between positive and negative returns. Thus, rather than using the absolute returns, its beneficial to use the average absolute differences. This method can be expressed as the following formula (Frino & Gallagher, 2001):

$$TE = \frac{\sum_{t=1}^n |e_{p,t}|}{n} \quad (9)$$

Where:

$$e_{p,t} = r_{fund,t} - r_{index,t}$$

n = number of time series observations

## 6.2. Standard deviation of return differences.

In existing literature, one of the most commonly used ways of determining the tracking error of a security, is the standard deviation of the return differences. This method estimates the tracking error by calculating the differences between the returns of the portfolio and its benchmark, and is expressed as the annualized standard deviation of the calculated differences. (Cremers et al. 2009)

$$\text{Tracking error 2} = \sqrt{\frac{\sum_{t=1}^n (r_{fund,t} - r_{index,t})^2}{n-1}} \quad (10)$$

Where:  $r_{fund,t}$  = Return of the portfolio  
 $r_{index,t}$  = Return of the benchmark index  
n = number of time series observations

### 6.3. Standard deviation of OLS-regression residuals

The standard way of calculating tracking error using the absolute return differences encounters issues with overestimating the value due to autocorrelation when using price data more frequent than the observation period, which is usually the case. Similar overestimation issues may occur, if the portfolio is not trying to exactly replicate the benchmark index, and deviates from the assumption of portfolio beta being one. (Pope & Yadav 1994).

In order to account for these issues, it is possible to estimate the tracking error of a portfolio or a fund with the standard deviation of residuals from an Ordinary Least Squares (OLS) -regression where the returns of the portfolio are regressed on the returns of the benchmark index. This regression can be expressed with the following model (Frino & Gallagher, 2001):

$$R_p = \alpha + \beta + R_{pm} + \varepsilon_{pt} \quad (11)$$

Where:

- $R_p$  = Returns of the portfolio
- $\alpha$  = Alpha of the portfolio
- $\beta$  = Beta of the portfolio
- $R_{pm}$  = *Returns of the benchmark*
- $\varepsilon_{pt}$  = *Residual term*

Using this model, the tracking error is the standard deviation of the error term  $\varepsilon_{pt}$  of the function 11 above. Estimating the tracking error using the regression residuals yields a measurement of the portfolio specific idiosyncratic risk, as using the linear regression enables to distinguish the additional deviations of the portfolio from the volatility of the benchmark index returns (Frino & Gallagher, 2001). Like the conventional methods, using the OLS-regression assumes a linear relationship between the returns between the portfolio and the benchmark, and the method will overstate the tracking error if the relationship returns non-linear (Pope & Yadav, 1994)

#### **6.4. Interpretation of tracking error**

The Tracking error signifies the portion of the portfolio return volatility that cannot be explained by the volatility of the benchmark index (Petäjistö 2013). This deviation of risk profiles can be due to active management of the fund, or differences between the holdings in the portfolios. A typical active fund has a Tracking error of 5%, while a passive index fund typically yields a Tracking error of around 0,5%. In the case of index-based funds, such as LEFTs, investors should be looking for funds with lower tracking errors, as they will follow the desired benchmark more closely (Lovicek et al. 2014).

## 6.5. Net Asset Value

The Net asset Value, or NAV of a fund or portfolio represents the market value of the underlying assets of the fund at the time of calculation. It is a commonly used metric in evaluating the investment viability of indices, ETFs or traditional funds. Nav is a commonly used metric through ETF-investors and scholars, as it represents the value of the fund per-share. (Madhavan & Sobczyk, 2016)

The portfolio of a fund can be constructed from various types of assets, securities, contracts, and liquid cash. For a single share of an ETF, the NAV is calculated by deducting any liabilities from the total value of all the assets in the portfolio to get the underlying value of the portfolio. These liabilities can be the accrued fees and other costs accrued from the transactions done to form and manage the portfolio of the fund, any financing costs or cash loaned from the institutions that the ETF was formed with, and any other expenses faced by the fund. (Madhavan & Sobczyk, 2016)

To calculate the value for each of the shares of an ETF, the underlying value of the fund is divided by the total number of shares outstanding for the particular ETF. The resulting metric is the NAV of the ETF, and be exhibited by the following formula:

$$\text{Net Asset Value (NAV)} = \frac{\text{Underlying value of the Fund}}{\text{Number of shares outstanding}} \quad (12)$$

The valuation of the NAV for any fund is calculated from the closing values of the previous trading day. Traditional mutual funds are priced based on this daily valuation, as they are not traded securities similarly to stocks or ETFs. And as the shares of an ETF can be traded intra-day in exchanges, the market price of these funds can fluctuate from their actual values based on the NAV. This means that there can be opportunities for positive alpha for an average investor when using ETFs, unlike with mutual funds. (Madhavan & Sobczyk, 2016).

This price fluctuation however means, that if the focus of the research on the performance of ETFs is on the functionality of the funds, rather than the efficiency of the markets, it has to be done based on the daily NAVs of the funds being studied. As the NAV is a daily metric, this does not allow for intraday performance measurements, and that must be conducted via market prices (Charupat et al. 2014).

## **7. Data**

This chapter provides an overview of the chosen LEFTs, and the data that has been selected and gathered to analyze their performance with regards to the fund performance measurements described in an earlier chapter and the methodology that follows.

The data for the purposes of the statistical analysis of this study, as well as the fund information and data for the descriptive statistics are retrieved from the Datastream, accessed via the University of Vaasa. The complete dataset used in the execution of the analysis spans from January 2020 to December 2023.

### **7.1. Data description**

The focus of this paper is on LEFT's that target either the S&P 500 or the Dow Jones Industrial Average (Later just DOW 30) indices. Both indices are widely used in passive index investing, both in mutual funds and in the ETF -markets. These indices also have a large variety of Leveraged products available for investors in various markets, making it possible to select similar funds from different markets as well as make multiple pairings of bear- and bull funds, that track the same index with the same leverage.

The LEFT's selected for the purposes of this study are either twice or triple leveraged, in order to assess the significance of the amount of leverage on the performance of these instruments. The selection includes 14 LEFT's in total, from which 7 are traditionally leveraged, and the other 7 are leveraged invertedly. Furthermore, 6 of the funds are twice leveraged, while there are 8 triple leveraged funds in the selection in total. The group of funds are also divided by the indices they track, from the selected group, 8 are targeting the S&P500 index, and the other 6 use the DOW30 as their benchmark.

All of the LEFTs selected for this study are issued by ProShares, this is mainly due to the accessibility of data, but also using the same issuer for all of the funds improves the ease

of comparability between the datasets. ProShares is one of the largest issuers of ETFs with over 65 billion U.S. Dollars in AUM. They are especially prevalent in the market of leveraged and inversed ETFs, which is the subject of this study, thus the limited selection of the ETF issuers should not impact the setup of this research or its results. (Proshares 2024)

The selection of analyzed LETFs has funds targeting the largest US indices from both the U.S. stock market, as well as from the European stock markets, as due to the regulatory discrepancies between the two, trading directly in US ETFs is in many cases impossible for European investors. First leveraged funds to be selected to the study were the UPRO and SPXU, as they are very popular and highly liquid funds. Investors are also able to and have been selling them short before. These are not the only liquid funds in the selection, but as table 1 shows, there are some discrepancies between the bid-ask spreads of these leveraged instruments. Liquidity is an important factor to consider when selecting these funds, as it can have a significant impact on the tracking ability and thus the performance of these leveraged funds (Piccotti, 2018).

**Table 1. Selected ProShares Leveraged ETFs and corresponding fund information.**

| ETF Ticker | ETF Name                              | Index  | Leverage | Market | Expense ratio | Bid-Ask Spread | AUM*     |
|------------|---------------------------------------|--------|----------|--------|---------------|----------------|----------|
| UPRO       | PROSHARES ULTRAPRO S&P500             | S&P500 | 3x       | USA    | 0.91%         | 0.02%          | 2 238 M  |
| SPXU       | PROSHARES ULTRAPRO SHORT S&P500       | S&P500 | -3x      | USA    | 0.90%         | 0.08%          | 898.36M  |
| SSO        | PROSHARES ULTRA S&P500                | S&P500 | 2x       | USA    | 0.89%         | 0.02%          | 3 369 M  |
| SDS        | PROSHARES ULTRASHORT S&P500           | S&P500 | -2x      | USA    | 0.90%         | 0.05%          | 915.39 M |
| UDOW       | PROSHARES ULTRAPRO DOW30              | Dow30  | 3x       | USA    | 0.95%         | 0.03%          | 701.69 M |
| SDOW       | PROSHARES ULTRAPRO SHORT DOW30        | Dow30  | -3x      | USA    | 0.95%         | 0.05%          | 498.49 M |
| DDM        | PROSHARES ULTRA DOW30                 | Dow30  | 2x       | USA    | 0.95%         | 0.04%          | 378.38 M |
| DXD        | PROSHARES ULTRASHORT DOW30            | Dow30  | -2x      | USA    | 0.95%         | 0.06%          | 126.65 M |
| P2SA       | PROSHARES ULTRAPRO (BER) DOW30        | Dow30  | 3x       | GER    | 0.95%         | 1.30%          | 626.43 M |
| J405       | PROSHARES ULTRAPRO (BER) SHORT DOW30  | Dow30  | -3x      | GER    | 0.95%         | 3.13%          | 436.29 M |
| P2S8       | PROSHARES ULTRAPRO (BER) S&P500       | S&P500 | 3x       | GER    | 0.91%         | 2.17%          | 2 015 M  |
| J40Q       | PROSHARES ULTRAPRO (BER) SHORT S&P500 | S&P500 | -3x      | GER    | 0.90%         | 2.98%          | 817.56M  |
| PS0P       | PROSHARES ULTRA (BER) S&P500          | S&P500 | 2x       | GER    | 0.89%         | 1.60%          | 3 019 M  |
| PS0H       | PROSHARES (MUN) ULTRASHORT S&P500     | S&P500 | -2x      | GER    | 0.90%         | 1.97%          | 778.20 M |

*Notes:* Descriptive statistics expressed as averages of the dataset. Assets under management (AUM) expressed as million (M) dollars. Information gathered from ProShares.

From the information in the Table 1 we can point out a few details on the selection of the LETF's. The total assets under management of the selection is 16.8 billion U.S. Dollars. And while there are variances between the sizes of AUM: s between these funds, the median AUM is still 797,88 Million. The assets are not divided equally between the two different indices being tracked however. The Leveraged ETF's using S&P500 as their benchmark, are responsible for most of the total AUM with 14 billion, while the 6 funds tracking DOW 30 comprise of 2.8 billion of assets under management. This is to be expected, as the S&P 500 index is the most commonly used benchmark in index-based investing.

The bid-ask spreads of the selected LETF's are also included in the table, since there is a relationship between the bid-ask spread of the fund and increased total trading costs and the tracking error of a fund. (Jiang & Peterbursky, 2017) Furthermore, as it's visible in table 1, there are significant variations on the bid-ask spreads between the funds selected. Noting these differences can be utilized in analyzing the results of the empirical research done in this study further on. The most significant differences between these spreads are between the funds on the U.S. markets, and their corresponding European counterparts. This shows the significantly higher liquidity on the U.S. markets with regards to these leveraged and inverse ETF instruments. There are smaller but still notable and systematic differences between the positively leveraged ETF's and their inverse-leveraged counterparts. The inverse leveraged ETFs seem to have higher bid-ask spreads to those with positive leverage, this can be considered when reviewing the performance differences on these fund types.

In addition to the factors outlined in the previous research chapter, the expense ratios of these funds play a significant role on the alpha that an investor can expect and achieve. This is especially the case in the case of passive investing, such as the index-based LEFTs analyzed in this study (Charupat & Miu, 2014). Due to all of the funds selected are issued by the same provider, the expense ratios are fairly uniform. From the data in Table 1, we can conclude that there are only small differences between these funds. Furthermore, these differences cannot be determined to have been caused systematically by the differences in characteristics of the funds.

The timeframe of the dataset used in the research of the performance of these products spans from January 2020 to November 2021 and includes the daily NAVs for each of the ETFs and their underlying indices. This time-series data includes 7245 individual data-points, which are used to calculate the individual and pooler returns of the ETFs studied. Furthermore, to gather the descriptive statistics of these funds, a longer timeframe is used, and the data spans from January 2020, until the end of 2023. This dataset includes the bid and ask prices, total expense ratios and the assets under management for each of the selected ETFs and consists of a further 41 280 individual observations.

## 8. Methodology

For the analysis of the performance of these selected LEFTs, we use a time series of the daily net asset values (NAV from now on). The daily returns of the LEFTs are calculated from the changes on the nav from day to day.

The complete dataset used in the completion of the analysis spans from January 2020 to December 2023, but since this paper targets to examine the high volatility period in the stock markets subsequent to the outbreak of the Covid19 pandemic in early 2020, the timeframe chosen for the analysis is fist of January 2020 to 30.th of June 2020. The performance analysis will be conducted based on daily NAVs rather that the closing/opening prices, which is the common practice when analyzing the tracking errors of LEFTs (Charupat et al. 2014). This approach has been used previously by for example Frino and Gallagher, 2001; Elton, Gruber, Comer and Li, 2002 and Gastineau, 2004. Using the NAVs rather than the market prices guarantees that any pricing inefficiencies in the markets are not prevalent in the analysis. (Charupat et al. 2014)

Using daily NAVs as the data points for this study means that this study will not include an analysis of intraday performance, and rather focus on longer holding periods, ranging from daily returns to 3 month holding period returns during the observation period. Analysis of the intraday performance would require the performance analysis to be conducted on a market-price basis, introducing new and different variables based on the market inefficiencies on the valuations of these funds, furthermore, the Funds are designed to provide desired leveraged returns *daily* (Charupat & Miu, 2014). Moreover, despite the warnings on utilizing these products on long holding periods, most investors are holding on to their LEFT-positions longer than a day (Dulaney et al. 2012).

For the time series data of the daily returns calculated from the fund NAVs, the observations are normally distributed, but due to the method of using overlapping data for the calculations of the holding period- and cumulative average returns of the funds, some heteroscedasticity and autocorrelation issues in the data are expected. Newey-

West (1987) estimation has been utilized to correct for this issue when estimating the standard errors of the regressions using overlapping data.

### **8.1. Construction of research variables**

Apart from the largest LETFs targeting the S&P 500 index, the other twice and triple-leveraged and inverse-leveraged ETFs targeting the S&P 500 and DOW 30 indices are comparatively less liquid, thus, rather than analyzing each fund separately, portfolios pooling all Bull and Bear portfolios of the same leverage together. This is done in order to effectively analyze the performance of these products as an investment strategy for an investor, rather than analyzing the differences between certain products and the effectiveness of fund management.

### **8.2. Descriptive statistics.**

To introduce the funds, and their performance during the selected timeframe, firstly in this paper, the returns of these funds are analyzed through the descriptive statistics of each of the funds. This data is calculated by the daily changes in the NAVs of the funds. From these statistics alone it is possible to get a preliminary idea on how well the funds have performed, especially when comparing the four different groups and types of funds to each other. Thus, it's a decent first step on the process, but it is not possible to draw full conclusions from this analysis alone.

### **8.3. Risk adjusted returns of LETF portfolios.**

To further analyze the risk adjusted performance of these funds, the portfolio performance measurements are used for each of the formed pools of LETFs. The returns for each of

the portfolios formed have been calculated using the daily NAVs of the separate funds. These returns are compared to the weighted returns of the corresponding indices, to consider the number of funds tracking S&P 500 and DOW 30 respectively in each portfolio.

Each of the previously explained risk-adjusted portfolio performance measurements are calculated for all of the formed pools of leveraged ETFs (individual portfolios for Bull and Bear portfolios for both triple and twice leveraged funds separately). These measurements include Jensen's Alpha, Sharpe ratio, Sortino ratio, Treynor ratio and Information ratio. Also included is the Tracking error expressed as the standard deviation of the return differences, (Tracking Error 2) as introduced in the earlier chapter.

Each of these measurements have their unique approach on how the risk of the portfolio is measured and interpreted, thus analyzing the results through a variety of measurements can give insights on where each of these strategies excel or lack behind. These measurements differ in how they calculate the risk of the portfolios, and what is being used as the comparison for the returns achieved. All of these models are explained in more detail in an earlier chapter.

#### **8.4. Tracking Error from average return differences**

The Tracking Error as the average differences of returns between the portfolios and their benchmarks are also separately calculated. This method of tracking error is also explained in the earlier chapter as the Tracking Error 1. These Tracking Errors are calculated for multiple investment periods, to track the performance of these instruments with varying holding time strategies. These calculated timeframes are: Daily, Two-Day, Weekly, Monthly, and 3-Month periods.

These returns differences are calculated for each of the generated LETF portfolios for their Holding period returns (HPR) and average cumulative returns (CAR) separately for each of the determined timeframes. The holding period returns are calculated with the differences in the NAVs from the start to end of each holding period, while the cumulative

average returns are calculated from the daily returns of each observation from the duration of the period.

### 8.5. OLS-regression of returns

Fourth way of analyzing the performance of these constructed portfolios of leveraged ETFs, is to run an OLS-regression between the performance of the LEFT portfolios and their corresponding benchmark index portfolios. The individual returns of each LETF are pooled and regressed against the pooled returns of the indices, weighted correspondingly to the contents of the LETF portfolio.

Similarly to the calculations for the average differences between the returns, the regression will be run for multiple timeframes similar to the previous part of the analysis for each bull and bear LEFT portfolio respectively. These investment periods include: Daily, Two-Day, Weekly, Monthly, and 3-Month periods. To run this regression analysis, both holding period returns and cumulative average returns are calculated for each LEFT individually, and these returns are then pooled together to make up the returns of the formed LETF portfolios. Corresponding returns for the indices are then calculated identically.

These formed returns, for each of the bull and bear portfolios are regressed against the corresponding calculated returns of the index portfolios. The regression analysis will be conducted by regressing each of the calculated HPR's and CAR's for all of the specified timeframes. The dependent variable is the pooled returns on the LETF portfolio, and the independent variable is returns of the underlying indices. This estimation will be done using the following regression model:

$$R_{LETF} = \alpha_{LETF} + \beta_{LETF}R_{INDX} + \varepsilon_{LETF} \quad (13)$$

Where the  $R_{LETF}$  is the returns of the portfolio, the intercept  $\alpha_{LETF}$  is the excess return on the portfolio compared to the index, the slope coefficient  $\beta_{LETF}r_{INDEX}$  is the Beta of the portfolio with regards to the market, where the market is represented by the benchmark index, and the  $\varepsilon_{LETF}$  is the error term.

With the regression model it's possible to estimate the alphas and betas for each of the formed bull and bear portfolio separately. By running the regression separately with each of the calculated datasets of the returns for various holding periods, allows for examine any discrepancies within the results between differing investment horizons. Analyzing the  $\alpha$  and the  $\beta$  of the portfolio allows for examining whether the leveraged ETF funds deliver results that the investment products promise. If the returns are as expected by the regression model, the value of  $\alpha$  should be 0, and the value  $\beta$  of should be -3, -2, 2 or 3, depending on the leverage ratio of the analyzed pool of LETFs.

Interpreting the results of this model, a significant differing from these expected theoretical values suggests a gap in either the performance or tracking ability of the fund portfolio compared to the portfolio of the benchmark indices.

This approach allows for adequate analysis of how well the performance of these funds correlate to the promised returns in terms of the acquired leverage, and the experienced performance separately. One major drawback of the model however is that using a single explanatory variable does not allow for determining the source of any possible tracking errors that are found. As listed in chapter 4, the variations in fund performance and the tracking errors can be caused by multiple effects. These outlined factors can have an impact on both the intercept and the slope coefficient, making it challenging to separate the impact of the different factors when interpreting the results of the regression. (Charupat et al. 2014)

Previous research can be used to provide insight and to help in interpretation when analyzing the estimations of the regression model in this paper. For example, based on the previous research, we can determine that the compounding effect explained in chapter 4 can cause the slope coefficient  $\beta_{LETF}r_{INDEX}$  to differ from the leverage ratio of the fund,

even if the fund is tracking the index closely, and replicating the index with the intended leverage ratio. Furthermore, it is known that the impact of this phenomenon is stronger the longer the holding period and the higher the leverage ratio, as well as that it is more prevalent in bear LETFs. (Charupat et al. 2014)

## **8.6. Tracking errors from regression residuals.**

Ultimately, the tracking errors of these LETF -portfolios are calculated based on the residuals of the OLS-regression (Tracking Error 3). Using the residuals of the OLS -regression for the calculation of the tracking errors allows for singling out the idiosyncratic risk of the funds. This approach also does not assume a beta of 1, and as the subject of this study is purely on leveraged ETFs, this is vital for the empirical analysis.

As overlapping weekly returns are used to generate the portfolio returns for holding periods of over a week, autocorrelation and heteroscedasticity are expected in the dataset for these holding periods. The Newey–West (1987) procedure is used to correct the results of the OLS-regression, to calculate the standard errors of the estimates for the regressions involving overlapping observations. However, it must be noted, that based on the research by Harri and Brorsen (2009), the efficiency of this method can be questioned as it tends to underestimate the standard errors, especially with small sample sizes. With the sample size being used, the underestimation of the standard errors should be non-significant, but it is useful to take note of this issue.

## 9. Empirical results

This chapter includes an overview of the results from the empirical research conducted with the framework outlined previously. Results of each method will be presented and analyzed separately, and their significance will be explained.

### 9.1. Descriptive statistics

Fistly, the descriptive statistics of each of the funds selected are presented, the selected double-leveraged funds are gathered on table 2, while the triple-leveraged ETFs are on the table 3 below. For each of the funds presented, the statistics calculated are the average net asset values, the average prices for each of the holding periods used in this study, as well as the minimum and maximum returns, cumulative returns, and the standard deviations both on the value and the returns of each fund.

Using these statistics, it is possible to evaluate the performance of each fund separately on a surface level, but furthermore it is possible to analyze the differences between the different fund types, that will form the ETF portfolios used in further analysis in this study. On average, the ETFs studied in this paper seemed to underperform compared to their benchmark indices when looking at the average returns on the set timeframes, apart from one double leveraged fund (SSO) and two triple leveraged funds (P2S8 and UPRO) on the 3-month holding period. The overall underperformance of these products is in line with the previous literature, and the results experienced from low volatility markets. However, the overperformance of these mentioned Bull-funds goes against this outlook on the ETFs, as the performance of these funds seems to strengthen when the holding period is lengthened. This overperformance could however be explained by the changes in market conditions to be favorable for the bullish-products when including data for the 3-month period, as suggested by the overall overperformance of the bull-ETFs over their bear-counterparts.

Moreover, based on the standard deviations of the returns on each of the funds, and the corresponding information on the underlying indices, the ETFs can be noted to be more volatile than the indices they follow. These findings are in line with the findings of Avellaneda and Zhang when they suggest that the investors are over-exposed to the volatility of the markets when holding ETFs. The leverage ratios of these funds have an impact on the volatility of the returns, as the volatilities of the triple-leveraged funds are constantly and significantly higher than the ones of the double leveraged ETFs. Based on the data presented on the tables 2&3, there doesn't seem to be significant differences on the volatilities on the positively- and inversely leveraged funds. However, the funds traded in the European markets seem to be less volatile compared to the funds tracking the same indices available on the U.S. markets. This suggests that the differences between the regulatory constraints and the constructions of these funds between the two markets might have an impact on the performance of these products.

**Table 2. Descriptive statistics of selected double leveraged ETFs.**

|                         | DXD      | DDM      | SSO      | PSOP     | SDS      | PSOH     | S&P500   | Dow30    |
|-------------------------|----------|----------|----------|----------|----------|----------|----------|----------|
| Avg. Value              | 23,48    | 42,93    | 62,47    | 56,65    | 24,73    | 22,07    |          |          |
| Avg. Daily Returns      | 0,00032  | -0,00058 | 0,00042  | -0,00001 | -0,00060 | -0,00116 | 0,00073  | 0,00126  |
| Avg. Two-Day Returns    | -0,00013 | -0,00268 | -0,00086 | -0,00106 | -0,00180 | -0,00171 | -0,00016 | -0,00104 |
| Avg. Weekly Returns     | -0,00051 | -0,00569 | -0,00146 | -0,00208 | -0,00474 | -0,00426 | -0,00027 | -0,00240 |
| Avg. Monthly Returns    | -0,00596 | -0,01696 | 0,00456  | -0,00062 | -0,02305 | -0,02684 | 0,00276  | 0,00259  |
| Avg. 3-Month Returns    | -0,15637 | 0,03592  | 0,09071  | 0,05169  | -0,18512 | -0,20202 | 0,05187  | 0,02602  |
| Cumulative Returns      | 84,47    | 71,43    | 80,75    | 79,66    | 80,29    | 81,43    | 105,81   | 111,50   |
| Standard Deviation      | 4,7418   | 10,7098  | 12,9663  | 11,6219  | 4,7896   | 4,3846   |          |          |
| Daily returns Std. Dev. | 0,0596   | 0,0588   | 0,0557   | 0,0470   | 0,0553   | 0,0496   | 0,0291   | 0,0314   |
| Min. Daily Returns      | -0,2224  | -0,2318  | -0,2336  | -0,1724  | -0,1838  | -0,1324  | -0,0858  | -0,1021  |
| Max. Daily Returns      | 0,2451   | 0,2246   | 0,1889   | 0,1553   | 0,2260   | 0,3007   | 0,1362   | 0,1485   |

*Notes: Descriptive statistics of selected double leveraged ETFs and their benchmark indices.*

**Table 3. Descriptive statistics of selected triple leveraged EFTs.**

|                           | UDOW     | P2S8     | UPRO     | P2SA     | SDOW     | J405     | J40Q     | SPXU     | S&P500   | Dow30    |
|---------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| Avg. Value                | 39,84    | 45,06    | 49,65    | 36,13    | 150,00   | 136,22   | 84,77    | 93,07    |          |          |
| Avg. Daily Returns        | -0,00105 | -0,00075 | 0,00058  | -0,00194 | 0,00033  | -0,00108 | -0,00179 | -0,00099 | 0,00073  | 0,00126  |
| Avg. Two-Day Re-<br>turns | -0,00506 | -0,00262 | -0,00228 | -0,00486 | -0,00127 | -0,00124 | -0,00324 | -0,00358 | -0,00016 | -0,00104 |
| Avg. Weekly Returns       | -0,00969 | -0,00517 | -0,00380 | -0,01028 | -0,00367 | -0,00322 | -0,00898 | -0,00978 | -0,00027 | -0,00240 |
| Avg. Monthly Re-<br>turns | -0,02733 | -0,00268 | 0,00447  | -0,03319 | -0,02154 | -0,02506 | -0,04654 | -0,04463 | 0,00276  | 0,00259  |
| Avg. 3-Month Re-<br>turns | 0,03352  | 0,06826  | 0,11697  | -0,00984 | -0,27994 | -0,29553 | -0,32301 | -0,30715 | 0,05187  | 0,02602  |
| Cumulative Returns        | 49,54    | 59,72    | 60,88    | 48,21    | 64,60    | 65,94    | 62,28    | 61,54    | 105,81   | 111,50   |
| Standard Deviation        | 17,8135  | 16,5044  | 18,3098  | 16,1245  | 50,6406  | 46,6714  | 27,8607  | 29,7877  |          |          |
| Daily Return Std.<br>Dev. | 0,0869   | 0,0659   | 0,0835   | 0,0765   | 0,0884   | 0,0716   | 0,0703   | 0,0818   | 0,0291   | 0,0314   |
| Min. Daily Return         | -0,3543  | -0,2273  | -0,3495  | -0,2858  | -0,3164  | -0,3166  | -0,2146  | -0,2779  | -0,0858  | -0,1021  |
| Max. Daily Return         | 0,3267   | 0,1985   | 0,2797   | 0,2424   | 0,3608   | 0,2691   | 0,2968   | 0,3266   | 0,1362   | 0,1485   |

*Notes:* Descriptive statistics of selected Triple leveraged EFTs and their benchmark indices.

## 9.2. Risk-adjusted fund performance measurements.

The calculated results for the risk-adjusted portfolio performance measurements are presented in the table 4 for each of the formed LETF-portfolio types. Using these metrics, it is possible to determine further on the differences between these funds with regards to the relationships between their returns and the excess volatilities.

**Table 4. Risk-adjusted portfolio performance metrics.**

|                   | 2x Leverage |         | 3x Leverage |         |
|-------------------|-------------|---------|-------------|---------|
|                   | Bull        | Bear    | Bull        | Bear    |
| Jensen's Alpha    | 4,29 %      | 0,38 %  | 29,06 %     | 12,29 % |
| Sharpe ratio      | 1,03        | -0,99   | 1,04        | -0,23   |
| Sortino ratio     | 1,34        | -1,36   | 1,36        | -0,46   |
| Treynor ratio     | 24,74 %     | 18,54 % | 23,93 %     | 7,84 %  |
| Tracking Error    | 3,01 %      | 2,35 %  | 4,36 %      | 6,39 %  |
| Information ratio | 8,92        | -18,38  | 11,55       | -0,88   |

Using Jensen's Alpha, we are comparing the returns of the portfolio to the expected returns based on the CAPM. All of the created portfolios yielded returns greater than expected, but the triple leveraged funds fared significantly better. This goes against the early studies on the matter where the performance of funds with higher leverage ratios were comparatively significantly lower. These results suggest that the LETFs performed better during this period of market volatility than what has been usually experienced when analyzing their performances on low volatility markets.

Despite going against the expectations for these funds, these findings are however supported by for example Bansal and Marshall (2015), who suggest that the same mechanics that create the undesired effects, can in right circumstances and right market conditions also act beneficial to the investor.

It is also notable that the Bull-portfolios returned alphas greater to their inverse leveraged counterparts, this in return is backed by the earlier finding on this matter, according to which inverse leveraged fund are more prone to tracking errors (Charupat & Miu, 2014). This difference in performance between the two types of funds is not typically attributed to the constant leverage drag, and rather the higher operating expenses on the inverse LETFs (Avellaneda & Zhang, 2010), thus this difference is not expected to be affected by the same factors that affect the causalities of the constant leverage.

This phenomenon is even more clear when utilizing the Sharpe ratio to analyze these portfolios. The Bull-portfolios returned Sharpe ratios that are acceptable, even if just a fraction over 1 in both cases. The Bear-portfolios yielded annualized returns less than the risk-free rate (3-Year Treasury Bill) during the selected time-period, thus the Sharpe ratios are negative. The Sortino ratio is also negative for these funds for the same reason. This, however, could be at least partly due to the market conditions being more unfavorable than not to the Bear-portfolios during the analysis-period.

Similarly to the Sharpe ratio, the risk adjusted returns of the Bull-portfolios are acceptable but not particularly impressive. However, the Sortino ratio seems to be a better indicator on the performance of these products, as the differences between the results of the different types of funds are more pronounced. The leveraged funds are designed to be volatile, thus some of their desired aspects might be construed negatively when using the Sharpe ratio. However, neither of these metrics are able to differentiate on the performances of the differently leveraged Bull-portfolios in any significant manner.

Treynor ratio, similarly to Jensen's Alpha, measures the excess returns of the portfolio, but instead of the CAPM expected returns, the risk-free rate (3-Year Treasury Bill) is used as the benchmark for the returns. Similarly to the previous metrics, and following the expectations, the Bull-portfolios outperformed the Bear counterparts significantly. However, unlike in the case for the Jensen's Alpha, the higher leveraged funds underperformed compared to the ones with lower leverage ratios. In the case of the positively leveraged products, this discrepancy was not especially large, but it was more noticeable in the inverse leveraged funds.

The tracking errors were calculated from the standard deviations of the return differences (TE 2). Similarly to the findings of most of the early research on the ETFs, in the tracking errors of the funds within the scope of this study, it is noticeable, that the higher the leverage ratio, the more susceptible for tracking errors these funds are. Furthermore, higher leverage ratios for the inverse leveraged funds are especially detrimental to the performance of these products according to these tracking errors.

The information ratio, which is based on the return differences between the portfolio and the returns of the benchmark, corrected with the excess risk incurred by the portfolio represented by the tracking errors, is in line with the findings that the Bull-portfolios significantly outperformed their Bear-counterparts. However, using this metric, the portfolios with higher leverage ratios fared comparatively better on their risk-adjusted returns.

In conclusion, the risk-adjusted portfolio performance metrics of these created ETF-portfolios significantly different from those of the underlying indices. There were significant discrepancies between the bull- and bear-funds, but generally the ETFs fared better than their underlying indices on risk adjusted basis, this finding suggests that the hypothesis 1 should be rejected. The ETFs also overperformed their expectations based on assumptions made on research using data from low volatility markets. Indicating that hypothesis 2, which suggests that these products should perform relatively worse in these market conditions should also be rejected

### **9.3. Average return differences.**

The tracking errors calculated by the absolute average differences between the returns of the ETF portfolios and their benchmark indices are presented in table 5. With the exception of the 3-month returns of the Bull-portfolios, all of the tracking errors are negative, indicating that the ETFs underperformed systematically their benchmark indices during the selected timeframe. The outlier of the 3-Month Bull-portfolios could be

explained at least partly with how the return calculations of this long holding period over emphasize the later portion (the bull market) of the chosen volatile market period.

**Table 5. Average return differences.**

| Duration                              | Bull LEFTs |          | Bear LEFTs |          |
|---------------------------------------|------------|----------|------------|----------|
|                                       | HPR        | CAR      | HPR        | CAR      |
| <u>Panel A: Double leveraged ETFs</u> |            |          |            |          |
| Daily                                 | -0,00028   |          | -0,00027   |          |
| Two-day                               | -0,00107   | -0,00067 | -0,00165   | -0,0007  |
| Weekly                                | -0,00209   | -0,00112 | -0,00412   | -0,0018  |
| Monthly                               | -0,00699   | -0,00405 | -0,01579   | -0,0113  |
| 3 Month                               | 0,02034    | 0,04067  | -0,14113   | -0,0878  |
| <u>Panel B: Triple leveraged ETFs</u> |            |          |            |          |
| Daily                                 | -0,00113   |          | -0,00066   |          |
| Two-day                               | -0,00308   | -0,00303 | -0,00291   | -0,00235 |
| Weekly                                | -0,00586   | -0,00551 | -0,00768   | -0,00516 |
| Monthly                               | -0,01722   | -0,02078 | -0,03152   | -0,02661 |
| 3 Month                               | 0,00891    | 0,05514  | -0,25617   | -0,18053 |

*Notes:* Tracking errors calculated as the averages of the return differences between the LEFT- and Index portfolios.

From the calculated average differences, it is also possible to note that the Bear portfolios yielded systematically higher negative tracking errors in comparison to the Bull-portfolios. Furthermore, the tracking errors are also systematically higher on the triple leveraged portfolios compared to the twice leveraged ones. In line with the previous consensus on these products, the tracking errors are rising significantly the longer the holding period gets.

These estimations of the tracking error, indicate that the provided hypothesis 1 would hold, as the LETFs systematically underperformed their underlying indices. This estimation also suggests performances in line with the literature (Avelaneda & Zhang, 2010) that suggests that market volatility has a negative impact on the performance and tracking ability of these products.

### 9.4. Pooled regression results.

The results from the OLS-regressions between the returns of the LETF-portfolios and their underlying indices are presented in tables below. Table 6 consists of the double leveraged portfolios, while the triple-leveraged portfolios are presented in table 7. The regressions have been run with both HPR and CAR data for each of the runs, excluding the daily data, where the holding period returns, and the cumulative average returns would be the same.

**Table 6. Pooled regression results of double leveraged ETF portfolios.**

| Duration | Bull LEFTs                |                          |                            |                           | Bear LEFTs                |                            |                            |                            |
|----------|---------------------------|--------------------------|----------------------------|---------------------------|---------------------------|----------------------------|----------------------------|----------------------------|
|          | HPR                       |                          | CAR                        |                           | HPR                       |                            | CAR                        |                            |
|          | Alpha<br>1                | Beta<br>2                | Alpha<br>3                 | Beta<br>4                 | Alpha<br>5                | Beta<br>6                  | Alpha<br>7                 | Beta<br>8                  |
| Daily    | <b>-0,0005</b><br>(-0,55) | <b>1,7361</b><br>(52,85) |                            |                           | <b>-0,0003</b><br>(-0,16) | <b>-1,2333</b><br>(-23,05) |                            |                            |
| Two-day  | <b>-0,0007</b><br>(-0,69) | <b>1,8928</b><br>(57,99) | <b>-0,0006</b><br>(-0,63)  | <b>1,9114</b><br>(90,56)  | <b>-0,0019</b><br>(-1,18) | <b>-1,6613</b><br>(-33,23) | <b>-0,0008</b><br>(-0,21)  | <b>-1,6769</b><br>(-19,79) |
| Weekly   | <b>-0,0012</b><br>(-0,98) | <b>1,9464</b><br>(80,65) | <b>-0,0011</b><br>(-0,44)  | <b>1,9544</b><br>(50,99)  | <b>-0,0049</b><br>(-1,97) | <b>-1,7660</b><br>(-30,86) | <b>-0,0018</b><br>(-0,33)  | <b>-1,7841</b><br>(-34,95) |
| Monthly  | <b>-0,0096</b><br>(-1,89) | <b>1,9435</b><br>(27,25) | <b>-0,0059</b><br>(-1,79)  | <b>2,0314</b><br>(112,67) | <b>-0,0132</b><br>(-0,56) | <b>-2,0034</b><br>(-9,40)  | <b>-0,0066</b><br>(-0,89)  | <b>-2,0547</b><br>(-26,05) |
| 3 Month  | <b>-0,0298</b><br>(-4,47) | <b>2,0622</b><br>(80,04) | <b>-0,0174</b><br>(-15,47) | <b>2,0091</b><br>(262,34) | <b>-0,1285</b><br>(-6,89) | <b>-1,2173</b><br>(-24,11) | <b>-0,0309</b><br>(-10,82) | <b>-1,9892</b><br>(-76,43) |

*Notes:* Results of pooled regressions using OLS regression with formula 13. Associated t-statistics in brackets.

From the data for the double leveraged funds in the table 6, it is firstly noticeable that all of the Alphas are negative, meaning that these funds systematically underperformed their benchmarks based on the regression model. This underperformance is further exacerbated by the lengthening of the holding period. The effects of the longer holding periods are also more pronounced in the inverse leveraged funds.

Theoretically the value of Beta for these double leveraged funds should be 2 on the daily data. From the regression estimations, these values fall short of their targets on the holding period the funds promise the leverage ratio and achieve values close to the promised amount only in the longer holding periods. This issue of underleveraging is also more prevalent in the inverse leveraged portfolios than in the positively leveraged ones.

**Table 7. Pooled regression results of triple-leveraged ETF portfolios.**

| Duration | Bull LEFTs                |                          |                           |                          | Bear LEFTs                |                            |                            |                            |
|----------|---------------------------|--------------------------|---------------------------|--------------------------|---------------------------|----------------------------|----------------------------|----------------------------|
|          | HPR                       |                          | CAR                       |                          | HPR                       |                            | CAR                        |                            |
|          | Alpha<br>1                | Beta<br>2                | Alpha<br>3                | Beta<br>4                | Alpha<br>5                | Beta<br>6                  | Alpha<br>7                 | Beta<br>8                  |
| Daily    | <b>-0,0015</b><br>(-0,67) | <b>2,3801</b><br>(32,61) |                           |                          | <b>-0,0005</b><br>(-0,20) | <b>-2,2571</b><br>(-27,05) |                            |                            |
| Two-day  | <b>-0,0021</b><br>(-0,86) | <b>2,8263</b><br>(38,71) | <b>-0,0024</b><br>(-1,12) | <b>2,8452</b><br>(57,26) | <b>-0,0039</b><br>(-1,53) | <b>-2,7465</b><br>(-36,05) | <b>-0,0030</b><br>(-1,25)  | <b>-2,7973</b><br>(-50,39) |
| Weekly   | <b>-0,0034</b><br>(1,37)  | <b>2,9144</b><br>(50,11) | <b>-0,0046</b><br>(-0,75) | <b>2,9645</b><br>(55,01) | <b>-0,0100</b><br>(-1,80) | <b>-2,7046</b><br>(-23,13) | <b>-0,0060</b><br>(-1,56)  | <b>-2,7896</b><br>(-20,96) |
| Monthly  | <b>-0,0220</b><br>(-1,23) | <b>2,7489</b><br>(12,54) | <b>-0,0206</b><br>(-1,93) | <b>3,1358</b><br>(42,45) | <b>-0,0266</b><br>(-0,45) | <b>-2,9131</b><br>(-5,80)  | <b>-0,0268</b><br>(-2,42)  | <b>-2,8320</b><br>(-56,41) |
| 3 Month  | <b>-0,0684</b><br>(-3,46) | <b>3,0984</b><br>(0,07)  | <b>-0,0614</b><br>(-5,64) | <b>3,1746</b><br>(92,85) | <b>-0,2498</b><br>(-4,54) | <b>-1,3248</b><br>(-13,05) | <b>-0,0834</b><br>(-10,45) | <b>-2,8133</b><br>(-89,19) |

*Notes:* Results of pooled regressions using OLS regression with formula 13. Associated t-statistics in brackets.

In the table 7, for the regression estimations of the triple leveraged funds, it is possible to notice a pattern similar to the one in the double leveraged products. The portfolios underperformed their benchmarks and were underleveraged on the daily data. Similarly to the double leveraged funds, these phenomena were more significant with the inverse leveraged funds and with higher leverage ratios. The inverse effect of the higher leverage ratio on the performance of the funds is also noticeable when comparing the data of both tables, as the triple leveraged funds underperformed their benchmarks more than the funds with

a lower leverage ratio. The discrepancies on the amount of leverage are also higher on the triple leveraged funds.

Based on the results of the conducted regression estimation outlined above, the hypothesis 1 of LETFs underperforming their benchmarks on extended holding periods would be withheld. The alphas of the portfolios are close to their theoretical values on the daily data, but they drift significantly apart when the holding period is longer. The betas of the inspected LETF portfolios differ significantly from their expected values in the daily data, signifying that the funds are not able to achieve the stated leverage-ratios.

Comparatively to previous research conducted with data from stable markets (see for example Charupat & Miu, 2014) the underperformance of the LETFs is significantly higher, especially when the holding period is extended to months. This would back the presented hypothesis 2, signifying that the undesired effects of these products are more pronounced when the market volatility is high.

### **9.5. Regression estimation-based Tracking errors.**

The following tables include the tracking error calculations derived from the error terms of the OLS-regression. Table 8 includes the tracking errors calculated from both CAR and HPR data for all of the portfolios for the selected holding periods for the double leveraged portfolios, and table 9 presents the same information for the triple leveraged portfolios.

**Table 8. Tracking errors of twice leveraged EFT from OLS regression residuals.**

| Duration | Bull LEFTs                        |                                   | Bear LEFTs                        |                                   |
|----------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
|          | HPR                               | CAR                               | HPR                               | CAR                               |
|          | Tracking Error                    | Tracking Error                    | Tracking Error                    | Tracking Error                    |
| Daily    | <b>0,0108</b><br>(0,0094, 0,0121) |                                   | <b>0,0176</b><br>(0,0153, 0,0196) |                                   |
| Two-day  | <b>0,0121</b><br>(0,0107, 0,0138) | <b>0,0101</b><br>(0,0090, 0,0115) | <b>0,0185</b><br>(0,0164, 0,0211) | <b>0,0404</b><br>(0,0360, 0,0461) |
| Weekly   | <b>0,0132</b><br>(0,0118, 0,0151) | <b>0,0120</b><br>(0,0107, 0,0137) | <b>0,0224</b><br>(0,0199, 0,0256) | <b>0,0442</b><br>(0,0394, 0,0504) |
| Monthly  | <b>0,0268</b><br>(0,0238, 0,0305) | <b>0,0151</b><br>(0,0134, 0,0172) | <b>0,0672</b><br>(0,0598, 0,0767) | <b>0,0534</b><br>(0,0394, 0,0504) |
| 3 Month  | <b>0,0262</b><br>(0,0234, 0,0299) | <b>0,0118</b><br>(0,0105, 0,0135) | <b>0,0556</b><br>(0,0495, 0,0634) | <b>0,0389</b><br>(0,0346, 0,0444) |

*Notes:* Table represents the tracking errors of twice leveraged ETFs calculated from the standard deviations of the regression residuals. Chi-distribution 29 percent confidence intervals are in brackets.

Similarly to the previous metrics, the tracking errors of the double leveraged portfolios have a rising trend the longer the holding period is, until the 3-month holding period, where the trend flattens out or even decreases. There is also a clear trend where the tracking errors for the Bear-portfolios are significantly larger than the ones of the Bull-portfolios.

**Table 9. Tracking errors of triple-leveraged EFT from OLS regression residuals.**

| Duration | Bull LEFTs                        |                                   | Bear LEFTs                        |                                   |
|----------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
|          | HPR                               | CAR                               | HPR                               | CAR                               |
|          | Tracking Error                    | Tracking Error                    | Tracking Error                    | Tracking Error                    |
| Daily    | <b>0,0243</b><br>(0,0212, 0,0271) |                                   | <b>0,0277</b><br>(0,0242, 0,0313) |                                   |
| Two-day  | <b>0,0275</b><br>(0,0245, 0,0313) | <b>0,0241</b><br>(0,0215, 0,0275) | <b>0,0287</b><br>(0,0255, 0,0327) | <b>0,0270</b><br>(0,0240, 0,0308) |
| Weekly   | <b>0,0302</b><br>(0,0269, 0,0344) | <b>0,0285</b><br>(0,0253, 0,0325) | <b>0,0389</b><br>(0,0346, 0,0444) | <b>0,0307</b><br>(0,0273, 0,0350) |
| Monthly  | <b>0,0678</b><br>(0,0603, 0,0773) | <b>0,0385</b><br>(0,0343, 0,0440) | <b>0,1503</b><br>(0,1338, 0,1714) | <b>0,0394</b><br>(0,0351, 0,0450) |
| 3 Month  | <b>0,0804</b><br>(0,0716, 0,0917) | <b>0,0336</b><br>(0,0229, 0,0383) | <b>0,0969</b><br>(0,0863, 0,1105) | <b>0,0337</b><br>(0,0300, 0,0385) |

*Notes:* Table represents the tracking errors of triple-leveraged ETFs calculated from the standard deviations of the regression residuals. Chi-distribution 29 percent confidence intervals are in brackets.

The data for the triple leveraged funds in the table 9 supports the findings that the tracking errors are larger for the long holding periods, as well as for the inverse leveraged products. The table also supports the earlier findings that the tracking errors are larger for the higher leveraged funds, as the tracking errors of these triple leveraged LETFs in table 9 are significantly higher than the tracking errors of the double leveraged portfolios in table 8.

## 10. Conclusions

This thesis presents the background and fundamental mechanics of ETF-investing and introduces the most common Exchange traded funds and their structures. The focus of this paper is on leveraged- and inverse leveraged ETFs, and their risk adjusted performance during a period of market volatility. The purpose of the paper is to provide an investor-centric outlook on the validity of LETFs, studying the funds during the market conditions they are perceived to be useful, and using the holding periods these funds are typically held by an average investor. This is done to provide a comparison to existing literature that studies the performance on steady market conditions.

There have been studies conducted on these funds before, most of them finding inefficiencies on their performances, leading to widespread warnings against the use of LETFs by the average investor. During the last few years, contradictory evidence has also surfaced, leading to more interest in studying this subject.

This study utilizes a variety of different metrics to analyze the performance of these funds during the market volatility period following the Covid19-pandemic in early 2020. This is done to gather a broad perspective on the validity of these products, and to analyze the reasons behind the contradictions in earlier research on the matter. The metrics analyzed in the paper quite expectedly provide various and sometimes mixed results on the matter.

Based on the absolute returns of these funds, both separately and in the formed portfolios, they seem to underperform their benchmarks while being more volatile. This was especially the case for the funds with higher leverage ratios, and for inverse-leveraged funds. This finding is supported by the widespread consensus on these products and suggests that these underperformances are due to the factors outlined earlier in this study (Leverage, Management and Financing). These findings also indicate that the performance of these products is especially weak during times of market volatility. There was, however, significant differences between the performance of funds in traded the two different markets studied in this thesis, which could be of interest when researching this topic further.

The inverse leveraged funds continued to underperform the positively leveraged funds when analyzing the funds using the risk-adjusted portfolio performance metrics. However, the higher leverage ratio wasn't as clearly detrimental to the investor. Overall, the funds fared significantly better on metrics that used the underlying indices as their benchmark, rather than the risk-free rate. Based on the metrics used, the funds present to be more attractive investments than their underlying indices during volatile markets. However, this is much more clearly the case for the Bull-funds. This is contradictory to most of the previous, especially earlier studies on these products. But is in line with more recent studies on ETFs, most notably Lovicek et al. 2014 and Bansal and Marshall (2015).

However, the findings of the regression estimation suggests that these funds systematically fall short on their expected returns, as well as on their promised daily leverage ratios. Similarly to the analysis using absolute returns and the return differences, the findings of the regression analysis also suggests that the undesired effects of these funds are more prominent in higher leverage ratios, inverse leveraged funds, and with longer holding periods. This is furthermore supported by the analysis on the tracking errors of these funds using the residuals of the OLS-regression. Based on earlier research, these effects are exacerbated by market volatility, signifying that these funds fare worse in these conditions.

In total, these findings support the consensus that the ETFs tend to underdeliver on their promised returns and leverage ratios. Based on earlier research, these performance- and tracking issues can be explained using the constant leverage trap, and financing and management effects. An interesting finding of this thesis is that the funds overperform their benchmarks when the comparisons are made on a risk-adjusted basis in volatile market conditions. This suggests a rise on the returns of these products beyond the additional risk endured by the investor holding these products when the markets are volatile, this would signify that even though these products suffer from undesired effects caused by their mechanics, and these effects are especially prevalent during market volatility, there is still profitable ways to utilize these products for an informed investor.

Further research could elaborate on this finding by using a larger dataset either by analyzing a larger set of funds or using a longer timeframe. These funds are commonly understood to perform differently in varying market conditions; thus, the risk-adjusted performance of these products could be further studied by simulating varying market conditions and comparing the performances to determine the effects of the path-dependence of these products. When analyzing the absolute returns of these funds, they seem to systematically provide negative alpha. An investor can short sell many of these funds, and it has been done before. Further research on these funds could also expand on the papers by Jiang and Peterburgsky (2017) and furthermore Peterburgsky (2021), on the research of utilizing short selling of these systematically underperforming products to create systematic positive alpha.

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