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Mispricing of Exchange traded funds (ETFs) and its determinants: Evidence from German XETRA

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TIIVISTELMÄ

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Tämä tutkielma keskittyy tarkastelemaan ETF-osakkeiden hintojen ja niiden hallinnassa olevien sijoituksien arvon eroa, toisin sanoen hinnoitteluvirhettä, ja siihen vaikuttavia tekijöitä. Tutkimuksen tulokset osoittavat, että vaikka tyypillisesti ETF-osakkeet ovat hinnoiteltu oikein suhteessa niiden omistamiin sijoituksiin, merkittäviä ja pitkäkestoisia hinnoitteluvirheitä esiintyy. Virheen suuruus riippuu ETF-osakkeiden kategoriasta ja esimerkiksi Aasian osakkeisiin tai kansainvälisiin osakkeisiin keskittyvät ETF-rahastot ovat virheeltään suurempia kuin valtioiden velkakirjoihin tai eurooppalaisiin osakkeisiin sijoittavien rahastojen hinnoitteluvirheet. ETF-rahastojen optimoidulle replikointi-menetelmälle havaittiin vähäisempi hinnoitteluvirheen suurusluokka kuin täydelliselle tai johdannaisia hyödyntäville replikointi menetelmille. Riippuen ETF-kategoriasta hinnoitteluvirheet olivat merkittäviä kahdesta viiteen päivään. Hyödykkeet ja Yhdysvallat ETF-kategorioiden hinnoitteluvirheet kestivät tutkimuksen lyhimmän ajan, kaksi päivää. Idiosynkraattinen volatiliteetti (IVOL) lisäsi hinnoitteluvirheitä Aasia, hyödykkeet, yhtiöiden velkakirjat sekä kehittyvät markkinat kategorioille. IVOL vähensi hinnoitteluvirheitä Yhdysvaltoihin keskittyville ETF-rahastoille. Tutkimuksessa havaittiin, että ETF-rahastojen kokonaiskulut ovat negatiivisesti korreloituneita hinnoitteluvirheen suuruusluokan kanssa. Sijoittajien tulisi tunnistaa ETF-osakkeiden hinnoitteluvirheet ja niiden kehittämät mahdollisuudet mahdollisiin arbitraasi-tuottoihin.

ABSTRACT

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This thesis focuses on the difference between ETFs share price and the net asset value of the underlying asset, in other words the mispricing of the ETFs and possible factors that might have an effect. The results of this thesis show that despite the ETF are typically traded near the NAV, significant and persistent mispricing can be found. The level of mispricing is category dependent and exotic categories, such as Asian equity, international equity and emerging market, have significantly higher level of mispricing than more conventional categories, such as government bonds or Eurozone equity. Optimized replication method had the lowest level of mispricing when compared to full and swap-based replication methods. The mispricing was persistent for two to five days depending on the category. Commodities and US equity categories presented lowest mispricing persistence with two days persistence. Idiosyncratic volatility (IVOL) had positive relationship with Asian equity, commodities, corporate bonds and emerging market categories, meaning that increase in IVOL increased the level of mispricing. The relationship was negative for US equity category, meaning that increase in idiosyncratic volatility decreased the level of mispricing. The total expense ratio (TER) was found to be negatively correlated with mispricing, meaning that increase in TER decreased the level of mispricing. The results suggest that investors should acknowledge the possibility of ETF mispricing while making transactions. The result also indicates that arbitrage possibilities exist for investors willing to take advantage of the market inefficiencies.

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In Ylöjärvi, the 16st of May 2018
Lari-Matti Kuvaja

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List of Abbreviations

ARCH	Autoregressive Conditional Heteroscedasticity
APT	Arbitrage Pricing Theory
ARMA	Autoregressive Moving Average
APs	Authorized Participants
CAPM	Capital Asset Pricing Model
ETFs	Exchange Traded Funds
EGARCH	Exponential Generalized Autoregressive Conditional Heteroscedastic
GARCH	Generalized Autoregressive Conditional Heteroscedastic
NAV	Net asset value
TER	Total Expense Ratio
ICAPM	Intertemporal Capital Asset Pricing Model
IVOL	Idiosyncratic Volatility
IVV	iShares Core S&P 500 ETF
IAPT	International Arbitrage Pricing Theory
TRACE	Trade Reporting and Compliance Engine
SPY	SPDR S&P 500 ETF Trust

1 INTRODUCTION

Many investors throughout the world have started to use exchange traded funds (ETFs) as investment vehicles in their portfolios since their introduction in North America in the 1990's. Exchange traded funds have given retail investors the opportunity to invest in asset categories that typically where not easily reachable for retail investors (Samadder, 2013). For example, assets classes such as bonds, commodities and other more exotic assets had high associated costs for retail investors compared to typical investments such as domestic bonds. Similarly, the indices constructed out of these assets classes where typically untradeable for retail investors (Deville et al., 2014). The growth of ETF sector in Europe has taken much longer time than in the United States and ETF investing has become a major product only in the last few years. In Europe, the first ETF was introduced much later than in the United States on April 11, 2000. The ETF was LDRS DJ STOXX 50 and it was listed on the Deutsche Börse. Today, Xetra, a subsidiary of Deutsche Börse, is the Europe's largest trading platform for ETFs (Fuhr, 2013).

In the beginning of 2003 only a 54 ETF were traded in German based stock exchange Xetra, the leading trading platform in Europe with market share of 31 %. However, since 2010 the ETF market has grown exponentially reaching 1 136 ETF and assets of 358,1 billion Euro under management in Xetra. The overall growth of ETF market in German stock exchange Xetra is presented below in Figure 1. (Deutsche Börse, 2016)

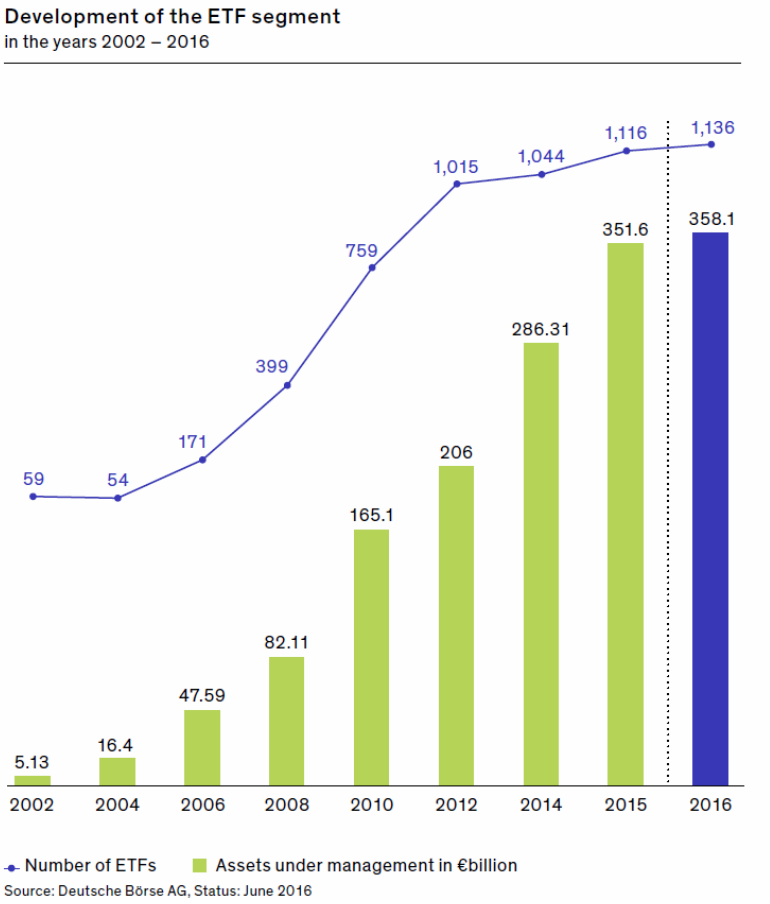

Figure 1. ETF sector growth (Deutsche Börse, 2016)

However, the rapid growth of the ETF market, just like with the case of any new financial instrument, has not happened without problems. The value of the ETF, and thus the price, should reflect the value of the underlying asset that the ETF consists of. The construction mechanism of redemption and creation of ETF shares should keep the variation between underlying asset value and the price of the ETF very close to each other. However, this may not always be the case. Petäjistö (2017) found that US ETF markets have significant ETF mispricing with non-trivial amounts due to inefficiencies at the ETF market place. As the trading volume for ETFs is very large, the historical mispricing premiums paid by the investors in actual transaction adds up to over $40 billion a year. Thus, the ETF mispricing cannot be taken lightly and investors should take matter seriously. At the same time, the ETF mispricing presents a possible arbitrage potential for creating attractive profits with low risk. Petäjisto (2017) concluded that for the categories that had the highest level of mispricing, an historical Carhart alpha of 16 % could be achievable.

The research on ETF mispricing phenomenon has mainly focused on the US stock exchange, Petäjisto (2017), Fulkerson et al. (2017). Other markets like Japan, India and Australia have also received some share of mispricing studies, Tripathi & Garg (2016), but research on mispricing at European settings is still lacking. The Xetra is a very significant stock exchange for European investors, and especially small retail investors, as it is the largest stock exchange in Europe for ETFs. Thus, the efficiency of the market place is a crucial question that should be studied. This thesis aims to fill the research gap on mispricing in European context and evaluate the efficiency of trading in Xetra.

1.1 Objective of the thesis and research questions

The objective of this thesis is to determine whether the mispricing phenomenon has been significant between January 2014 and January 2017 in European ETF marketplace and study the possible determinants. Especially the effect of idiosyncratic volatility on the possible mispricing is studied.

Research questions are:

1) Are ETFs traded in Xetra correctly priced with respect to their underlying asset?
2) Is mispricing of ETF persistent at daily level?
3) Does idiosyncratic volatility of underlying assets affect mispricing?
4) What determinants might explain the mispricing phenomenon?

1.2 Motivation and Contribution to Existing Literature

Much research has been done concerning idiosyncratic volatility and its effect on stock return. However, the effect of idiosyncratic volatility on ETF mispricing has not been thoroughly studied. Similarly, the research on ETF mispricing in major European stock exchange has been lacking.

1.3 Structure of the Study

This thesis is divided to seven chapters. The introduction chapter provides general introduction and introduces development of the exchange traded funds and the mispricing phenomenon. Literature review chapter discusses the ETF mispricing phenomenon in more

detail and previous research on done on the matter. Hypothesis chapter presents the hypotheses developed based on the existing research and literature. Methodology chapter introduces the research methods used in thesis. Data chapter describes the data collection method and overall description of the final dataset used in the research. Empirical results are displayed in their own chapter combined with discussion of the results. In the conclusion chapter, a comprehensive conclusion of the findings of this thesis is provided.

2 LITERATURE REVIEW

2.1 Exchange traded funds

The idea of an exchange traded fund was originally introduced in 1976 Financial Analyst Journal article entitled ‘‘The Purchasing Power Fund: A New Type of Financial Intermediary’’ by Nils Hakansson. However, the roots of ETF were created in the late 1970’s and the early 1980’s by portfolio trading or program trading, where one had the ability to place an order for entire portfolio of stocks. Before first ETFs were traded in the early 1990’s, Index Participation Shares (IPS) started trading in 1989 with motivation to replicate performance of S&P 500 Index by synthetic instruments. The first ETF started trading at the American Stock Exchange in 1993. The ETF SPDR, nicknamed spider, was meant to track the Standard & Poor’s 500 Composite Stock Price Index. The first ETF in Europe started trading much later in the beginning of the new millennium, in year 2000 in Deutsche Börse and London Stock Exchange.

Exchange-traded funds are securities that trade like common stocks and they can be traded continuously, unlike mutual fund where investors can only trade once a day after market is closed. An ETF is a collection of underlying assets, for example a basket of stocks. The first ETFs introduced were designed to track the performance of stock market index by holding all the index stocks with their relative weights. The ETF market is divided into two separate markets primary and secondary market, illustrated in ***Figure 1***. The primary market consists of only issuers of exchange traded funds and authorized participants (APs), who can redeem or create ETF shares. APs are typically market makers, arbitrageurs and other exchange specialist. (Deville, 2008).

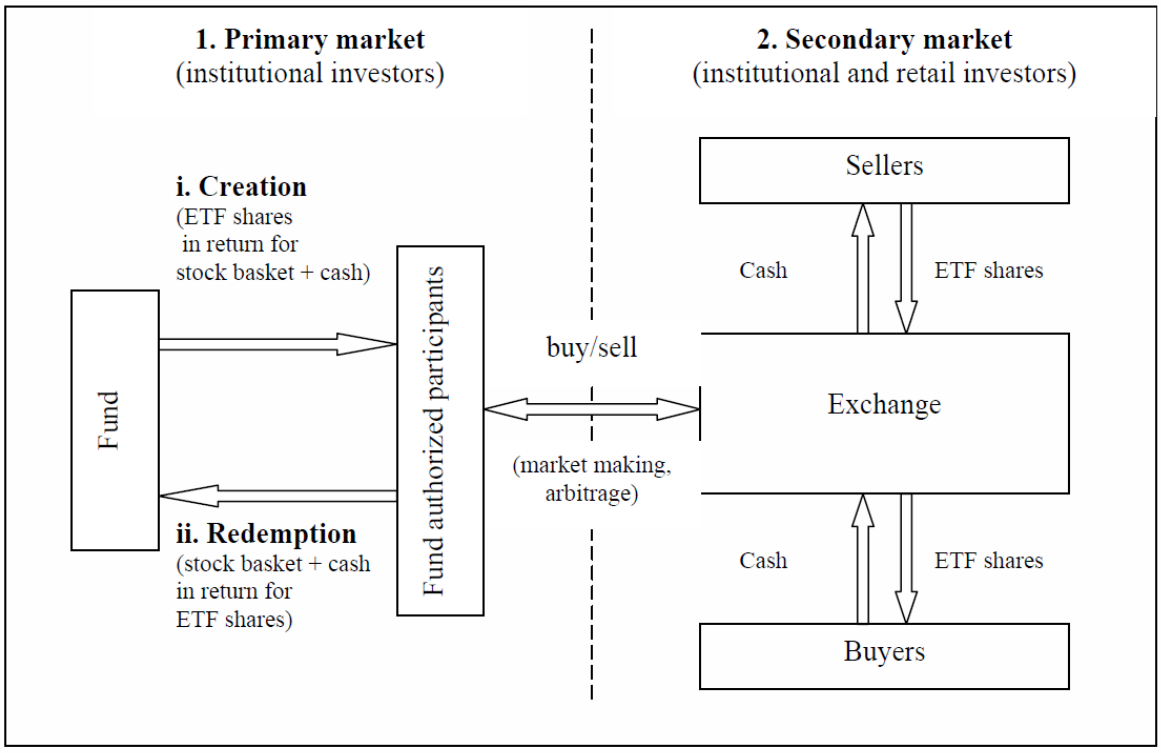

Figure 1. ETF market structure (Deville, 2008, pp.11)

Creations and redemption of ETF share are done in-kind (meaning consisting of similar assets, not cash) and in large size. These primary market transactions have minimum creation and redemption size, for example SPDR ETF has unit size 50 000 shares. This creation and redemption of ETF shares ensures by arbitrage opportunity that the shares trade very close to the net asset value of its underlying assets. In 2013 the fixed creation or redemption cost was between $500 and $3000 per transaction regardless of the share amount. The creation/redemption cost would thus be approximately 3,4 basis points (0,034 %) for creation of single SPDR ETF (Petäjistö, 2017). As ETFs are redeemed only by in-kind basis, it holds tax and cost efficiency compared to conventional mutual funds where redemption is made typically in cash that means that mutual fund may have to sell some of its positions in order to settle redemption with cash. This increases the risk and cost for mutual fund operation. (Anderson et al., 2010) (Gastineau, 2001).

In addition to arbitrage trading by creation and/or redemption of ETFs, there are also other ETF related arbitrage that affect how the ETFs are traded, which may affect the ETF mispricing with its NAV. Steven D. Dolvin (2010) pointed out in his article the statistical arbitrage potential in ETFs that trade the same underlying asset, for example SPY and IVV

ETFs that both are based S&P 500. If one of ETFs is traded at premium and the other at discount, investor could construct a long/short portfolio by short selling the ETF traded at premium and buying the ETF traded at discount. When difference between ETF share prices narrows, the investors would close both positions and collect possible profit. Marshall et al. (2013) studied the ETF mispricing and arbitrage potential at intraday level and included research on arbitrage between SPY and IVV ETFs like Steven D. Dolvin (2010) had previously proposed.

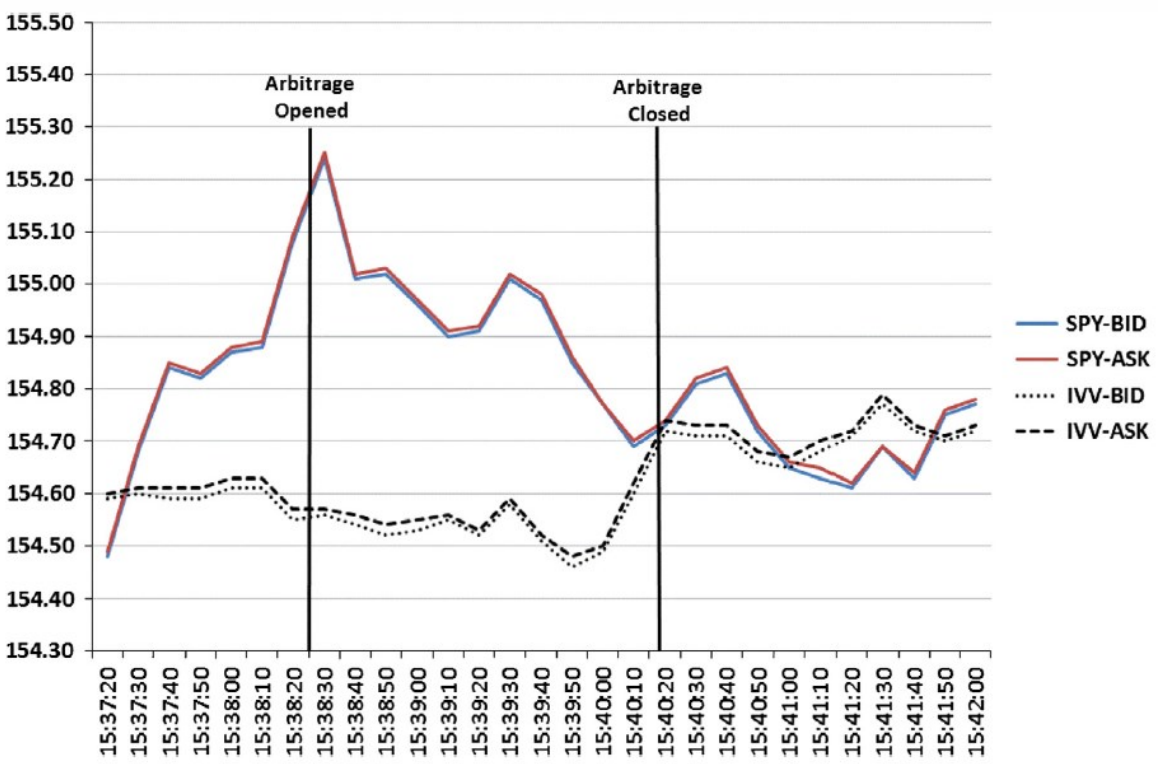

Figure 2. Example of ETF arbitrage by long/short position on SPY and IVV ETFs (Marshall et al., 2013, p.3492)

Figure 2 presents intraday arbitrage between SPY and IVV ETFs that both track the S&P 500 stock index. When the share price of SPY is considerable above the share price of IVV, arbitrager open short position of SPY and long position on IVV. When gap between prices diverges, both positions are closed. However, the selected ETFs may not be identical always, as SPY ETF is allowed to have certain amount of difference between weighted underlying stocks until re-balancing is required. The IVV ETF uses representative index sampling strategy for replication (optimized replication) and thus might not always hold all 500 stocks belonging to S&P 500. Despite these minor differences, the two ETFs are highly correlated with underlying index. The authors conclude that at intraday level arbitrage potentials exist

and that differences in NAV is not the driver for mispricing between the two ETFs share price.

2.2 Mispricing of exchange traded funds

In theory as authorized participants can create and redeem ETF shares without impacting the market price, the deviation between share price and NAV should quickly disappear due to arbitrage. As ETF shares are traded independently from their underlying asset and correct pricing relies on the arbitrage mechanism, it's understandable that some level mispricing will occur in the market as various factors and limitations are present at the market place making the actual trading conditions deviating from ideal conditions and limiting the arbitrage potential. If only insignificant and minor mispricing is displayed, the market can be deemed efficient. The Net Present Value is calculated based on the closing prices of underlying securities or in case more illiquid fixed asset securities NAV calculated by latest bid prices. The calculation of daily NAV may present the problem of stale NAV value for illiquid securities that are not often traded or for international securities where the market for underlying asset is open at different time than the ETF market. (Johnson et al, 2013) (Deville, 2008) (Petäjistö, 2017). Johnson et al. (2013) found that ETFs using synthetic replication had, on average, lower mispricing than funds with physical funds and suggested replication as one influencing factor.

Petäjistö (2017) studied ETF mispricing for ETF traded in the US market and found while ETFs are on average traded at only 6 basis points (0,06 %) mispricing, the volatility of these ETF is significant and investors should be aware that significant mispricings may persist in the ETF market. Petäjistö used novel approach to deal with possible stale NAV and bid-ask spread and still found significant ETF mispricing. The lowest levels of mispricing were perceived for ETF with underlying assets as diversified US equity, US government bonds or short-term bonds. ETFs with international equities or bonds and illiquid US securities, for example high-yield bonds, were found to have the largest mispricings. Petäjistö found that mispricing was more persistent for ETFs that had different trading hours than its underlying assets. Author stated mispricing half-life of half a day on average for equity funds and for non-Treasury bond ETFs half-lives between two and three days on average. Fulkerson et al. (2017) found similar results and stated most deviation from NAV where corrected within five days.

Tripathi & Garg (2016) studied ETF pricing efficiency compared NAV for 17 ETFs tracking equity indices from five different countries, US, UK, Japan, Australia and India. The study was conducted for period between 2000 and 2012. All ETF had pricing deviating from their net asset value at daily level, but US based ETFs were the most price-effective and deviated with an average of less than 0,15 %. Similarly, UK, Japan and Australia showed small mispricing on average with range from 0,14 % to 0,67 %. The authors found that ETFs based on US indices where the most efficient with shortest persisting mispricing. The mispricing persisted for one day for two US based ETF and three US based ETF where found to have no daily level persistence. The authors found that Indian ETF market had significant mispricings with average between 0,52 % and 1,40 % and persistence up to three days. However, despite the low average mispricing, almost all ETFs had at least one daily mispricing occurrence with mispricing higher than 2 %. Out of the 17 ETFs used in the study, only four US based ETFs had all daily mispricing occurrences below 2 %. The mispricing results are considerably high when considering that these EFTs are based on major equity indices, like FTSE 100, NIKKEI 225 and TOPIX.

2.2.1 Commodity ETF mispricing

Commodities is one of the assets categories that became much more reachable for retail investors by the emergence of ETFs and investors can easily add exposure to commodities by many exchange traded funds available at significant lower cost than before. However, many ETFs use futures as their replication method for tracking the underlying commodity. As actual storing and delivering commodities is highly unpractical and costly, the futures contracts must be replaced before the expiration of the futures contract. Otherwise, the commodity is delivered. This rolling-over process exposes commodity ETFs to additional costs and may significantly affect the funds ability to replicate performance of the underlying asset. The structure of futures market is downward- or upward-sloping. Meaning that near-term future prices are higher than long-term futures prices, typically called backwardation. In backwardation investors are ready pay more for the delivery of the commodity now than in the future. The other conditions where investors are willing to pay more for receiving the commodity later in the future rather than at the present moment is often called “Contango”. This phenomenon was recently displayed in the futures market as oil price slumped in 2016. Futures based oil ETF faced significant roll-over costs as the new futures where significantly

more expensive than futures expiring in near-future that ETF was holding. In effect selling low and buying high at the futures market, had strong negative effect on the performance of some funds. For example, United States Oil Fund ETF[1] was down 4,5 % during the first three months of 2016, while at the same time crude oil had gained 8,3 %. The spot price for the commodity is not the only factor driving the commodity ETF returns. The term structure of futures market can have positive or negative effect on the fund performance. (Guedj et al, 2011), (Roy, 2016).

Guedj et al. (2011) research did not focus on the actual mispricing (difference between ETF share price and its NAV), but the authors studied the deviations between selected oil ETFs and WTI crude oil spot price ***Figure 3*** presents the performance of selected ETFs against the crude oil spot price between April 2007 and April 2010.

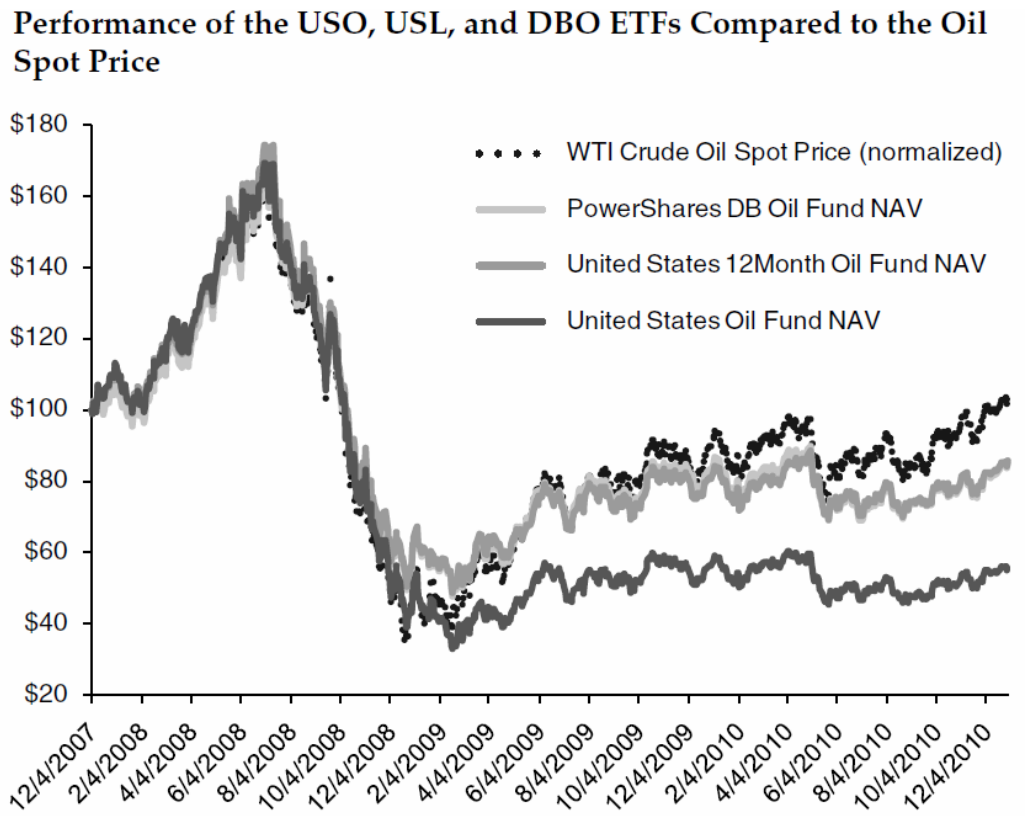

Figure 3. Performance of selected oil ETFs and WTI crude oil spot price Guedj et al. (2011, p.17)

United States Oil Fund uses near-month futures contract and roll them over each month two weeks before expiration, meaning that in practice the fund rolls over the whole NAV each month. United States 12 Month Oil Fund holds twelve futures contacts with equal weights

[1] http://www.etf.com/USO

starting from the near-month futures. Meaning that the fund rolls over one of twelve contracts each month. The PowerShares DB Oil Fund do not fully disclose the contracts they are holding. The fund also contributes to Deutsche Bank master fund and uses banks own methods for optimal tracking and they're free to select any portfolio of futures that are believed to deliver higher risk-adjusted return rather than primary objective of tracking the oil spot price as closely as possible. Guedj et al. (2011) conclude in their research that NAV deviations are mainly due to rolling over the futures contracts and that these roll over costs lead to negative performance when term structure in futures market is upward trending and that selected ETFs are not suitable for retail investors. Although the research did not focus mispricing itself, the results provide insight on the performance of futures based ETFs. These roll-over costs may add to arbitrage costs and increase the uncertainty, thus limiting the arbitrage potential.

2.2.2 Leveraged ETF mispricing

Leveraged ETFs were introduced to the market quite long since the beginning of ETF market itself in 2006. These leveraged ETFs aimed to replicate the performance of underlying assets, typically an index, by a multiple, most often one, two or three including inverse (Bearish) varieties. However, many investors may not be aware that leveraged ETFs aim to generate the multiplied performance at daily level, meaning that the fund must be rebalanced at the end of each trading day. Because of this dynamic rebalancing, the actual performance of the fund may differ from the multiple target. This fact overlooked fact generated lawsuits when the leveraged ETFs arrived into the marketplace. Because of daily rebalancing many authors have raised concerns and warned that leverage fund cannot achieve the multiple target in the long run. Bansal & Marshall (2015) studied the tracking error for S&P 500 based leveraged ETF from 1964 to 2013 and found that the tracking error is beneficial for investor rather than detrimental, by returning positive tracking error when the index appreciated and negative error when the index returned negative gains. In other words, the tracking error gained too much and did not lose enough, to accurately the follow the multiplied performance of S&P 500 index. (Bansal & Marshall, 2015)

2.2.3 Bond ETF mispricing

Because bond ETF shares are created and redeemed on in-kind basis, all participants in the primary market are necessarily active also in the Over The Counter (OTC) bond market.

Typical bond ETF had 32 reported authorized participants in 2014, but most of them were inactive, leaving the number of active APs between three and five. Many bond based ETFs have underlying assets that are not frequently traded and thus many underlying bonds do not have recent transaction prices available. Because lack of transaction prices, the net asset value of underlying bond is often calculated by bid prices. Bid and ask quotes are often available through various sources, for example Bloomberg, but they are not binding and for small quantities in some cases. The quotes can also be stale further complicating the calculation of NAV. Other source for bond valuation information is private companies, for example Markit which offers end-of-day bond valuation for OTC bonds by combining inputs from different dealers. Since October 2004 all OTC transaction have been required to be submitted to the Trade Reporting and Compliance Engine (TRACE), which significantly increased the available information for investors. However, there have been reported significant differences between the quotes by Markit and prices recorded in TRACE that cannot be explained bid-ask spread. This difference further underlines the difficulty of calculating the net asset value for a based ETF.

Because the net asset value is often calculated by bid prices, significant mispricing may persist due difference between the recorded NAV and the actual price for arbitrageur. Fulkerson et al. (2014) studied the mispricing from arbitrageur's point of view and presented three different scenarios for mispricing and arbitrage potential that could correct the mispricing.

Figure 4 presents three possible scenarios for ETFs trading at discount or premium when compared to its net asset value. As observable from the figure, the ETF bid-ask spread typically smaller than bid-ask spread for the underlying bond or bonds. As the NAV is calculated by bid quotes, the ETF is often traded at premium, presented in scenario A. However, in this case arbitrage is not possible as the ask-quote exceeds the ETF market price (midpoint of bid-ask spread). The same applies for all situations, where ETF price is within the underlying bond bid-ask spread. In this scenario A, the ETF mispricing (premium) is mainly dependent on the bid-ask spread of the underlying bond portfolio, which for illiquid bond can be very large and for highly liquid bonds (e.g., government bonds) narrow. (Fulkerson et al., 2017) (Fulkerson et al., 2014).

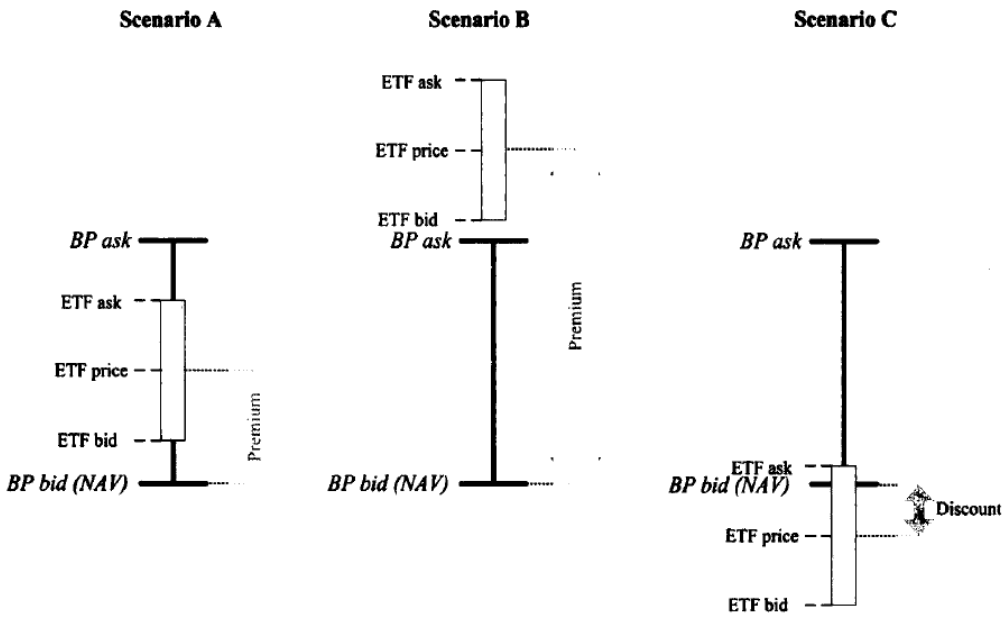

Figure 4. Bond ETF bid-ask spread scenarios (Fulkerson et al., 2014, p.52)

In scenario B, the bid price is outside the spread for the underlying portfolio and arbitrage is possible. Very high demand for illiquid ETF share, might cause the ETF market price to surge above the ask price of the underlying bond portfolio. In this case authorized participant would buy the underlying bond portfolio and create new ETF shares and sell them. In this case possible profit is not the observed premium between underlying NAV bid price and ETF market price, but NAV ask price and ETF bid price where the transaction would actually take place. Scenario C presents a situation where the ETF is selling at discount. In this case the ETF market price is below NAV, the authorized participant can buy the ETF share and redeems the share to create underlying portfolio at NAV (bid price of the underlying asset). There's no arbitrage potential available in this case, unless the ETF ask price is below the underlying portfolio bid-price. If the transaction cost is higher than available arbitrage profit, the authorized participant does not have incentive to engage in creating or redeeming ETF shares. (Fulkerson et al., 2014).

Fulkerson et al. (2014) studied the ETF mispricing phenomenon with bond ETF and found that bond ETF mispricing is typically highest at the first day of the mispricing and that mispricing may be persistent over 30 days as APs cannot arbitrage the deviation because illiquidity of the underlying bonds inside the ETF. Authors also recorded that after very high day of ETF premium, there was often a steep drop in underlying bond closing price from previous evening and opening price at the next day, which suggests that prior day high

premium are corrected at the next day. The research also discovered a strong statistical relationship between ETF mispricing and various factors measuring liquidity.

Fulkerson et al. (2017) found that ETFs that are mispriced, either discount or premium ETFs, have increased share redemption or creation when compared to correctly priced fund. However, at the same time authors found that share creations do not happen consistently all the time for ETFs traded at premium or share redemptions for ETFs traded at discount. Authors state that lack of arbitrage activity by APs can be partly explained by factors affecting the secondary market. ETFs with low volume or high bid-ask spread to increase the arbitrage risk. Fulkerson et al. (2017) conclude that uncertainty, liquidity and other cost are the main reasons, why significant mispricing may be persistent in the bond ETF market.

2.3 Idiosyncratic volatility

Idiosyncratic risk, often called unsystematic risk, is risk rising from the asset itself and is uncorrelated with market-specific risk. The idea of idiosyncratic risk was introduced by William Sharpe (1964) with his capital asset pricing model (CAPM) theory. The CAPM theory states that investors are able reduce firm specific risk by diversifying their portfolio in equilibrium. In CAPM expected return from individual stock depends on the correlation (Beta) between the stock return and market return while considering risk-free return.

$$E(r_i) = r_f + B_i[E(r_m) - r_f]$$

Where $E(r_i)$ is expected stock return, r_f the risk-free rate, β_i the correlation between stock and market return, and $E(r_m)$ expected market return.

According to the CAPM, volatility from firm specific events (idiosyncratic volatility) should not affect the expected return for individual stock as the risk can be diversified away by holding market portfolio. Later Merton (1987) showed that it is possible to have less optimally diversified portfolio that is in equilibrium with market portfolio when the concept of incomplete information at capital market is used. In practice investors rarely hold optimally diversified portfolio according to CAPM as most investors hold less than stocks (Hueng & Yau, 2013). Campbell et al. (2001) concluded in their research that investor should need more than 50 randomly selected stocks to achieve significant diversification of investment portfolio. Most traditional asset pricing theories suggest that if investors are

unable to hold well diversified portfolio due to market perfections or other reason, under-diversified investors should require additional return for bearing the firm-specific risk. (Aslanidis et al., 2016). This risk-return trade-off is fundamental part of financial theory and should not wary across assets or time (Aslanidis et al., 2018).

After the introduction of CAPM, the research on risk-return trade has started to account for the fact that investors do not hold well-diversified portfolios and thus should require additional return for taking firm-specific risks. Merton (1973) presented Intertemporal Capital Asset Pricing Model (ICAPM) as an extension of CAPM. The ICAPM assumes that investors hedge their investment positions by time-varying factors. Stephen Ross (1976) presented an Arbitrage Pricing Theory (APT) that asset's return can be predicted by using its relationship between different risk variables as a linear combination of independent variables. Various extensions for the APT has been developed since its introduction. Solnik (1983) presented International Arbitrage Pricing Theory (IAPT) where the model itself does not change by investors different home currencies, but factor weights and risk premiums vary depending on the currency. Later dynamic approach on asset pricing models have been adopted. The CAPM has been studied using time-varying betas, for example Cai et al. (2015) and K.Kim & T.Kim (2016).

The results for relationship between stock returns and idiosyncratic volatility has varied from negative to positive relationship in different studies.

Malkiel and Xu (1997) studied the relationship of idiosyncratic volatility and stock return and found strong positive correlation between idiosyncratic volatility and stock returns, which is in contrast with CAPM that argues that idiosyncratic volatility should not affect the stock returns, since the risk may be diversified away. The authors used to measure the idiosyncratic volatility by measuring the difference of variance of individual stock and S&P 500 index.

Ang et al. (2006) studied idiosyncratic volatility and its effect on stock returns. The research found the relationship to be negative, which means that investors are not compensated for the additional risk. Because the relationship was found to negative, investors actually receive decreased payoff by taking additional risk. This documented phenomenon has been typically

called as idiosyncratic volatility puzzle as increase in stocks idiosyncratic volatility is followed by lower future returns.

Stambaugh et al. (2015) found that idiosyncratic volatility has a negative relationship with overpriced stocks and a positive relationship with underpriced stocks. Authors concluded that higher idiosyncratic volatility increases arbitrage risk and thus increases the arbitrage cost and arbitrage asymmetry. Under arbitrage asymmetry investors are more willing and able to buy underpriced securities than they are willing and able to short overpriced securities. Cao & Han (2016) had similar results in their research as they found that idiosyncratic volatility increases average stock return for undervalued stocks and decreases returns for stocks that are overvalued. Their results showed robustness in various subsamples and in different industries.

The idiosyncratic volatility has received academic attention and several studies on the matter have been very recently published. Recent research on idiosyncratic volatility by Aslanidis et al. (2018) found that when controlling macro-financial factors, the relationship with idiosyncratic volatility and stock returns is positive. However, when the macro-financial factors where not controlled, the relationship turned negative and was consistent with the findings of Ang et al. (2006). Malagon et al. (2018) found in their research that negative relationship between idiosyncratic volatility and stock returns is time-varying phenomenon caused by liquidity issues in recessions and after the recessions. Zaremba et al. (2018) studied the relationship between idiosyncratic volatility and stock returns by simulation. They contributed to research done earlier by Stambaugh et al. (2015). The authors simulation results indicate that in random samples, correlation between stock returns and idiosyncratic volatility depends on the alpha, abnormal returns from the CAPM. The authors find positive correlation for stocks with positive alpha and negative correlation for stock with negative alpha.

Campbell et al. (2001) studied the idiosyncratic volatility for common stock for time between 1962 and 1997. Authors decomposed the stock return to three different components: market return, industry return and company specific return, which they had as residual from market and industry returns. Authors conclude their research to the notion that firm specific volatility, idiosyncratic volatility, showed upward trend for their observation period.

However, later Brandt et al. (2010) later presented new evidence on the matter and showed that firm specific volatility had dropped by the year 2003 to pre-1990's levels reversing any trend in the volatility. In their research, Brandt et al. (2010) found that firm specific volatility was greater for smaller companies on average. The authors also conclude that episode of increasing firm specific volatility observed by Campbell et al. (2001) can be interpreted as episodic event instead of a time trend.

2.3.1 ETF idiosyncratic volatility

Much of the research conducted for idiosyncratic volatility has been conducted for stocks and not for exchange traded funds. The research on idiosyncratic volatility of ETF shares is very limited. Research between idiosyncratic volatility and mutual fund performance is studied as mutual funds are relatively close to ETFs.

Tularam and Reza (2016) studied the relationship between idiosyncratic risk (volatility) and return of four exchange traded funds that invested in water resource related companies using Markov switching model. The observation period in their research was between June 2004 and August 2015. The authors conclude that idiosyncratic risk has positive effect on water ETF returns.

Vidal-García and Vidal (2014) studied the effect of idiosyncratic volatility on 728 UK based mutual funds. Their research did not find any significant relationship between fund performance and idiosyncratic volatility. Authors also state that no relationship between idiosyncratic volatility and seasonality was observed.

Vidal-García et al. (2018) recently studied the 949 UK based mutual funds for 28-year period. The authors found that idiosyncratic volatility had negative relationship with fund returns for all different categories. Despite diversification, idiosyncratic risk (volatility) is present with the mutual fund performance. Their results also show that idiosyncratic volatility increases the number of fund with statistically significant alpha returns. The authors conclude that after controlling macro-level economic variables such as Treasury bill yield and dividend yields, idiosyncratic volatility can forecast mutual fund returns.

3 HYPOTHESIS

In this chapter based on existing literature and research regarding mispricing on exchange traded fund and according to research questions, four hypotheses are developed. Based on the research by Petäjistö (2017) it is expected that ETF are mispriced in relation to their underlying assets also in European stock exchange Xetra and that the mispricing is persistent at daily level. The results of idiosyncratic volatility's effect on stock returns has varied from positive to negative in literature. However, the structure of ETF market depends on arbitrage trading to correct possible mispricing between ETF and NAV. The cost of pursuing the potential arbitrage may sometimes be the reason for mispricing according to Stambaugh et al. (2015). The idiosyncratic volatility may increase the arbitrage cost, for example cost of short selling. The idiosyncratic volatility may also be positively correlated with liquidity, which can especially with rarely traded assets limit arbitrage potential due to the fact that ETFs are created and redeemed in large units amounts, typically 50 000 shares. Studies by Petäjistö (2017), Fulkerson et al. (2017) and Tripathi & Garg (2016) found that mispricing varies between different ETF categories. Whether the ETF consists of more exotic underlying assets like Asian equities or more conventional assets like government bonds, have be deemed to have effect on the mispricing. The developed hypotheses based on literature and previous research are presented below.

Hypotheses:

1) ETF traded in Xetra present significant mispricing with respect to their underlying assets (NAV)

2) The ETF mispricing phenomenon is persistent at daily level

3) Idiosyncratic volatility of underlying assets has positive effect mispricing

4) Mispricing varies between different ETF categories

4 METHODOLOGY

This chapter introduces method used in this thesis for empirical analysis and the reasoning behind method selection. Estimation for ETF mispricing and idiosyncratic volatility are introduced together with panel data regressions that are used in the study. Selected ETFs are categorized to ten different categories presented below in ***Table 1.*** The categorization is made manually based on Morningstar category for ETFs[2].

Table 1. ETF categories

Asian Equity	Commodities	Corporate Bond	Emerging Market	Eurozone equity	Global Equity	Government Bond	Interest Rate	US Equity	international equity

In addition to ETF share categories, the data is also categorized by the ETF issuer and replication method.

4.1 Mispricing and ETF return

I define the ETF mispricing as difference between daily ETF value and NAV in absolute terms based on the research done by (Tripathi & Garg, 2016), (Caginalp & DeSantis, 2017), (Shin & Soydemir, 2010) and (Fulkerson et al., 2014).

The ETF mispricing is defined as value by following equation:

$$P_t = \frac{ETF_t - NAV_t}{NAV_t} \quad (1)$$

Where ETF_t is the daily price of one ETF share at time t and NAV_t is the daily net asset value per share at time t (one day). The return for each ETF and their net asset value are calculated as logarithmic return.

The return for each ETF is calculated as arithmetic returns by following equation

$$Re_{-t} = \frac{ETF_t - ETF_{t-1}}{ETF_{t-1}} \quad (2)$$

Where ETF_t is the daily price of one ETF share at time t (one day), and ETF_{t-1} the daily price of one ETF share at time t-1.

[2] http://www.morningstar.com/etfs.html

The return for each NAV is calculated as arithmetic returns by following equation:

$$NAVre_{\_t} = \frac{NAV_t - NAV_{t-1}}{NAV_{t-1}} \quad (2)$$

Where NAV_t is the daily net asset value of one ETF share at time t (one day), and NAV_{t-1} the net asset value of one ETF share at time t-1.

4.2 Measuring idiosyncratic volatility with ARMA and EGARCH model

The idiosyncratic volatility is often modeled as standard deviation of residuals Fama and French (1993) three-factor pricing model (Berggrun et al., 2016) (Shi et al., 2016) or by residuals from difference between index and individual stock return (Malkiel & Xu, 1997) (Aabo et al., 2017). As the data consist of 401 different ETFs with underlying assets from various markets and market segments, it's not practically possible to use Fama and French three factor pricing model to estimate idiosyncratic returns. One possibility would be to use index-based approach, but this method faces similar challenges as the three-factor pricing model of find suitable index for all ETFs in the data set.

Here I use novel approach of estimating the idiosyncratic returns as residuals from autoregressive moving average (ARMA) model fitted to daily ETF returns. The ETF daily returns are modeled with ARMA (p,q) model for each ETF. Following Shi et al. (2016) and Fu (2009) the idiosyncratic volatility (IVOL) is estimated by EGARCH (p,q) model to catch the asymmetric property of volatility often called "leverage effects" where the drop in stock price increases the risk of the firm due to increase in leverage ratio.

The idiosyncratic volatility for each individual ETF is estimated by following equation:

$$NAV_{re\_t} = \alpha + \beta_1 NAV_{re\_t-1} + \beta_2 \varepsilon_{t-1} \ldots + \varepsilon_t \quad (3)$$

$$\varepsilon_t \sim N(0, \sigma_t^2)$$

$$\ln \sigma_t^2 = \alpha + \sum_{l=1}^{p} \beta_l \ln \sigma_{t-l}^2 + \sum_{k=1}^{q} \beta_k \left[\theta \frac{\varepsilon_{t-k}}{\sigma_{t-k}} + \gamma \left\{ \left| \frac{\varepsilon_{t-k}}{\sigma_{t-k}} \right| - \sqrt{\frac{2}{\pi}} \right\} \right] \quad (4)$$

Where σ_t^2 is idiosyncratic volatility from equation (3)

The best fitting EGARCH (p,q) and ARMA (p,q) models for estimating idiosyncratic volatility, are selected based on Akaike Information Criteria (AIC). The maximum order of the EGARCH is set to be EGARCH (3,3) based on the maximum order selection following the research done by Fu (2009). Fu (2009) concluded after examining previous research on GARCH models in modelling volatility of returns that maximum order of three is suitable for the research. The Akaike Information Criteria also selects order (3,3) or under for EGARCH model when using higher maximum order further supporting the use of (3,3) maximum order. The maximum order for ARMA model is set to be (5,5) based on the fact that AIC selects order under (5,5) for all examined ETFs

4.3 Panel data regression analysis

The relationship between mispricing and explanatory factors are studied with panel data regression analysis. F-test between categorized and pooled OLS for fixed effect and Hausman test for Fixed or Random Effects model.

Based on the work of Purohit & Malhotra (2015), Charteris (2013) and Tripathi & Garg (2016) the persistence of mispricing is measured with

$$P_t = \alpha + \beta_1 P_{t-1} + \beta_2 P_{t-2} + \beta_3 P_{t-3} + \beta_4 P_{t-4} + \beta_5 P_{t-5} + \varepsilon_t \quad (5)$$

where Pt denotes the mispricing on at time t, P_{t-1} to P_{t-5} the lagged mispricing of previous five days and α is the intercept term. The β_1 to β_5 represents the coefficient of lagged previous day mispricing and ε_t is the error term at time t. Significant coefficient would present the persistence of mispricing.

The effect on idiosyncratic volatility is studied with following regression:

$$P_t = \alpha + \beta_1 IVOL_t + \varepsilon_t \quad (6)$$

where Pt denotes the mispricing at time t, $IVOL_t$ the idiosyncratic volatility at time t, β_1 the coefficient of idiosyncratic volatility, α the intercept term and ε_t is the error term at time t.

The effect of Total Expense Ratio (TER) on mispricing is studied by using dummy variable TER_{dummy} in ordinary least square regression model by following equation:

$$|P_t| = \alpha + \beta_1 TER_{dummy} + \varepsilon_t \quad (7)$$

where Pt denotes the absolute mispricing on at time, α is the intercept term, TER_{dummy} is the dummy variable that has value of zero when TER is TER below 0,5% (low) and one when TER is exactly or above 0,5 % (high).

Based on the research done by Blitz & Huij (2012) and Purohit & Malhotra (2015), the effect of replication method is studied by using dummy variable REP_{dummy} in ordinary least square regression model by following equation:

$$|P_t| = \alpha + \beta_1 REP_{dummy} + \varepsilon_t \quad (8)$$

where Pt denotes the absolute mispricing on at time, α is the intercept term, REP_{dummy} is the dummy variable that has value one if the replication method is optimized replication and zero if replication method is swap-based or full replication.

5 DATA

Data is gathered between January 2014 and January 2017, as older data may not present the current situation in ETF marketplace accurately. The selected ETFs are traded in German platform Xetra and have both fund and exchange currency noted in Euros to remove possible currency effect. Daily closing price, daily NAV, trading volume, daily high and low prices are collected from Thomson Reuters Datastream. Total Expense Ratio (TER), use of profits, replication method for each ETF are collected from Deutsche Börse website.

Like Fulkerson et al. (2017) I filter the sample to remove effect of newly issued ETFs and effect of very small ETFs. Similar approach was also used by other authors, for example Be-David et al. (2014). ETFs listed before February 2013 are selected to ensure that ETF are well established in the marketplace. ETFs that have below $10 million assets under management are excluded together with inverse and leveraged ETF as the focus of study is the mispricing phenomenon with conventional ETF that normal risk-averse investor might choose. After removing ETFs with missing values or inconsistencies, the final data consist of 401 ETFs. The selected ETFs are listed in Appendix 1.

6 EMPIRICAL RESULTS

In this main chapter results from empirical analysis are presented.

6.1 Exchange traded fund mispricing

The ETF mispricing was studied at daily level between January 2014 and January 2017. Trend of average ETF and NAV closing values from all ETFs, meaning that value for each day is the average of all ETF closing value at that day, are presented below in ***Figure 5***. When studied as an average of all ETFs, the NAV remains very close to ETF share price almost all the time.

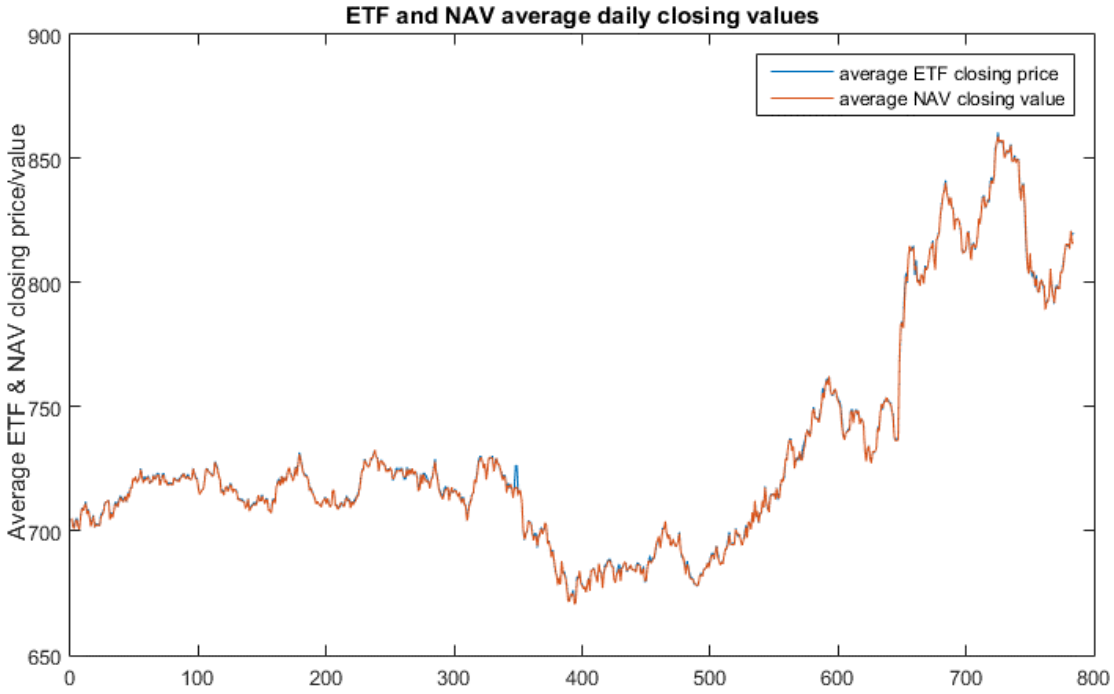

Figure 5. ETF and NAV average closing values from all ETFs

However, the situation is different when move to focusing on individual ETFs. In this three-year time period, mispricing for the whole data was typically small, under 0,25 %. However, the data for the time period also consisted of days with significant high mispricing even up to 20 %. The mispricing is graphically presented in ***Figure 6***, that presents bar chart and histogram for the whole data.

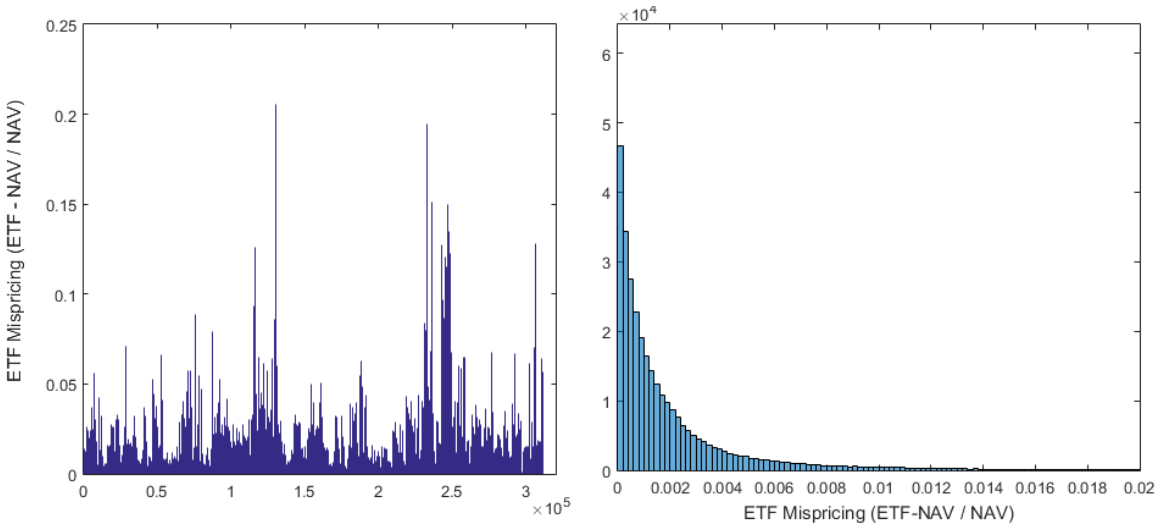

Figure 6. Bar chart and histogram for ETF sample mispricing

Table 2 presents frequency table for the whole dataset. Most of the daily observation are as mentioned insignificant from investors perspective as 75 % of observation are below 0,25 % of mispricing and even 1,88 % without mispricing at all. Deviation between ETF share price and its net asset value is however significant for roughly 25 % if the limit for considering significant mispricing is set at 0,25 %. If the limit is moved to 0,5% which can be clearly deemed significant from investors perspective, the share of significant mispricings from the daily observations is approximately 11 %.

Table 2. Frequency table for ETF sample mispricing

Mispricing	***Frequency***	***Share %***	***Cumulative %***
0,00 %	5853	1,88 %	1,88 %
< 0,25 %	227627	73,15 %	75,03 %
0,25 - 0,50 %	43888	14,10 %	89,14 %
0,50 - 1,00 %	22381	7,19 %	96,33 %
1,00 - 1,50 %	6479	2,08 %	98,41 %
1,50 - 2,00 %	2292	0,74 %	99,15 %
2,00 - 5,00 %	2272	0,73 %	99,88 %
5,00 - 10,00 %	286	0,09 %	99,97 %
10,00 - 15,00 %	92	0,03 %	99,998 %
15,00 - 22,00 %	6	0,002 %	100,00 %

Mispricing becomes rarer as the overall amount of deviation increases and only 384 observations from the 311 176 observations are above 5 %, whereas deviation between 0,5 and 1,0 % is common with 7,19 % share of the daily observations in sample time-period.

Mispricing by different categories are presented below in ***Table 3*** together with value from t-test hypothesizing the mean value of zero. Asian equity had the highest absolute mispricing and government bond the lowest absolute mispricing.

*Table 3. ETF mispricing based on categories, * significant at 5% level.*

Category	Number of ETFs	Observations	Mean	Max	Std.Dev	t-value
Asian Equity	17	13328	0,0063	0,2056	0,0088	82,16*
Commodities	4	3136	0,0036	0,0337	0,0034	57,93*
Corporate Bond	26	20384	0,0016	0,0590	0,0015	146,13*
Emerging Market	5	3920	0,0050	0,0641	0,0051	62,02*
Eurozone equity	201	157584	0,0019	0,1497	0,0043	179,19*
Global Equity	31	24304	0,0047	0,1947	0,0067	108,64*
Government Bond	84	65856	0,0009	0,0471	0,0014	153,04*
Interest Rate	10	7840	0,0016	0,0317	0,0023	59,5*
US Equity	11	8624	0,0049	0,1282	0,0068	66,50*
international equity	12	9408	0,0051	0,0795	0,0057	87,09*

The t-test null hypothesis for mispricing mean of zero for all ETF categories can reject at 5% significance level, meaning that all categories presented non-zero mispricing on average. Government bond ETFs showed the lowest average mispricing of 0,09 % with modest fluctuation among all the categories, which was expected based on previous research. Low mispricing results were also obtained for interest rate ETF category. Government bond category contains ETFs that consists only of government bonds. The interest rate category ETFs can contain other assets than regular bonds, for example treasury inflation protected securities or government bonds with currency protection. Government bonds are very liquid and their bid-ask spreads are narrow, which enables efficient arbitrage trading. Asian equity, emerging market and international equity ETFs have more exotic underlying assets that are less liquid and with higher transaction costs, which make arbitrage significantly harder. Asian, emerging market and international equities observed the highest mispricings. Asian equity ETFs particularly had the most significant mispricing with average of 0,63 % and with extreme high maximum of 20,56 %. However, in the case of Asian equity ETF the largest mispricings may be subject to stale NAV. The stale NAV might also account for the largest mispricing values for global equity and US equity categories. The Eurozone ETF category had the lowest average mispricing for equity based funds. As the ETF marketplace studied was in Europe, the result was expected as based on previous research the home

market was often among the least mispriced funds. However, largest mispricing in Eurozone ETF category is almost 15 %. As the market for underlying asset and for the ETF, the large mispricing is unlikely to be caused by stale NAV. The US equity category had quite high mispricing and very close to emerging market results. This in contrast with previous literature where the mispricing at US market have traditional being very low. However, in these previous studies, the research was done is US market and not at European stock exchange.

Mispricing by different issuers are presented below in ***Table 4*** together with value from t-test hypothesizing the mean value of zero.

*Table 4. ETF mispricing by issuers, * significant at 5% level.*

Issuer	Number of ETFs	Observations	Mean	Max	Std.Dev	t-value
Amundi	54	42336	0,0019	0,0631	0,0029	132,48*
BNP Paribas Easy	1	784	0,0020	0,0187	0,0020	27,94*
ComStage	34	26656	0,0018	0,1263	0,0034	87,27*
Deka	23	18032	0,0018	0,0305	0,0022	107,50*
HSBC	2	1568	0,0051	0,0296	0,0045	44,86*
Lyxor	83	65072	0,0034	0,2056	0,0061	139,78*
Market Access	1	784	0,0141	0,0795	0,0103	38,34*
Ossiam	5	3920	0,0041	0,0673	0,0050	51,09*
PowerShares	3	2352	0,0026	0,0277	0,0034	37,29*
SPDR	17	13328	0,0031	0,1497	0,0116	30,88*
Source Markets	18	14112	0,0019	0,0505	0,0024	91,75*
UBS-ETF	7	5488	0,0027	0,0405	0,0034	58,92*
db X-trackers	59	46256	0,0020	0,0650	0,0038	114,08*
iShares	94	73696	0,0017	0,0600	0,0024	189,82*

The t-test null hypothesis for mispricing mean of zero for all ETF issuer categories can reject at 5% significance level, meaning that all categories presented non-zero mispricing on average. The mispricing among different issuers does variate much, except for Market Access, which had only one ETF in the represented in the data. The ETF in question focused Brazil, Russia, India and China equities (BRIC).

Mispricing by different replication method are presented below in ***Table 5*** together with value from t-test hypothesizing the mean value of zero.

*Table 5. ETF mispricing by replication method, * significant at 5% level.*

Replication Method	Number of ETFs	Observations	Mean	Max	Std.Dev	t-value
Full Replication	148	116032	0,00221	0,149658	0,00478	157,50*
Optimized	73	57232	0,00128	0,127431	0,00291	105,69*
Swap-Based	180	141120	0,00278	0,205575	0,00499	208,84*

All replication method rejected the null hypothesis in t-test for mean zero mispricing. The average mispricing for the methods are very close to each other, but optimized replication method has the lowest mispricing, standard deviation and maximum mispricing, whereas the swap-based method has the highest values in these categories. It's notable that swap-based replication method exhibits the largest daily deviation measured from the whole dataset.

6.2 Mispricing persistence

This sub-chapter presents results from panel data regression for mispricing persistence. The results are divided to three different sub-chapters. The first sub-chapter ***6.2.1*** presents the results for all ETF. The sub-chapters ***6.2.2*** and ***6.2.3*** present the results by category with fixed effects and random effects model depending the results of Hausman test.

6.2.1 Fixed effects model for all ETFs

The results from panel data fixed effects regression model for all ETFs is presented below in ***Table 6*** and ***Table 7***. Hausman test shows rejection of null hypothesis of preferring random effects model. Thus, only fixed effects model is used.

Table 6. Fit statistics for fixed effects regression model for mispricing persistence with all ETFs

R-Square	Hausman test		F-test for no fixed effects	
0,3507	m value	p-value	F-value	p-value
	482,84	<0,0001	5,31	<0,0001

F test for no fixed effects shows rejection of null hypothesis that are all coefficient in the model are zero. The model has R-square value of 0,3507 that means the model can explain approximately 35 % of the overall mispricing variation.

Table 7. Fixed effects regression results for mispricing persistence with all ETFs

Variable	Intercept	Pt-1	Pt-2	Pt-3	Pt-4	Pt-5
Coefficient	-0,0010	0,3271	0,1522	0,1265	0,0465	0,0633
t-value	-6,85	182,56	80,8	66,95	24,71	35,3
p-value	<0,0001	<0,0001	<0,0001	<0,0001	<0,0001	<0,0001

The intercept and all lagged mispricing terms are significant at 1 % level. The coefficient of lagged mispricing terms decreases from the previous days mispricing until the fourth day and then on the fifth day the coefficient increases. The results mean that mispricing is persistent for five when studying the ETFs as one common group. The previous days mispricing has the highest influence on the mispricing.

6.2.2 Fixed effect regression model by Category

The results from fixed effects model for mispricing persistence is presented below in ***Table 8***. Commodities, US equity and emerging market categories failed to reject the null hypothesis at 5 % level that random effects model is preferred that they are studied in next chapter ***6.2.3*** with random effects model.

All categories studied with fixed effects model reject the F-test null hypothesis of all coefficients being zero. All ETF categories except Asian equity and international equity had mispricing persistent up to five days with significant terms in the regression results. Because Asian and international equity categories have higher level on mispricing than other categories, the shorter mispricing persistence can be explained by higher arbitrage cost. The higher level of mispricing and shorter mispricing persistence would indicate that arbitrage trading activity is higher for these categories once the arbitrage profits turn higher than the arbitrage cost. In other words, the level of mispricing can be much higher for these categories, when arbitrageurs begin to take advantage of mispricing.

Asian equity and International equity had mispricing persistence for three previous days. The categories also showed that mispricing five days before had effect on current mispricing, but similar behavior was not found with the fourth day that had non-significant variable at 5 % level. The R-square fit value is meaningful for all other categories. The significance of the lagged mispricing from previous days decreases and the most significant effect on the mispricing is the value from previous day. The coefficient for lagged mispricing variables

decreases toward the fifth and last day, which can be expected based on previous research. As all categories present mispricing for several days, the mispricing cannot be regarded as rare and short-lived phenomenon

Table 8. Fixed effects regression model for mispricing persistence by category

Category	Fit Statistic	Value	p-value	Variable	Intercept	Pt-1	Pt-2	Pt-3	Pt-4	Pt-5
Asian Equity	R-Square	0,4016		Coefficient	0,000042	0,352085	0,169995	0,164893	-0,00225	0,075037
	F Test	2,34	0,0018	t-value	0,14	40,53	18,46	17,88	-0,24	8,64
	Hausman test	14,56	0,0124	p-value	0,8893	<0,0001	<0,0001	<0,0001	0,8073	<0,0001
Corporate Bond	R-Square	0,5613		Coefficient	0,000109	0,406687	0,121491	0,085282	0,054842	0,071167
	F Test	21,87	<0,0001	t-value	2,47	57,88	16,02	11,2	7,22	10,1
	Hausman test	35,56	<0,0001	p-value	0,0137	<0,0001	<0,0001	<0,0001	<0,0001	<0,0001
Eurozone equity	R-Square	0,4502		Coefficient	0,000108	0,334329	0,18978	0,148615	0,069137	0,050724
	F Test	2,68	<0,0001	t-value	0,87	131,98	71,19	55,41	25,94	20,03
	Hausman test	211,67	<0,0001	p-value	0,3869	<0,0001	<0,0001	<0,0001	<0,0001	<0,0001
Global Equity	R-Square	0,3446		Coefficient	8,18E-08	0,459603	0,087814	0,054499	0,023592	0,039414
	F Test	5,22	<0,0001	t-value	0	71,21	12,36	7,66	3,32	6,11
	Hausman test	35,33	<0,0001	p-value	0,9997	<0,0001	<0,0001	<0,0001	0,0009	<0,0001
Government Bond	R-Square	0,3733		Coefficient	0,000045	0,318523	0,11172	0,093602	0,059034	0,061921
	F Test	19,94	<0,0001	t-value	0,96	81,32	27,18	22,72	14,35	15,72
	Hausman test	159,47	<0,0001	p-value	0,3347	<0,0001	<0,0001	<0,0001	0,0009	<0,0001
Interest Rate	R-Square	0,63		Coefficient	0,00014	0,36095	0,136368	0,102722	0,106459	0,117044
	F Test	13,24	<0,0001	t-value	2,32	32,04	11,44	8,59	8,93	10,4
	Hausman test	22,66	<0,0001	p-value	0,0204	<0,0001	<0,0001	<0,0001	0,0009	<0,0001
International equity	R-Square	0,3171		Coefficient	0,000148	0,223724	0,102089	0,088138	0,018974	0,033017
	F Test	45,08	<0,0001	t-value	0,66	21,57	9,6	8,28	1,78	3,18
	Hausman test	32,84	<0,0001	p-value	0,5072	<0,0001	<0,0001	<0,0001	0,0744	0,0015

6.2.3 Random effect regression model by category

The results from random effects model for mispricing persistence is presented in ***Table 9***. Mispricing is persistent for two days for commodities category and four days for emerging market category. Commodity based ETFs hold mainly futures for different commodities. These futures are typically easily available at the market, which may explain the lower mispricing persistence.

US equity has significant variables for first three days and for the fifth day, meaning that they effect the current mispricing. The US equity based ETFs contain mainly US stocks that are highly liquid when compared to more exotic ETF categories, such as the emerging market category, making creation and redemption or ETF shares easier for arbitrageurs. The arbitrage potential and possibilities can explain the difference between the categories. The result suggest that US equity mispricing is persistent up to three days with some effect also from the fifth day. Unlike with fixed effects model the R-square fit statistic is low for all three categories. Emerging market category has decreasing coefficients for mispricing variables meaning that significance decreases due time. Commodities and US equity categories do not present similar trend decreasing in previous days mispricing effect.

Table 9. Random effects regression model for mispricing persistence by category

Category	Fit Statistic	Value	p-value	Variable	Intercept	Pt-1	Pt-2	Pt-3	Pt-4	Pt-5
Commodities	R-Square	0,006		Coefficient	-0,00106	-0,05238	0,035702	0,006863	-0,02097	0,034744
				t-value	-1,66	-2,91	1,99	0,38	-1,17	1,93
	Hausman test	2,79	0,7322	p-value	0,0979	0,0036	0,0472	0,7028	0,2433	0,0533
Emerging Market	R-Square	0,1764		Coefficient	-0,00049	0,344111	0,088177	0,094736	-0,03483	0,015225
				t-value	-1,31	21,41	5,19	5,58	-2,05	0,95
	Hausman test	3,73	0,5892	p-value	0,1887	<0,0001	<0,0001	<0,0001	0,0406	0,344
US Equity	R-Square	0,0038		Coefficient	0,00016	-0,0246	-0,03142	0,028752	0,014983	0,035698
				t-value	1,05	-2,27	-2,9	2,65	1,38	3,29
	Hausman test	9,57	0,0883	p-value	0,2916	0,0232	0,0038	0,008	0,167	0,001

6.3 Idiosyncratic volatility on ETF mispricing

This sub-chapter presents results from panel data regression between mispricing and idiosyncratic volatility. The results are divided to two sub-chapters **6.3.1** and **6.3.2** where the first chapters present and discusses the results for all ETFs and later chapter presents and discusses the results by ETF categories.

6.3.1 Random effects model for all ETFs

The results from panel data random effects regression model for all ETFs is presented below in ***Table 10*** and ***Table 11***. Hausman test failed to reject the null hypothesis of using fixed effects model and thus random effects model is selected.

Table 10. Random effects regression model fit statistics for all ETFs.

Hausman Test |		**R-Square**
m-value	**p-value**	0.000
0,000	0,9995	

R-square value suggests that the model fails to explain variation of mispricing. Both intercept and ivol term are not significant at 5% level and their coefficients are very close zero.

Table 11. Random effects regression model results for all ETFs.

Variable	**Coefficient**	**t value**	**p-value**
Intercept	-0,000067	-1,00	0,317
ivol	-2,29E-07	-0,83	0,406

According the model idiosyncratic volatility did not affect the magnitude of mispricing when studying the ETF as one common group. The results show that on average the idiosyncratic volatility does not have effect on the magnitude of mispricing.

6.3.2 Random effect model by category

The results from random effects regression model by category is presented in ***Table 12***. Asian equity, commodities, corporate bond, emerging market and US equity categories had significant idiosyncratic volatility term in the regression results at 5 % significance level. Eurozone equity, global equity, government bond, interest rate and international equity categories did not present statistically significant relationship between mispricing and idiosyncratic volatility. The result explains why in previous chapter the idiosyncratic volatility did not have effect on the mispricing while all ETFs where studied as one group. The regression results by category presents that the effect of idiosyncratic volatility is category dependent.

The Asian equity, commodities, corporate bond, emerging market categories presented positive relationship between idiosyncratic volatility and mispricing, showing that when idiosyncratic volatility increases, the ETF mispricing also increases. Increasing underlying asset volatility for bonds can increase the bid-ask spread if volatility increases due to lower trading volumes. This may increase arbitrage costs and reduce arbitrage trading, thus increasing the mispricing. Volatility affects derivative pricing of underlying assets contained by commodity ETFs, which in turn may reduce

Increasing volatility of underlying assets for Asian equity and emerging market can increase arbitrage cost due to reduced liquidity and increasing transaction costs, thus increasing the mispricing. Investors should pay additional attention to ETF mispricing with these categories in times of high volatility in the market. Idiosyncratic volatility was negatively related to mispricing meaning that increase of idiosyncratic volatility for US category decreased the level of ETF mispricing. Possible explanation is that increase in volatility is driven by increased underlying asset trading volume, which increase liquidity and thus facilitates arbitrage trading to reduce the mispricing.

The results are in-line with findings of Petäjistö (2017) that exotic ETF categories have the highest mispricing. The ETF mispricing at Xetra can be significantly explained by conditional volatility of the underlying assets.

Table 12. Random effects regression model by category results

Category	Fit Statistic	Value	p-value	Variable	Intercept	ivol
Asian Equity	R-Square	0,0033		Coefficient	-0,00086	0,00035
				t-value	-1,71	6,64
	Hausman test	0,01	0,9044	p-value	0,0867	0,0001
Commodities	R-Square	0,0015		Coefficient	-0,00105	0,001097
				t-value	-1,4	2,16
	Hausman test	0,000	0,9655	p-value	0,1623	0,0306
Corporate Bond	R-Square	0,0004		Coefficient	0,001213	1,27E-06
				t-value	3,87	2,84
	Hausman test	0,05	0,8149	p-value	0,0001	0,004
Emerging Market	R-Square	0,0097		Coefficient	-0,00102	0,000258
				t-value	-1,29	6,19
	Hausman test	0,01	0,919	p-value	0,1986	<0,0001
Eurozone equity	R-Square	0,000		Coefficient	-0,00015	-1,11E-06
				t-value	-2,03	-1,24
	Hausman test	0,21	0,6491	p-value	0,0425	0,214
Global Equity	R-Square	0,0001		Coefficient	0,000062	-1,18E-06
				t-value	0,2	-1,22
	Hausman test	0,00	0,9656	p-value	0,844	0,223
Government Bond	R-Square	0,000		Coefficient	0,000141	-1,13E-07
				t-value	1,77	-1,23
	Hausman test	0,00	0,9994	p-value	0,0775	0,22
Interest Rate	R-Square	0,000		Coefficient	-0,00036	0,000023
				t-value	-0,71	0,42
	Hausman test	0,73	0,3943	p-value	0,4764	0,6728
US Equity	R-Square	0,0006		Coefficient	0,00015	-0,00019
				t-value	0,98	-2,19
	Hausman test	0,28	0,5987	p-value	0,3259	0,0287
international equity	R-Square	0,000		Coefficient	-0,00143	4,57E-06
				t-value	-1,26	0,57
	Hausman test	0,01	0,9259	p-value	0,2084	0,566

6.4 Total expense ratio and replication method on mispricing

The results from panel data random effects regression model for effects of Total Expense Ratio is presented below in ***Table 13*** and descriptive statistics for all ETFs in ***Table 14***. The average total expense ratio for exchange traded fund in the sample was 0,307 % which is modest expense ratio for retail investors and one reason for the success and popularity of ETFs around the globe. The lowest expense ratio of just 0,050 % was observed for bond and interest rate based ETFs, whereas the exotic Asian and emerging market ETFs typically had the highest total expense ratio observed in the data.

Table 13. Descriptive statistics of Total Expense Ratio for all ETFs

Variable	Average	Mean	Std.Dev.	Min	Max
TER	0,307 %	0,307 %	0,160 %	0,050 %	0,950 %

The random regression for total expense ratio with dummy variable had no explanation power indicated by near zero R-square value and low coefficient for dummy variable suggests. The model itself is significant at 5 % level together with significant variables. The results suggest that ETF with high Total Expense Ratio, exactly or above 0,5 %, have lower magnitude of mispricing. ETF categories with higher ETFs enables funds to use optimized replication method, which requires more labor, but also was found to have the lowest level of mispricing among replication methods. Similarly, arbitragers looking for high level of mispricing should focus in the light of the results to ETFs with lower TER combined with full or swap-based replication.

*Table 14. Random regression results for Total Expense Ratio, * significant at 5 % level.*

R-Square	Variable	Coefficient	Std. Err.	t-value
0,0446	TER_Dummy	-0,0029	0,0003	-10,28*
	Intercept	0,0048	0,0003	18,46*

Investors focusing on minimizing the mispricing possibility should focus on ETFs with higher TER combined with optimized replication method. The total expense ratio is typically higher for more exotic categories, such as Asian equity and emerging market categories. These categories presented high level of mispricing and thus more focused management of

funds is appropriate. Higher TER enables the funds to use more labor and focus more on the management of the funds, which can decrease the level of mispricing.

The results from panel data random effects regression model for effects of replication method is presented below in ***Table 15***.

*Table 15. Random regression results for Replication Method, * significant at 5 % level.*

R-Square	Variable	Coefficient	Std. Err.	t-value
0,0106	REP_Dummy	-0.0012434	0,002715	-4,58*
	Intercept	0,0025265	0,0001158	21,81*

The random regression for replication method variable shows similar results as the regression for total expense ratio. The model itself and dummy variable at 5 % level. The model had no explanation power indicated by near zero R-square value and low coefficient for the dummy variable. Coefficient for the replication dummy variable has negative effect on mispricing, meaning optimized replication has negative relationship toward mispricing. Funds which use optimized replication method are able update their holdings by purchasing only the necessary part of the underlying assets required for feasible operation. As the fund is not obligated to buy possibly illiquid underlying assets, it may benefit from lower magnitude of mispricing between the ETF price and value of net asset value.

7 CONCLUSION

This thesis studied the mispricing of ETF shares, the difference between ETF share price and net asset value of underlying assets, and its determinants in German stock exchange Xetra between January 2014 and January 2017. Hypotheses formed based on existing research where that there is significant and persistent at daily level mispricing for the ETFs traded in Xetra, idiosyncratic volatility of underlying assets increases the level of mispricing and that mispricing phenomenon is category depended. The idiosyncratic volatility was studied by ARMA-EGARCH model and the determinants of mispricing with panel data analysis.

Despite ETFs are traded most of the time within narrow range around their net asset value, still moments when the mispricing is at significant level was found. Approximately a bit more than 10 % of observation had mispricing above 0,5 %, which can be deemed significant. Small fraction of the overall observations, 98 days, showed very high mispricings of above 10 %. Corporate and government bond ETFs and funds focusing on interest rates were the most correctly priced on average, followed by Eurozone focusing funds. However, Eurozone category observed very high maximum daily mispricing of nearly 15 %. As the market for ETFs and underlying assets have same opening hours, the results are unlikely explained by stale NAV. The most significant mispricings were observed with fund investing in Asian equity, Global equity and US equity. Results for replication method showed that optimized replication method was the most efficient with minimum mispricing on average and on maximum with the slightest fluctuation. The mispricing was found to be persistent from two to five days depending on the ETF category. Commodities and US equity had the lowest mispricing persistence with two days. The mispricing had negative relationship with Total Expense Ratio (TER), meaning increase in TER decreased the mispricing on absolute terms.

Idiosyncratic volatility (IVOL) did not have effect on mispricing at general level, but further research by different ETF categories revealed that IVOL affected ETF categories differently. IVOL had positive relationship with Asian equity, commodities, corporate bonds and emerging market categories, meaning that increase in idiosyncratic volatility increased the level of mispricing. The relationship was negative for US equity category, meaning that

increase in idiosyncratic volatility decreased the level of mispricing. Eurozone equity, global equity, government bond, interest rate and international equity categories did not present statistically significant relationship between mispricing and idiosyncratic volatility.

The results suggest that investors should acknowledge that it's possible that they buy ETFs at premium (or at discount) compared to the net asset value. The results are in-line with existing research that exotic category ETFs have higher level mispricing due to their higher volatility. The result also indicates that arbitrage possibilities exist for investors willing take advantage of the market inefficiencies.

7.1 Limitations of the study

This thesis studied the mispricing at daily level and possible mispricing at intraday level was not studied. Due to lack of available data the effect of liquidity or ETF share creation and redemption was not included in the study. Both are very likely to have an effect on the mispricing and should be considered in future research. For future research, interesting perspective would be whether it's possible to construct alpha-return generating trading rule based on ETF mispricing at intra-day level (short premium ETFs, buy ETFs traded at discount and close the position when mispricing corrects itself.).

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APPENDIX 1. LIST OF ETFs

Name	ISIN
ISHRS EURO STOXX 50 UCITS EUR (DIST) ETF	IE0008471009
ISHRS STOXX EUROPE (LON) 50 UCITS EUR DIST ETF	IE0008470928
ISHARES DJ EURO STOXX 50 (DE)	DE0005933956
ISHARES DJ STOXX 50	DE0005933949
ISHARES CORE DAX UCITS ETF (DE)	DE0005933931
ISHARES MDAX (DE)	DE0005933923
ISH EUR STOXX TELECOM30 15 UCITS ETF	DE0006289317
ISHARES DJESXX. BANKS	DE0006289309
ISHARES DJ GLOBAL TITANS 50 (DE)	DE0006289382
UBS ETF DJ ER.STOXX 50 A	LU0136234068
UBS ETF - MSCI EMU UCITS ETF (EUR) A-DIS	LU0147308422
LYXOR EURO STOXX 50 (DR) UCITS ETF D-EUR	FR0007054358
ISHARES INV.EB REXX GVT. GERMANY UCITS	DE0006289465
LYXOR NASDAQ-100 UCITS ETF D-EUR	FR0007063177
ISHARES E C BD LG CAP UCITS EUR DIST ETF	IE0032523478
ISHARES TECDAX (DE)	DE0005933972
ISHARES INV.EB REXX GVT. GERMANY 1.5 2.5 UCITS	DE0006289473
ISHARES INV.EB REXX GVT. GERMANY 5.5 10.5 UCITS	DE0006289499
ISHARES INV.EB REXX GVT. GERMANY 2.5 5.5 UCITS	DE0006289481
ISHARES EB REXX JUMBO PFANDBRIEFE (DE)	DE0002635265
ISHARES EUR STOXX SML UCITS EUR DIST ETF	IE00B02KXM00
ISHARES EUR STOXX MID UCITS EUR DIST ETF	IE00B02KXL92
ISHARES FTSEUROFIRST 100 UCITS	IE0030974079
ISHARES FTSEUROFIRST 80 UCITS	IE0004855221

ISHARES DJ STOXX MID 200 (DE)	DE0005933998
ISHARES DJ STOXX SMALL 200 (DE)	DE000A0D8QZ7
ISHARES DJ STOXX LARGE 200 (DE)	DE0005933980
ISHARES DIVDAX (DE)	DE0002635273
ISHARES DJ EURO STOXX SLT.DIV.30 (DE)	DE0002635281
ISHARES DJ EURO STOXX (DE)	DE000A0D8Q07
ISHARES DJ STOXX SLT. DIV.30 (DE)	DE0002635299
LYXOR MSCI EMU GROWTH (DR) UCITS ETF	FR0010168765
LYXOR MSCI EMU SMALL CAP UCITS ETF	FR0010168773
LYXOR MSCI EMU VALUE (DR) UCITS ETF	FR0010168781
ISHARES EB REXX GVT.GER. 10 5 +	DE000A0D8Q31
LYXOR EAST EUROPE	FR0010204073
LYXOR CHIN.ENTER. (HSCEI) UCITS ETF C-EUR	FR0010204081
FTSE EPRA/NAREIT (FRA) ERZ.CPPD.UCITS ETF QD(D)	LU0192223062
ISHARES EURO DIVIDEND UCITS ETF EUR DIST	IE00B0M62S72
ISHARES EUROTOTALMARKETVALUELGE.	IE00B0M62T89
ISHARES FTSE/EPRA EURO PR.IDX.FUND	IE00B0M63284
ISHARES EUROTOTALMKTGROWTHLARGE	IE00B0M62V02
ISHARES INFL.LKD.GVT.BD	IE00B0M62X26
ISHARES DJ ASIA PACIFIC SELECT DIVIDEND 30	DE000A0H0744
ISHARES DJESXX.SUSTBY.40	DE000A0F5UG3
ISHARES ATX (DE)	DE000A0D8Q23
LYXOR EUROMTS 1 3Y INV. GDE.INTL.ASST.MAN.	FR0010222224
LYXOR MSCI EUROPE UCITS ETF D-EUR	FR0010261198
LYXOR ETF EUROMTS 3-5Y INV.GDE.INTL.ASST.MAN.	FR0010037234
LYXOR EUROMTS INFL.LKD. INTL.ASST.MANAGMENT	FR0010174292
LYXOR EURM.ALL- MAT.INV GRD DR UCITS ETF	FR0010028860

LYXOR ETF EUROMTS 10-15Y INTL.ASST.MAN.	FR0010037242
LYXOR DJ.INAG.UCITS ETF D-EUR	FR0007056841
LYXOR DAILY LEVDAX UCITS ETF	LU0252634307
LYXOR DAX (DR) UCITS ETF EUR	LU0252633754
ISHARES ER.GVT.BD. CPPD. 2.5-5.5 (DE)	DE000A0H08A8
ISHARES ER.GVT.BD. CPPD. 5.5-10.5 (DE)	DE000A0H08B6
ISHARES ER.GVT.BD. CPPD. 10.5+ (DE)	DE000A0H08C4
ISHARES IBOXX LIQUID SOVS.CAPPED 1.5-10.5	DE000A0H0785
ISHARES ER.GVT.BD CPPD. 1.5-2.5	DE000A0H0793
LYXOR JAPAN (TOPIX) (DR) UCITS ETF D-EUR	FR0010245514
LYXOR COMD.THOM RTRS. CORE ETF UCIT CE	FR0010270033
LYXOR MSCI AC ASPAC.EX JAP.UCITS ETF	FR0010312124
LYXOR MSCI USA UCITS ETF D-EUR	FR0010296061
LYXOR MSCI WORLD UCITS ETF D-EUR	FR0010315770
ISHARES EUR GV BD 1-3 UCITS EUR DIST ETF	IE00B14X4Q57
ISHM.EU.EX-UK UCITS ETF EUR (DIST)	IE00B14X4N27
LYXOR RSA.DOW JONES RSA. GDR UCITS ETF	FR0010326140
LYXOR TURKEY (DJ UCITS ETF	FR0010326256
LYXOR STOXX EUROPE 600 HEALTHCARE UCITS ETF	FR0010344879
LYXOR STOXX EUROPE 600 INSURANCE UCITS ETF	FR0010344903
LYXOR ST.600 TRVL.AND LEIS.	FR0010344838
LYXOR SXEP.600 BRS. UCITS ETF	FR0010345389
LYXOR SXEP.600 AUTOS. &PAS UCITS ETF	FR0010344630
LYXOR IND INAV	FR0010344887
LYXOR STOXX EU600 TELC. UCITS ETF	FR0010344812
LYXOR TNO INAV	FR0010344796
LYXOR ETF RETAIL	FR0010344986
LYXOR STOXX EUROPE 600 CHEMICALS UCITS ETF	FR0010345470

LYXOR SXEP.600 FOBE. UCITS ETF	FR0010344861
LYXOR PERS GOODS	FR0010344978
LYXOR SXEP.600 FNSR. UCITS ETF	FR0010345363
LYXOR STOXX EUROPE 600 BANKS UCITS ETF	FR0010345371
LYXOR STOXX EUROPE 600 UTILITIES UCITS ETF	FR0010344853
LYXOR CONSTR MAT	FR0010345504
LYXOR STOXX EUROPE 600 OIL & GAS UCITS ETF	FR0010344960
DBXT XES INAV	LU0274211217
DB X-TRACKERS FTSE MIB UCITS ETF (DR) 1D	LU0274212538
DB X-TRACKERS DAX ETF	LU0274211480
LYXOR MSCI KOREA UCITS ETF D-EUR	FR0010361691
LYXOR HONG KONG (HSI) UCITS ETF D-EUR	FR0010361675
LYXOR MSCI INDIA UCITS ETF C-EUR	FR0010361683
LYXOR SXEP.SLT.DIV. 30 UCITS ETF	FR0010378604
LYXOR BRZL.UCITS (Ibovespa) ETF C-EUR	FR0010408799
ISHARES GOVT BD.7- 10YR UCITS ETF EUR DIST	IE00B1FZS806
ISHRS EUR GOVT BOND 3- 5YR EUR (DIST) ETF	IE00B1FZS681
ISHARES GOVT BD.15- 30YR UCITS ETF EUR	IE00B1FZS913
LYXOR FTSE ATHEX LARGE CAP UCITS ETF	FR0010405431
LYXOR PRIVEX UCITS ETF D-EUR	FR0010407197
DB XTRS.ESX.SELV. DIV.30 UCITS ETF 1D	LU0292095535
DBXT XGS INAV	LU0292096186
DB X-TR II ERZ.GVT. BD. 10-15 UCITS ETF (DR)	LU0290357333
DB X-TR II EUZN INFL- LKD. BD UCITS ETF	LU0290358224
DB X-TRACKERS II IBOXX ER.SOVS.ERZ.15+ TR	LU0290357507
DXT.II ERZ.GOV BD 1-3 UCITS ETF 1C	LU0290356871
DBXT XEO INAV	LU0290358497
DB X-TRACKERS II IBOXX ER.SOVS.ERZ.7-10 TR	LU0290357259
DB X-TRACKERS II IBOXX ER.SOVS.ERZ.25+ TR	LU0290357846

DXT.II ERZ.GOV BD 3-5 UCITS ETF 1C	LU0290356954
DXT.II ERZ.GVT.BD. UCITS (DR) 1C ETF	LU0290355717
DXT.II IBOXX ER. SOVS. ERZ.5-7 UCITS ETF1C	LU0290357176
DB X-TR II GL INF LKD.BD UCITS ETF DR 1C	LU0290357929
MKTA.DXG.BRIC IDX. UCITS ETF	LU0269999792
DB XTRS.STOXX EUR 600 FOOD & BEV ETF 1C	LU0292105359
DB X-TRACKERS DJ STOXX 600 TECHNOLOGY ETF	LU0292104469
DB X-TRACKERS DJ STOXX 600 HEALTH CARE ETF	LU0292103222
DB X-TRACKERS DBLCI - OY BALANCED ETF	LU0292106167
DB XTRS.STOXX EUR 600 BRS.UCITS ETF 1C	LU0292100806
DB X-TRACKERS DJ STOXX 600 OIL&GAS ETF	LU0292101796
DB XTRS.STOXX EUR 600 BKS.UCITS ETF 1C	LU0292103651
DB XTRS.STOXX EU. 600 INDL.GOODS ETF 1C	LU0292106084
DB X-TRACKERS DJ STOXX 600 UTILITIES ETF	LU0292104899
DB X-TRACKERS II ITRAXX CRSO.5-YEAR TR INDEX ETF	LU0290359032
DXT.II ITRX EU.5- YEAR UCITS ETF 1C	LU0290358653
ISHARE DJ.AIG COMM SWAP UCITS ETF	DE000A0H0728
LYXOR AFS INAV	FR0010464446
LYXOR MSCI EMERGING MARKETS UCITS ETF C-EUR	FR0010429068
LYXOR ETF LATAM	FR0010410266
LYXOR ECB INAV	FR0010481127
POWERSHARES FTSE RAFI EUROPE FUND	IE00B23D8X81
PWSHS.FTSE RAFI EMM.FD.	IE00B23D9570
ISHARES MSCI EUROPE UCITS ETF EUR (DIST)	IE00B1YZSC51
POWERSHARES FTSE RAFI EU MID-SMALL UCITS ETF	IE00B23D8Y98
LYXOR NEW ENERGY UCITS ETF D-EUR	FR0010524777

LYXOR WORLD WATER UCITS ETF D-EUR	FR0010527275
DB X-TRACKERS II-IBOXX EO GER.C T R	LU0321463506
DB X-TRACKERS MSCI EU. SMALL CAP TRN INDEX ETF	LU0322253906
DB X-TRACKERS LPX@ MM PRIVATE EQUITY ETF	LU0322250712
LYXOR EURO CASH UCITS ETF	FR0010510800
ETFLAB DJ STOXX SRG.VAL. 20	DE000ETFL045
ETFLAB EURO STOXX 50	DE000ETFL029
DEKA DAX ETF	DE000ETFL011
DB X-TRACK II EM MKT LIQ EUBD UCITS 1C H	LU0321462953
DEKA DAX UCITS ETF	DE000ETFL060
ETFLAB EURO STOXX SELECT DIVIDEND 30	DE000ETFL078
ISHARES EB REXX MONEY MARKET UCITS	DE000A0Q4RZ9
DEKA MSCI EUROPE LC ETF	DE000ETFL086
DB X-TR.DJ EO STOXX 50 1C	LU0380865021
COMSTAGE STOXX EUROPE 600 INS UCITS ETF	LU0378436108
CMSG.SXEP.600 BKS. UCITS ETF	LU0378435399
CMSG.SXEP.600 P&HG UCITS ETF	LU0378436520
COMSTAGE ETF CBK.EONIA IDX.TR	LU0378437684
COMSTAGE STOXX EUROPE 600 A&P UCITS ETF	LU0378435043
COMSTAGE EURO STOXX SEL DIV 30 UCITS ETF	LU0378434236
CMSG.SXEP.600 TECH UCITS ETF	LU0378437098
COMSTAGE STOXX EUROPE 600 O&G UCITS ETF	LU0378436447
COMSTAGE STOXX EUROPE 600 BR UCITS ETF	LU0378435472
CMSG.SXEP.600 CHEM UCITS ETF	LU0378435555
COMSTAGE EURO STOXX 50 UCITS ETF	LU0378434079
COMSTAGE DAX UCITS ETF	LU0378438732
COMSTAGE ETF DJ STOXX 600 TR	LU0378434582
COMSTAGE STOXX EUROPE 600 HC UCITS ETF	LU0378435985
COMSTAGE STOXX EUROPE 600 F&B UCITS ETF	LU0378435803

LYXOR MSCI TAIWAN UCITS ETF C-EUR	FR0010444786
LYXOR UCITS ETF MSCI MALAYSIA C-EUR ETF	FR0010397554
LYXOR MSCI EMU (DR) UCITS ETF D-EUR	FR0007085501
COMSTAGE STOXX EUROPE 600 RE UCITS ETF	LU0378436793
LYXOR ETF MSCI ASIA APEX 50	FR0010652867
DB X-TR PRTF.TOR. UCITS ETF (DR) 1C	LU0397221945
COMSTAGE ETF ATX	LU0392496690
DB XTRS.STOXX EU. 600 UCITS ETF (DR) 1C	LU0328475792
DB X-TR II GLB.GOV BD. UCITS ETF DR 1C EUR	LU0378818131
DB XTRS.CAC 40 UCITS ETF 1D (DR)	LU0322250985
ETFLAB INVESTMENT GMBH IBOXX LIQUID SOV DIV7-10	DE000ETFL151
ETFLAB INVESTMENT GMBH IBOXX LQD SOV DIV 1-10	DE000ETFL110
ETFLAB INVESTMENT GMBH IBOXX LIQUID SOV DIV 10	DE000ETFL169
ETFLAB INVESTMENT GMBH IBOXX LIQUID SOV DIV 1-3	DE000ETFL128
ETFLAB INVESTMENT GMBH IBOXX LIQUID SOV DIV 5-7	DE000ETFL144
ETFLAB INVESTMENT GMBH IBOXX LIQUID SOV DIV 3-5	DE000ETFL136
ETFLAB INV.GMBH DEUTSCHE BOERSE EUROGOV GERM.3-5	DE000ETFL193
ETFLAB INVESTMENT GMBH DT.BOERSE EUROGOV GERM.	DE000ETFL177
ETFLAB INV.GMBH DT. BOERSE EUROGOV GERM.10	DE000ETFL219
DEKA DBGMM ETF	DE000ETFL227
DEKA DAXPLUS MAX. DIV. UCITS ETF	DE000ETFL235
SOURCE STOXX EUROPE 600 ETF	IE00B60SWW18

SOURCE EURO STOXX 50 UCITS ETF	IE00B60SWX25
SOURCE STOXX EUROPE MID 200 ETF	IE00B60SX063
SOURCE MSCI EUROPE ETF	IE00B60SWY32
ETFLAB STOXX 50	DE000ETFL250
DB X-TRACKERS MSCI PAN- EURO TRN INDEX ETF 1C	LU0412624271
ISHARES AGG.BD. UCITS ETF EUR (DIST)	IE00B3DKXQ41
ISHRS EUR GOVT BOND 0- 1YR EUR (DIST) ETF	IE00B3FH7618
ISHRS GLOBAL GOVT BOND USD (DIST) ETF	IE00B3F81K65
ISHRS CORE EUR BOND EUR (DIST) ETF	IE00B3F81R35
LYXOR LC125MT ETF	FR0010737544
DEKA MSCI EUR ETF	DE000ETFL284
DB X-TRACKERS DB CMOD. BOOSTER DJ-UBSCI ETF	LU0429790743
SCE.SXEP.600 OPT PERSNL&HOUSEHLDGDS ETF	IE00B5MTZ595
SOURCE STOXX EUROPE 600 OPT OIL & GAS ETF	IE00B5MTWH09
DJ.STOXX 600 OPTIMISED INDL.TRVL.& LEIS.SCE.ETF	IE00B5MJYC95
DJ.STOXX 600 OPTIMISED INDL.TRVL.&LEIS.SCE.ETF	IE00B5MJYX09
SCE.SXEP.600 OPT BRS.ETF	IE00B5MTWY73
SOURCE STOXX EUROPE 600 OPT HEALTH CARE ETF	IE00B5MJYY16
DJ.STOXX 600 OPTIMISED INDL.TELECOM.SCE.ETF	IE00B5MJYB88
SOURCE STOXX EUROPE 600 OPT UTILITIES ETF	IE00B5MTXK03
SOURCE STOXX EUROPE 600 OPT INSURANCE ETF	IE00B5MTXJ97
SOURCE STOXX EUROPE 600 OPTIMISED BANKS ETF	IE00B5MTWD60

DJ.STOXX 600 OPTIMISED AUTOS.& PARTS SOURCE ETF	IE00B5NLX835
SOURCE STOXX EUROPE 600 OPT TECHNOLOGY ETF	IE00B5MTWZ80
ISHARES DJ STOXX GLOBAL SELECT DIVIDEND 100	DE000A0F5UH1
ISHRS EUR GOVT BOND 5- 7YR EUR (DIST) ETF	IE00B4WXJG34
ISHARES MSCI EUROPE UCITS ETF EUR (ACC)	IE00B4K48X80
ISHRS CORE EUR GOVT BOND EUR (DIST) ETF	IE00B4WXJJ64
ISHARES GOVT BD.10- 15YR UCITS ETF EUR	IE00B4WXJH41
COMSTAGE ETF IBOXX LQD. SOVS.DIVR.5-7 ETF	LU0444606296
COMSTAGE ETF IBOXX LQD. SOVS.DIVR.7-10 ETF	LU0444606379
COMSTAGE ETF IBOXX LQD. SOVS.DIVR.OVERALL ETF	LU0444605645
COMSTAGE ETF IBOXX LQD. SOVS.DIVR.3-5 ETF	LU0444606023
COMSTAGE ETF IBOXX LQD. SOVS.DIVR.1-3 ETF	LU0444605991
COMSTAGE ETF IBOXX LQD. SOVS.DIVR.25+ ETF	LU0444606619
UBS-ETF MSCI EUROPE	LU0446734104
ISHRS EUR GOVT BOND 7- 10YR EUR (ACC) ETF	IE00B3VTN290
ISHM.EMU SMCP.UCITS ETF EUR (ACC)	IE00B3VWMM18
ISHRS EUR GOVT BOND 3- 7YR EUR (ACC) ETF	IE00B3VTML14
ISHRS EUR GOVT BOND 1- 3YR EUR (ACC) ETF	IE00B3VTMJ91
SOURCE EURO STOXX 50 UCITS ETF B DIS	IE00B5B5TG76
ISHARES CORPBOND EXFINANCIALSUCITS ETF	IE00B4L5ZG21
ISHARES EUR BOND 1- 5YR EUR DIST ETF	IE00B4L60045
DEKA IBOXX GCD ETF	DE000ETFL359
DXT.II GERM.1-3 UCITS ETF (DR) 1D	LU0468897110
DXT.GERM.GOVT BD. UCITS ETF (DR) 1D	LU0468896575

COMSTAGE ETF IBOXX SOVS. INFL.-LKD.ER.INFL.ETF	LU0444607187
AMUNDI ETF MSCI USA	FR0010688275
AMUNDI ETF MSCI EUROPE UCITS ETF (C)	FR0010655696
AMNE.MSCI PAC. EXJAPAN UCITS ETF DR	FR0010713669
AMUNDI ETF EURO STOXX 50 C INV.SOLUTIONS	FR0010654913
AMUNDI ETF MSCI WORLD EX EMU	FR0010756114
AMUNDI ETF MSCI INDIA	FR0010713727
AMUNDI ETF MSCI WORLD EX EUROPE	FR0010756122
AMUNDI ETF MSCI EMU UCITS ETF DR	FR0010655688
AMUNDI ETF MSCI GERMANY	FR0010655712
AMUNDI ETF MSCI CHINA	FR0010713784
AMUNDI ETF MSCI JAPAN	FR0010688242
DXT.EUR CBD.UCITS ETF(DR)1C	LU0478205379
DEKA IBOXX LCD ETF	DE000ETFL375
ISHARES CORE ESX.50 UCITS ETF EUR	IE00B53L3W79
ISHARES FTSE MIB UCITS ETF EUR (ACC)	IE00B53L4X51
ISHARES MSCI EMU UCITS ETF EUR (ACC)	IE00B53QG562
AMUNDI ETF MSCI EUROPE INDUSTRIALS	FR0010688218
AMUNDI ETF GOVT BOND EUROMTS BROAD 7-10	FR0010754184
AMUNDI ETF MSCI EUROPE TELECOM SERVICES	FR0010713735
AMUNDI ETF S&P GLB.LUX. UCITS ETF	FR0010688226
AMUNDI ETF GOVT BOND EUROMTS BROAD	FR0010754192
AMNE.MSCI EU.HI. DVDND FTR.UCITS ETF	FR0010718874
AMUNDI ETF MSCI EU.BANKS	FR0010688176
AMUNDI ETF EUROMTS CASH 3 MONTHS	FR0010754200
AMUNDI ETF MSCI EMU HIGH DIVIDEND	FR0010717090
AMUNDI ETF ER.CORPORATES	FR0010754119
AMUNDI ETF MSCI EUROPE UTILITIES	FR0010688234

AMUNDI ETFGOVT BDEUROMTS BRD IG 3-5	FR0010754168
AMUNDI ETF ER.INFLATION	FR0010754127
AMNE.MSCI EUROPE MIN VOLATILITY FACTOR U	FR0010713768
AMUNDI ETF GOVT BOND EUROMTS BROAD 5-7	FR0010754176
AMUNDI ETF GOVT BOND EUROMTS BROAD 10-15	FR0010754143
AMUNDI ETF MSCI EUROPE CONSUMER STAPLES	FR0010688168
AMUNDI ETF MSCI EUROPE HEALTHCARE	FR0010688192
AMUNDI ETF MSCI EUROPE CONSUMER DISCRETIONARY	FR0010688184
AMUNDI ETF MSCI EUROPE MATERIALS	FR0010791137
AMUNDIETF GOVT BND EURMTS BROAD IG 1-3	FR0010754135
LYXOR CORP EX BANK	FR0010814236
LYXOR FTSE EPRA NAREIT DEVD.EU.ETF	FR0010833558
LYXOR FTSE EPRA NAREIT GLB.DEVD.ETF	FR0010833574
LYXOR FTSE EPRA NAREIT US.UCITS ETF	FR0010833566
COMSTAGE ETF IBOXX GERM. COVERED CAPPED 5-7 TR	LU0488317453
AMUNDI ETF MSCI EASTERN EUROPE EX RUSSIA B	FR0010717074
AMUNDI ETF MSCI EUROPE EX EMU	FR0010821819
AMUNDI ETF MSCI WORLD ENERGY	FR0010791145
AMUNDI ETF MSCI UK	FR0010655761
AMUNDI ETF MSCI WORLD FINANCIALS	FR0010791152
AMUNDI ETF FTSE EPRA EU.REAL ESTATE ETF	FR0010791160
AMUNDI ETF STOXX 600 INV.SOLUTIONS	FR0010791004
AMUNDI ETF MSCI NORDIC	FR0010655738
AMUNDI ETF MSCI SWITZ.	FR0010655753

DB X-TRACKERS DBX FTSE EPRA NAR DEV EUR RLST.ET	LU0489337690
COMSTAGE CAC40 ETF	LU0419740799
DB XTRS.MSCI EUROPE VALUE TRN INDEX ETF	LU0486851024
LYXOR S&P 500 UCITS ETF D-EUR	LU0496786574
LYXOR MSCI CANADA UCITS ETF D-EUR	LU0496786731
LYXOR ETF S&P ASX 200	LU0496786905
COMZ.DE.FUNDS SLTN.SA COMSTE ER.STOXX 50 FR I	LU0488317297
COMZ.DE.FUNDS SLTN.SA COMSTAG IBOXX EGCCOTR I	LU0488317610
COMSTAGE ETF DAX	LU0488317024
AMUNDI ETF NASDAQ 100	FR0010892216
AMUNDI ETF ESX.SMALL CAP	FR0010900076
AMUNDI ETF CAC 40 UCITS ETF DR (C)	FR0007080973
AMUNDI S&P 500 UCITS ETF	FR0010892224
AMUNDI ETF INV.SLTN.EX AAA GOVT BD EUROMTS	FR0010892190
LYXOR ETF MSCI WORLD FINANCIALS	LU0533032859
LYE.MSCI WLD.INFO. TECH TR UCITS ETF C-EUR	LU0533033667
LYXOR ETF MSCI WORLD ENERGY	LU0533032420
LYXOR ETF MSCI WORLD CONSUMER DISCRETION	LU0533032008
LYXOR MSCI WLD CONSUMER SLS.TR UCITS	LU0533032263
LYXOR MSCI WLD. (MIL) UTILS.TR UCITS ETF - C	LU0533034558
LYXOR ETF MSCI WORLD INDUSTRIALS	LU0533033402
LYXOR ETF MSCI WORLD MATERIALS	LU0533033824
LYXOR ETF MSCI WORLD HEALTH CARE	LU0533033238
DB X-TRACKERS II IBOXX SOVEREIGNS EUROZONE	LU0484969463

DB XTRS.II IBOXX SOVS. ERZ.YLD.PLUS IDX.ETF	LU0524480265
HSBC ESTX50 ETF	DE000A1C0BB7
HSBC MSCI EUROPE UCITS ETF	DE000A1C22L5
DB XTRS.IBOXX ER.LQD. CPRT.100 NON-FINLS.ETF	LU0484968655
DB XTRS.IBOXX ER.LQD. CPRT.100 FINLS.SUB-IDX.	LU0484968812
SPDR MSCI EUR SMALL UCITS ETF C	IE00BKWQ0M75
SPDR MSCI EUROPE UCITS ETF	IE00BKWQ0Q14
SPDR MSCI EUROPE HEALTH CARE UCITS ETF	IE00BKWQ0H23
SPDR MSCI EUROPE UTILITIES UCITS ETF	IE00BKWQ0P07
SPDR MSCI EUROPE TECHNOLOGY UCITS ETF	IE00BKWQ0K51
SPDR MSCI EUROPE ENERGY UCITS ETF C	IE00BKWQ0F09
SPDR MSCI EUROPE CONSUMER DISCR UCITS ETF	IE00BKWQ0C77
SPDR MSCI EU.CSM. SLS. UCITS ETF	IE00BKWQ0D84
SPDR MSCI EUROPE MATERIALS UCITS EFT	IE00BKWQ0L68
SPDR MSCI EUROPE FINANCIALS UCITS ETF	IE00BKWQ0G16
ISHARES MARKIT IBOXX EUR HIGH YIELD BD.£	IE00B66F4759
COMSTAGE PSI20	LU0444605215
UBS ETFS PLC - HFRX GLOBAL HEDGE FUND INDEX	IE00B54DDP56
ETFLAB DTB FRANCE ETF	DE000ETFL425
ISHRS S&P 500 EUR HEDGED (ACC) ETF	IE00B3ZW0K18
ISHM.JAP.EUR HGD. UCITS ETF (ACC)	IE00B42Z5J44
ISHM.WLD.EUR HGD. UCITS ETF (ACC)	IE00B441G979
LYXOR BOFAML EUR HIY.EX- FINANCIAL BD.ETF	FR0010975771
AMUNDI ETF AAA GOV ETF	FR0010930636
AMUNDI ETF MSCI ETF	FR0010959676
DXT.PRTF.INC.UCITS ETF 1D	IE00B3Y8D011

DEKA IBX LNFD EUR ETF	DE000ETFL383
COMSTAGE SDAX UCITS ETF	LU0603942888
COMSTAGE DIVDAX UCITS ETF	LU0603933895
SPDR BARCLAYS CAP EURO GOVERNMENT BOND ETF	IE00B3S5XW04
SPDR BARCLAYS EURO AGGREGATE BOND UCITS ETF	IE00B41RYL63
SPDR BARCLAYS EURO CORPORATE BOND UCITS ETF	IE00B3T9LM79
ISHARES DJSTOXX 600 AUTOS.&PARTS (DE) UCITS	DE000A0Q4R28
ISHARES DJSXX.TELECOM.DE	DE000A0H08R2
ISHARES DJSXX.600 RET. (DE)	DE000A0H08P6
ISHARES DJSXX.600 BASIC RESOURCES (DE)	DE000A0F5UK5
ISHARES DJSXX.600 TECH. (DE)	DE000A0H08Q4
ISHARES DJSXX.600 CHEMS. (DE)	DE000A0H08E0
ISHARES DJ STOXX 600 PSNL.& HHLD.GO0DS (DE)	DE000A0H08N1
ISHARES DJSXX.600 CON.&. MATS.(DE)	DE000A0H08F7
ISHARES DJSXX.600 FINL. SERVICES (DE)	DE000A0H08G5
ISHARES DJSXX.600 FOOD & BEVERAGE (DE)	DE000A0H08H3
ISHARES DJSXX.600 HEALTHCARE (DE)	DE000A0Q4R36
ISHARES DJSXX.600 INDL. GOODS & SVS. (DE)	DE000A0H08J9
ISHARES DJSXX.600 TRVL. &.LEISURE (DE)	DE000A0H08S0
ISHARES DJSXX.600 REAL ESTATE UCITS	DE000A0Q4R44
ISHARES DJSXX.600 UTILS. (DE)	DE000A0Q4R02
ISHARES DJSXX.600 MEDIA (DE)	DE000A0H08L5
OSSIAM ETF ISTOXX EUROPE MINIMUM	LU0599612842
OSSIAM SXEP.600 EQL. WEIGHTNR UCITS1C	LU0599613147
OSSIAM ETF US MINIMUM VARIANCE EUR	LU0599612685
AMNE.ER.CPRTFINL. IBOXX UCITS	FR0011020957

AMNE.EUR IBOXX UCITS	FR0011020940
ISHARES MSCI EUROPE SRI UCITS ETF EUR (ACC)	IE00B52VJ196
ISHARES DJ. GLOBALSUSTSCR UCITS	IE00B57X3V84
UBS ETF-MSCI EMU (XET) SCLY.RESP.U (EUR) AD	LU0629460675
COMSTAGE ETF FAZ INDEX ETF	LU0650624025
UBS-ETF SMALL CAP A	LU0671493277
SPDR BCY.CAP.1-3 YR ER. GOVT BD ETF	IE00B6YX5F63
DXT.II ERZ.GVT.BD. UCITS ETF (DR)	LU0643975591
AMUNDI ETF EM ASIA	FR0011020965
AMUNDI ETF EM LATA	FR0011020973
AMUNDI ETF MSCI SPAIN	FR0010655746
AMUNDI ETF MSCI WORLD	FR0010756098
DXT.II ERZ.GOV BD 1-3 UCITS ETF 1D	LU0614173549
DB X-TR II GLB.GOV BD. UCITS ETF DR 1D EUR	LU0690964092
DXT.II ERZ.GOV BD 3-5 UCITS ETF 1D	LU0614173895
LYXOR ETF THAILAND	FR0011067529
LYXOR ETF MSCI ALL CTRY. WORLD	FR0011079466
LYXOR MSCI INDO. UCITS ETF C-EUR	FR0011067511
DB X-TRACKERS ATX UCITS ETF (DR) 1C	LU0659579063
SPDR BCY.CAP.ER. (LON) HIY.BD ETF	IE00B6YX5M31
UBS MKT IBOXX EUR LIQUID CORP. A ETF	LU0721553864
SPDR S&P EURO (FRA) DIVIDEND ARISTOCRATS ETF	IE00B5M1WJ87
OSIM.EMM.MIN VAR NR UCITS ETF 1CE	LU0705291903
LYXOR EURM.HSTRTD MACROWTD GOVBD3-5Y	FR0011146349
LYXOR EURM.HSTRTD MACROWTD GOVBD1-3Y	FR0011146315
SOURCE MSCI EUROPE VALUE ETF	IE00B3LK4Z20

ISHRS GERMANY GVT BND EUR (DIST) ETF	IE00B5V94313
ISHRS ITALY GOVT BOND EUR (DIST) ETF	IE00B7LW6Y90
ISHRS SPAIN GVT BND EUR (DIST) ETF	IE00B428Z604
ISHRS FRANCE GVT BND EUR (DIST) ETF	IE00B7LGZ558
DXTM.JP IX UCITS ETF 4C (DR) EUR HGD	LU0659580079
DB XTRS.II MTS EX-BANKIT BOT	LU0613540268
OSSIAM ETF WORLD MINIMUM VARIANCE NR CLASS EUR	LU0799656698
ISHARES CORPBDINTERESTRATEHGD	IE00B6X2VY59
LYXOR SG GLB.QLT. INC. NTR UCITS ETF D EUR	LU0832436512
LYXOR ETF S&P 500 VIX FUT. ENH. ROLL C-EUR	LU0832435464
DBX MSCI EMU IND ETF	LU0846194776
DBX EUR 50EXFD	LU0835262626
DB IBX EUR COV	LU0820950128
DBX DAX40 DIR ETF	LU0838782315
SPDR MSCI EMU UCITS ETF	IE00B910VR50
COMST SP SMT 40 ETF	LU0860821874