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Bachelor Thesis

Exchange traded funds: Comparison and evaluation of physical and synthetic index replication in the European market

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by

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Abstract

Exchange traded funds (ETFs) are passively managed, open-ended investment funds, which replicate the performance of a specific underlying index and can be traded in an exchange. While a physically replicating ETF holds the same securities as contained in the underlying index in the respective weightings, a synthetic ETF reaches the replication of its benchmark by means of a swap. Whereas physical ETFs engaged in securities lending expose investors to a borrower risk, synthetic funds entail a counterparty risk linked to its swap structure. However, the actual risks strongly depend on the specific practices of ETF providers. Beside those risks, investors should focus on the tracking quality of ETFs, once their highest aim is to replicate the performance of a benchmark. Therefore, the tracking error and tracking difference of both physical and synthetic ETFs were analysed. All ETFs show a high level of tracking quality. Yet, the results show that synthetic ETFs produce tendentially lower tracking errors, whereas a relationship between the level of tracking difference and the replication method cannot be recognised.

Keywords: exchange traded funds, ETF, physical replication, synthetic replication, tracking error, tracking difference

JEL classification: G11, G15, G23

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IV. List of abbreviations

AuM	assets under management
BIS	Bank for International Settlements
bsp	basis points
CESR	Committee of European Securities Regulators
CIP	Cash Index Participation
DAX	German Stock Index
e.g.	exempli gratia
EFAMA	European Fund and Asset Management Association
ESMA	European Securities and Markets Authority
et al.	et alii/aliae
ETC	Exchange traded commodity
ETF	Exchange traded fund
ETN	Exchange traded note
ETP	Exchange traded product
FSB	Financial Stability Board
IMF	International Monetary Fund
iNAV	indicative net asset value
IOSCO	International Organization of Securities Commissions
IPS	Index Participation Share
ISIN	International securities identification number
MSCI	Morgan Stanley Capital International
NAV	net asset value
OTC	over the counter
p.	page
pp.	pages
S&P	Standard & Poor’s

SEC	Securities and Exchange Commission
SPDR	Standard & Poor’s Depository Receipt
TD	tracking difference
TE	tracking error
TER	total expense ratio
TR	total return
UCITS	Undertakings for Collective Investment in Transferable Securities
YTD	year to date

1 Introduction

1.1 Research problem

During the last twenty years, the financial world has experienced the success story of a new kind of investment vehicle: Exchange Traded Funds (ETFs). Firstly introduced in 1993 in the United States (Kleine, 2008, p. 779), this innovation was brought to Europe in the year 2000, when the first ETF was listed at the German electronic exchange trading system “Xetra” (Wiesner, 2008, p. 85). Meanwhile, there are over 1,000 products listed on the ETF segment of Xetra, which is more than in any other European exchange (Deutsche Börse AG, 2012, p. 1). Across the world, ETFs comprise a total of US$ 1.52 trillion of assets under management (AuM) and are considered to be “one of the most successful innovations in the history of investment” (Charupat & Miu, 2013, p. 427).

Shortly explained, exchange traded funds are passively managed investment funds, which can be traded on an exchange like a stock and have the aim of reproducing the performance of an underlying index without the ambition to outperform the respective benchmark (Dieckmann, 2008, p. 16; SIX Swiss Exchange, 2010, p. 4). The recognition of the fact that only 20% of the actively managed investment funds are actually able to beat their benchmarks has contributed to the trend towards passive fund management and index orientation and therefore the success of exchange traded funds (Lang, 2009, p. 1).

Although all ETFs pursue the same purpose of tracking its respective index as exactly as possible, there are differences in the structure used by the ETF providers in order to reach this purpose (SIX Swiss Exchange, 2010, p. 47). Basically, there are two main ways to reproduce the performance of an index: physical and synthetic replication methods. While a physically replicating fund holds exactly the same securities as contained in the underlying index in the respective weightings or a representative sample of them, a synthetic ETF reaches the replication of its benchmark by means of a swap (Heidorn, et al., 2010, p. 7).

In 2011 an intense debate about ETFs and the replication methods applied by ETF providers has been triggered after international financial and regulatory institutions like the International Monetary Fund, the Bank for International Settlement and the

Financial Stability Board have expressed severe criticism regarding the ETF industry and especially the derivative risk linked to swap-based ETFs. As a consequence, providers have made arrangements to enhance quality standards and regulation has been revised with the aim to provide investors with more transparency (Morningstar ETF Research, 2012a).

The aim of this thesis is to compare the replication methods practiced in the European ETF market and to elaborate the main aspects of these structures and their respective risks from the investor perspective. Considering that the highest aim of an ETF is to track its benchmark as exactly as possible, the tracking quality is the main criterion in the quality assessment of these products. An analysis of the tracking quality of both physical and synthetic ETFs will be carried out based on two popular European equity benchmarks. The intention is to assess to what extent the replication method contributes to the achievement of an accurate tracking of the underlying index.

1.2 Course of investigation

In order to analyse the different replication methods, it is necessary to first create a framework with respect to the products regarded and the market circumstances in which they operate. Therefore, this thesis will start by giving a basic understanding of ETFs in chapter 2. A brief history of the origin and development of ETFs will be followed by an overview of general aspects. The main features will be outlined with special focus on the index orientation and the trading mechanism, which are key attributes of these products. Afterwards, the European market landscape will be quickly presented with respect to the applicable regulation and providers active in the market. The chapter will be closed with the delimitation to similar financial products, which have the same main characteristics as ETFs, namely passive management and exchange tradability.

The physical and synthetic replication methods will be presented with greater detail in chapter 3. The different variations of the methods will be outlined with respect to their structure and market participants involved. The replication methods will be then compared and evaluated in chapter 4. First, the recent critics and the resulting debate around ETFs will be reviewed. Before analysing specific risks of physical and

synthetic ETFs, the main general risks entailed in every ETF, regardless of the replication method applied, will be roughly outlined. There are controversial views and opinions about which method is the best and less risky one. In fact, each replication method entails specific risks and chances, which will be analysed with greater detail. An analysis of the tracking quality will attempt to assess which method best replicates its underlying index by comparing the tracking error and tracking difference of physical and synthetic ETFs with a common benchmark. For that purpose, two popular European stock indices were chosen, the “Euro STOXX 50” and the “MSCI Europe”. Finally, the findings will be summarized and an outlook on the development of the ETF market in general and the specific replication methods will be provided.

2 Basic understanding of Exchange Traded Funds

2.1 Historical background

Being investment funds, ETFs have their first roots back in the year 1774 when the first fund was created in the Netherlands with the purpose of enabling investors to better diversify their risks. Despite a few throwbacks along history, investment funds have become the world’s leading investment vehicle (Seip, 2011, p. 13), with EUR 26,534 billion invested worldwide as of May 2013 (EFAMA, 2013). In the 1970ies, the first index mutual funds were created in the United States tracking the S&P 500 index and gained popularity very quickly. Soon, investors started demanding index funds, which could be traded on an exchange (Frush, 2012, pp. 23-24).

It is controversial which product was actually the first ETF in history. Since the early 1980s, so called exchange traded portfolios were being traded in the United States, the most popular being the Cash Index Participations (CIPs) and the Index Participation Shares (IPSs). However, the trading of these products on a stock exchange was soon prohibited, when a federal court decided that they were futures contracts and should be therefore traded on a commodities exchange (Frush, 2012, p. 26). After the stock market crash of 1987, the U.S. Securities and Exchange Commission (SEC) started to review regulations in order to make the exchange trading of such security baskets possible. The first product launched under the new regulation was the so called “SuperTrust” in 1993. It was an index fund and gave

“institutional investors the ability to buy or sell an entire basket of Standard & Poor’s (S&P) 500 stocks in one trade on a stock exchange” (Ferri, 2009, pp. 12-13). Simultaneously to the SuperTrust, the American Stock Exchange developed a similar product, the Standard & Poor’s Depository Receipts (SPDRs), which also began trading in 1993. The SPDR is widely considered to be the first ETF and is still one of the biggest ETFs worldwide (Ferri, 2009, pp. 13-14; Gastineau, 2010, pp. 27-28).

Following the demand for innovation, the first country and region ETFs were launched in 1996 followed by the first industry ETFs two years later. In the year 2000, ETFs were finally brought to Europe, where they began to trade in Germany, Swiss, the United Kingdom and Sweden, covering only a small range of European and US equity indices. However, soon the first emerging markets ETFs were introduced in the year 2004 and the following years were marked by an intensive growth of the European ETF industry, which led to the wide product range that can be observed today (SIX, Swiss Exchange, 2010, p. 17).

2.2 General aspects

2.2.1 Main characteristics

Exchange Traded Funds are open-end mutual funds (ETF Securities, 2013, p. 11). A mutual fund, or investment fund, is an investment product launched and managed by an investment company with the purpose to follow a defined investment strategy. By selling shares to investors, the fund pools money, which is used to buy diversified securities depending on the investment strategy. The investors then participate in the performance of these securities, which is reflected in the value of their shares (Morris & Morris, 2007, p. 133). A mutual fund is open-ended, when the number of shares issued is not restricted. The investment company can keep issuing shares but is also obliged to buy them back at any given time (Gerke, 2002, p. 584).

However, ETFs dispose of two essential characteristics, which differentiate them essentially from most mutual funds. First, ETFs are passively managed and their investment strategy is therefore to replicate the performance of an underlying index (Heidorn, et al., 2010, p. 7). Second, ETFs are traded on stock exchanges and provide investors with intraday liquidity (Lyxor Asset Management, 2013a, p. 5). Therefore, ETFs offer the possibility to trade a diversified portfolio in only one

transaction, helping investors to reach a better risk distribution with very low costs (SIX Swiss Exchange, 2010, p. 4).

The costs of an ETF are reflected in its total expense ratio (TER), which contains not only the management fee of the fund, but also further expenses such as transaction costs for the rebalancing of securities, fees for the custodian account, auditing and insurance fees as well as costs for the publication of information material (SIX Swiss Exchange, 2010, p. 27). The TER is calculated for a whole year and partially subtracted from the fund's net asset value (NAV) on a daily basis (Etterer & Wambach, 2007, p. 19). The NAV expresses the value of an ETF and generally represents the sum of a fund's total assets at current rates, plus cash, minus liabilities. The NAV per share results from the funds NAV divided by the number of shares outstanding (Lang, 2009, pp. 32-33; SIX Swiss Exchange, 2010, p. 62).

Since their introduction, the product range of ETFs has grown rapidly. Currently, exchange traded funds offer exposure to five main asset classes: equity, fixed income, money market, commodities and alternatives. Among the asset classes, one can differ between further investment styles and strategies (ETF Securities, 2013, p. 11). Table 1 gives an overview of the existing ETF types.

Table 1: Types of ETFs available in the European market

Asset Class	Equity	Fixed Income	Commodities	Money Market	Alternatives
ETF categories	- Global - Country/Region - Industry/Sector - Size - Strategy	- Government - Corporate - Inflation linked - High yield	- Broad - Metals - Agriculture/ Livestock	- EONIA - SONIA	- Volatility - Private equity - Hedge funds
% of total assets	71.9%	21.3%	6.4%	0.4%	

Source: adapted from ETF Securities, 2013, p. 11; Deutsche Bank Research, 2013, p. 4

Regardless of the asset class, ETFs also offer the possibility to get short or leveraged exposure to certain markets. In contrast to a regular long position, which profits from rising asset values, a short position profits if the respective asset loses value (ETF Securities, 2013, p. 14). A short or inverse index reflects the performance of the corresponding long index in the opposite direction and offers therefore an investment alternative for investors, who are expecting falling rates in that market

(Deutsche Börse AG, 2010). A leveraged position “uses financial instruments or borrowing money to increase the potential return of an investment. Both short and long positions can be leveraged” (ETF Securities, 2013, p. 14). Leveraged indices and the respective ETFs reflect multiple returns of the performance of a reference index, most commonly with a double leverage (Ramaswamy, 2011, p. 8; SIX Swiss Exchange, 2010, p. 41). Unlike regular long ETFs, which in most cases are designed for a buy-and-hold strategy, short and leveraged ETFs are by nature short term oriented products designed for speculative investors, who are willing to take higher risks (SIX Swiss Exchange, 2010, p. 41). Although the global AuM of leverage and short ETFs makes up to only 3% of total ETF assets, they are responsible for 20% of the turnover of ETF assets, which means that they are traded very frequently (Ramaswamy, 2011, p. 8).

ETFs can be used for several investment purposes. Due to the wide range of asset classes covered by ETFs, they are mostly applied for the asset allocation of portfolios, meaning the long-term distribution of assets into different classes with the aim to achieve a certain risk/return profile. Especially so called core/satellite strategies can be implemented by using country, region and sector ETFs accordingly. Further, ETFs can be used as a cash management tool, since they can be easily traded and are low cost. Finally, they can also be used for hedging purposes, especially when tracking short indices (Hehn, 2005, pp. 16-17). During the last years, ETFs have been increasingly included into savings plans and pension funds (Michalik, 2012, p. B3).

2.2.2 Index orientation

One of the main characteristics of an ETF is that it must track a specific index. Simply put, an index is a collective measure for the performance of a group of securities expressed in a single figure (Meyer zu Drewer, 2012, p. B1). Although the majority of the existing indices are for the stock market, there are indices covering almost every asset class: fixed income, commodities, currencies, funds and even derivatives (SIX Swiss Exchange, 2010, pp. 32-33). In most cases, components of an index have at least one aspect in common, such as region, industry or investment strategy (Lang, 2009, p. 85).

The original main function of security indices, especially country and sector oriented ones, is the information function, as they indicate the economic situation and the mood of investors in those markets, acting therefore as barometers (Lang, 2009, p. 85; SIX Swiss Exchange, 2010, p. 32). However, in the context of exchange traded funds, the relevant function is the one that indices fulfil as benchmarks. “In general, a benchmark is something that is used as a reference for comparison purposes” (Breuer, 2009, p. 42). Used as a benchmark, an index allows the objective judgment of the performance of an investment by comparing it to the performance of the benchmark itself (Gerke, 2002, p. 103). This function gains importance when distinguishing the concepts of active and passive fund management. While active fund managers try to outperform a given benchmark, the passive approach intends to achieve just the same return as the underlying index (Meyer zu Drewer, 2012, p. B1). Active managers are supposed to outperform their benchmarks by using two abilities. The first one is the ability to select single securities out of the benchmark, which will perform better than the rest of the market, also known as stock picking. The second one is the timing ability, meaning that the manager is able to predict market accessions and recessions and can therefore respectively increase or decrease the market exposure at the right time (Rompotis, 2009, p. 1).

Investors, who chose an active investment, assume that capital markets are inefficient, while investors who prefer a passive management rely on the efficiency of the markets (Johanning, et al., 2011, p. 10). It is argued that in the long run, active fund management has little chances to be successful, since information advantages are quickly overhauled and successful stock picking methods can be quickly copied (Etterer & Wambach, 2007, p. 6). Indeed, there is empirical evidence that most actively managed funds are not able to actually outperform their benchmark (Rompotis, 2009, p. 1). ETFs, being passively managed, have a cost advantage towards actively managed mutual funds, since research and management expenses as well as transaction costs are much lower. In Europe, yearly management fees for equity ETFs average 0.5%, while actively managed equity funds cost around 1.7% on average (Smeets & Wiesner, 2009, p. 22).

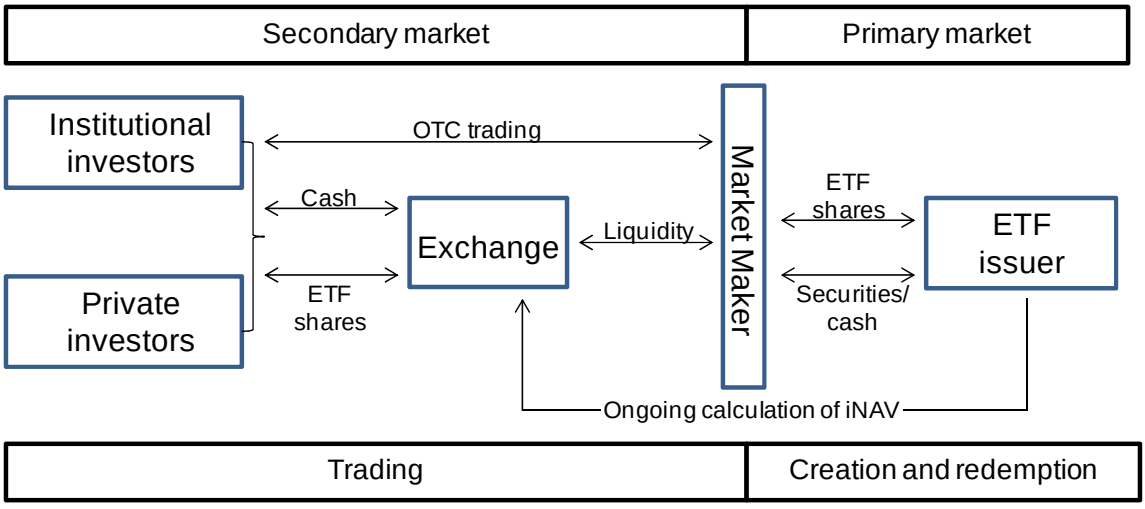
However, not every index is eligible as the underlying for an ETF. There are certain requirements an index needs to fulfil in order to successfully serve as a benchmark.

First of all, an index needs to be representative with regards to the market it intends to cover. The German stock market index DAX for instance, covers between 80% and 85% of the overall German stock market. Basically, the higher the number of titles contained in the index, the higher is its representativity. However, in order to cover specific regions and industries, narrowed indices are needed, which is why sub-indices of broad, well-known indices are created. Another important requirement is the transparency and publicity of the index methodology and calculation. The index composition must be comprehensible for investors and based on defined and public made rules. Further, an index needs to be replicable, meaning that the investor should actually be able to replicate the index by buying its single components. In order to ensure the replicability, an index should also be stable with regards to the frequency of adaptions of components and weightings (Meyer zu Drewer, 2012, p. B1; Lang, 2009, pp. 86-87).

2.2.3 ETF share cycle and trading

The ETF trading is based on the interaction of three main parties: the ETF issuer as the provider, the market makers as intermediaries and the investors as the demanders (Wiesner, 2008, p. 105). The following figure shows the ETF share cycle and trading mechanism on the primary and secondary markets and the market participants involved.

Figure 1: ETF trading mechanism



Source: adapted from Wiesner, 2008, p. 104

ETFs have a unique mechanism for the issuing and withdrawal of fund shares, the so called creation and redemption process, which takes place on the primary market

and is essential for the liquidity of these instruments (SIX Swiss Exchange, 2010, p. 63). The creation and redemption of ETF shares in the primary market is carried out exclusively through authorised market makers (Heidorn, et al., 2010, p. 9). A market maker is an intermediary, in most cases a bank, who has committed itself to do the quotation for certain securities during the trading time of an exchange and execute the respective orders (Gerke, 2002, p. 520).

In order to create shares of an ETF, a market maker hands over a basket of securities to the ETF provider and gets in exchange a block of ETF shares, a so called creation unit, which in most cases consists of 50,000 shares. In case of physically replicating ETFs, the securities basket used for the creation of shares has to correspond to the composition of the underlying index, while shares of synthetic ETFs are created in exchange of cash (SIX Swiss Exchange, 2010, p. 63; Heidorn, et al., 2009, p. 9). The redemption process occurs analogously when the market maker returns a creation unit in exchange for the securities basket or cash initially delivered to the ETF provider (Lang, 2009, p. 101).

After having created a share unit, the market maker can then turn to the secondary market and put the shares into circulation by either trading them on an exchange or selling them on the over the counter (OTC) market, meaning outside of an exchange. Since the OTC trading occurs in large amounts of shares, it is practiced mainly by institutional investors rather than private ones. For the exchange trading, each ETF must have at least one market maker, who sets bid and ask prices during the entire trading time of an exchange, ensuring therefore its liquidity. Although the trading mechanism of ETF shares on the secondary market does not differ from other types of securities, like e.g. stocks, there is one essential difference. While changes in demand for a certain stock affect directly its price, changes in demand for an ETF are adjusted by changing the quantity of shares through the creation and redemption process. The price of an ETF depends therefore solely on the value of its underlying index (Wiesner, 2008, pp. 109-110).

A crucial measure for the ETF exchange trading is the indicative net asset value (iNAV). In contrast to the NAV, which is calculated once daily, the iNAV is calculated in real time throughout each trading day. It represents an approximate current value of the ETF shares, since it is calculated based on the real time rates of the securities

contained in the fund. The iNAV serves as price orientation for all market participants in the ETF exchange trading. Market makers set bid and ask prices based on the iNAV, while it allows investors to better judge the fairness of the pricing (Etterer & Wambach, 2007, p. 42).

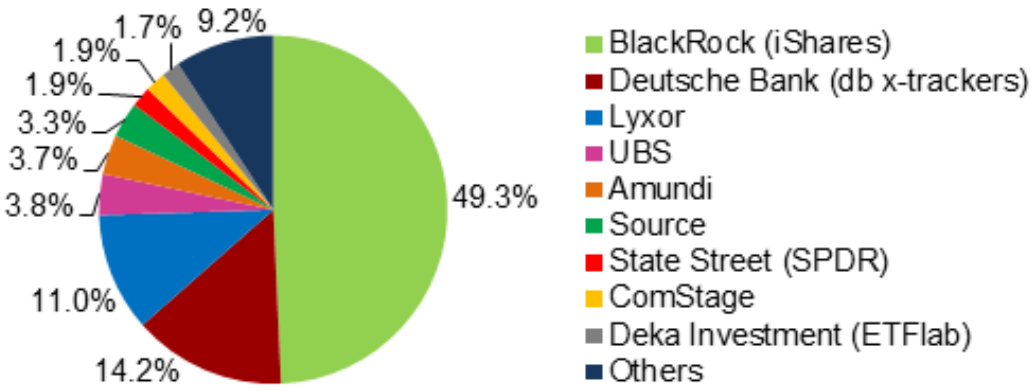
2.3 European ETF market landscape

Most European investment funds, including exchange traded funds, are ruled under the directives for Undertakings for Collective Investment in Transferable Securities (UCITS). First introduced in 1985, the aim was to reach a standardised regulation and allow for easier public distribution of investment funds across the European borders (Szylar, 2010, pp. 4-9). Being EU-directives, the UCITS regulation must first be incorporated by the single country legislations (Etterer & Wambach, 2007, p. 81).

The UCITS regulation is based upon a set of principles targeting investors' protection. The probably most important one is the concept of segregation of assets, meaning that the fund's assets have to be deposited in a segregated account with a custodian bank. In case of bankruptcy of the ETF issuer, these assets are not included in the insolvency estate and are therefore protected. Also important is that the UCITS directives impose criteria for the eligibility of assets and the diversification of the fund's portfolio, limiting for example the percentage that can be invested in a single title or in titles originated from one single issuer. Further, the regulation requires that certain information has to be made available to the investor and that shares have to be redeemable at the NAV, which clearly distinguishes UCITS compliant funds from e.g. hedge funds (Szylar, 2010, p. 12; Johanning, et al., 2011, pp. 12-14).

The competitor landscape in the European ETF market is characterised by a high level of competition among the providers. While the market leader BlackRock (iShares) comprises almost half of the assets under management, the followers, namely Deutsche Bank with its ETF brand "db x-trackers" and the Société Générale subsidiary Lyxor Asset Management, fiercely fight over market shares and the second position in the market. The rest of the market is divided among many smaller providers (Narat, 2013). Figure 2 shows the distribution of market shares among the biggest of the overall 37 ETF providers active in Europe as of August 2013.

Figure 2: Market shares in the European ETF market



Source: own illustration based on the data of Deutsche Bank Research, 2013, p. 6

ETF issuers are mainly differed between physical and synthetic providers, depending on the replication method applied by their funds. Best known physical providers are iShares, UBS, SPDR, Deka (formerly ETFlab) and HSBC. On the other hand, db x-trackers, Lyxor, Amundi, Source, ComStage and EasyETF are well known names among the synthetic providers. Meanwhile, many physical providers include synthetic ETFs in their product range and vice versa. As an example, iShares offers swap-based ETFs for the replication of some emerging markets and commodities indices, that otherwise could not be physically replicated (BlackRock Advisors, 2013a; BlackRock Advisors, 2013b). On the other hand, some synthetic providers have recently introduced physically replicating funds into their product spectrum (Morningstar ETF Research, 2012a, p. 12; Lyxor Asset Management, 2012), partly as a reaction to the recent critics on the synthetic replication, which will be reviewed in chapter 4.1.

2.4 Delimitation to similar financial products

2.4.1 ETCs and ETNs

Following the success of ETFs, new products were introduced into the market, which names may imply a high level of similarity to ETFs: exchange traded commodities (ETCs) and exchange traded notes (ETNs). The products have indeed some characteristics in common, such as exchange tradability, high level of liquidity and a similar creation and redemption mechanism, but they differ essentially from a legal perspective (SIX Swiss Exchange, 2010, p. 14; Müller & Schöne, 2011, p. 116). Unlike ETFs, ETCs and ETNs are no collective investment vehicles (funds), but debt

securities and therefore expose investors to an issuer risk. The three product categories are commonly put together and referred to as exchange traded products or just ETPs (Müller & Schöne, 2011, p. 116; ETF Securities, 2013, p. 13).

ETCs are fully collateralised bearer bonds, which are linked to the performance of a single commodity or a commodity basket (Müller & Schöne, 2011, p. 116). Generally, they are collateralised by a segregated basket of either physical assets or derivatives, which is protected in case of bankruptcy of the provider, eliminating therefore the issuer risk mentioned above. ETCs were created as an alternative to commodity ETFs, which for being funds are ruled by the UCITS regulation and are therefore only allowed to track diversified commodity indices. ETCs being a debt security are not submitted to this regulation and can offer exposure to single commodities (ETF Securities, 2013, p. 12).

ETNs are like ETCs also debt securities, but are issued by a financial institution. The notes have a defined maturity like regular bonds but there are no interest payments (Morris & Morris, 2007, p. 73). Instead, the notes are linked to the performance of an underlying index or asset. Since the repayment depends only on the issuer, ETNs offer a way to get exposure to certain markets even when they are facing liquidity shortages. However, since ETNs are not collateralised, investors are exposed to full issuer risk, meaning that the creditworthiness of the issuing entity gains relevance. A downgrading of the issuer can therefore lead to a value loss of the note (ETF Securities, 2013, p. 13).

2.4.2 Index certificates

Certificates belong to the so called structured securities, which are composed of different instruments in order to achieve a certain investment purpose. From an economic perspective, certificates are derivative products, meaning that they allow investors to participate in the performance development of an underlying asset to which the security is linked. These can be single stocks, commodities or indices (Zeller, 2012, p. 104). Index certificates offer therefore the same exposure as ETFs, namely the performance of an underlying index less fees.

Just like ETCs and ETNs, certificates are also debt obligations and underlie full issuer risk, which constitutes one of the main differences to the construction of ETFs.

Since the bankruptcy of Lehman Brothers in 2008 and the resulting default on certificates issued by the bank, issuer risk has become more crucial in the investment decision (Heidorn, et al., 2010, p. 8). A further essential difference is that index certificates can only be traded in an exchange, while ETFs can also be traded OTC as outlined in chapter 2.2.3 (Wiesner, 2008, p. 84).

3 Index replication methods

3.1 Physical replication structure

3.1.1 Full replication

The physical full replication is the historically oldest method used to replicate an index. Not only used the first ETF launched in 1993 this technique in order to replicate the S&P 500 index, but also the first European ETFs made use of this replication method (Liermann & Michalik, 2010, p. 28). Still today, physically replicating ETFs hold the majority of total assets invested in ETFs. As of 2011, this structure clearly dominated the US market with about 97% of the AuM. On the other hand, the European market shows a certain balance between the replication methods, with physically replicating ETFs comprising about 60% of the assets (Meinhardt & Müller, 2012, p. 20).

Under the full replication structure, the fund holds and owns a portfolio consisting of exactly the same securities as contained in the underlying index in the corresponding weightings (Heidorn, et al, 2010, p. 7). Therefore, the fund has to adjust its portfolio every time the underlying index experiences any changes such as inclusion or exclusion of certain components and rebalancing of components' weightings. That fact makes it necessary for physically replicating funds to hold a cash position in order to execute transactions whenever required (SIX Swiss Exchange, 2010, pp. 47-48; Deutsche Bank AG, 2010, p. 5).

3.1.2 Sampling

The sampling replication, sometimes also called partial physical replication, is a modified version of the full replication. It is sometimes used when the full replication method is stretched to its limits, for instance when it comes to replicating the performance of very broad indices or when some of the underlying securities are very

illiquid or hardly accessible. Under that structure, the ETF does not invest in each title, but only in a representative sample of the underlying index (Liermann & Michalik, 2010, p. 287; Deutsche Bank AG, 2012, p. 5).

The fund manager includes components, which carry a high weighting in the underlying index and excludes illiquid and low weighted components. The aim is to create a sample portfolio with the highest possible correlation to the performance of the underlying index. In order to achieve that, different quantitative models are applied. By using the sampling method, transaction costs and consequently management fees can be reduced compared to the full replication. However, that comes with the price of higher deviations between the ETF and the index, since the performance of the benchmark cannot be replicated entirely (SIX Swiss exchange, 2010, pp. 49-51).

3.1.3 Securities lending

Many European physically replicating ETFs engage in the process of securities lending in order to increase funds' returns. In 2011, about 45% of all European physically replicating ETFs were lending securities. In that process, the fund management lends part of the fund's portfolio to a third party in exchange for a fee. Normally, the lending period is open, so that the lender can claim back the securities at any time. The borrowers can be any kind of financial institution and the reasons for the borrowing of securities can also vary. Often, securities are lent to hedge funds, which borrow them in order to implement short strategies (Morningstar ETF Research, 2012b, pp. 5-7; Heidorn, et al., 2010, p. 14).

Since this process exposes the fund's shareholders to a counterparty risk in case the lender defaults and is not able to give back the lent securities, a collateral portfolio is usually posted by the lender during the lending period (SIX Swiss Exchange, 2010, pp. 67-68). The securities contained in the collateral usually correspond to a 100% of the value of the lent securities with additional application of margins, or so called haircuts, which can range from 0% to 15% (Morningstar ETF Research, 2012b, p. 11). "A haircut, in the financial industry, is a percentage discount [..] applied informally to the market value of a stock or the face value of a bond in an attempt to account for the risk of loss that the investment poses" (Morris & Morris, 2007, p. 94).

The practice of securities lending is not uniformly regulated in Europe. The UCITS regulation, which applies for European ETFs, leaves it to each member state to apply its own jurisdiction with regards to securities lending and the associated collateralisation. Therefore, lending practices can vary depending on where the fund is registered, commonly Ireland, Luxembourg, France or Germany (Kinateder, 2012, pp. 92-95).

3.2 Synthetic replication structure

3.2.1 Swap definition

The synthetic replication structures outlined in the following chapters replicate the performance of the underlying index by using derivative financial instruments, in most cases a swap, which is why synthetic ETFs are also often referred to as swap-based ETFs (Heidorn, et al., 2010, p. 7). “A swap is a financial transaction in which two counterparties agree to exchange streams of payment over time, according to a predetermined rule applying to both of them” (Chorafas, 2008, p. 295).

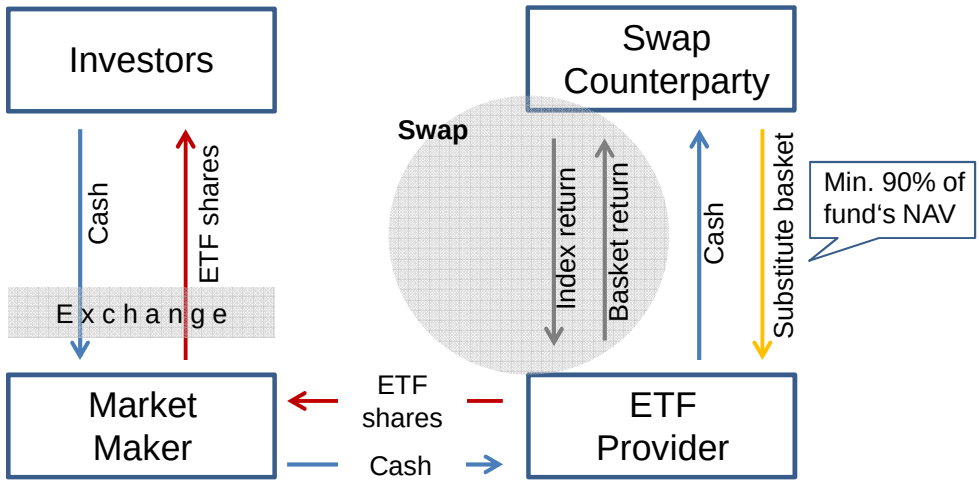
Swap contracts are legal agreements, which are not standardised and can be accordingly adapted to the needs of both parties. They can be applied for many different purposes and are very often used in order to transfer market or credit risk. The most used types of swaps are interest rate swaps, currency swaps and credit default swaps. In the construction of synthetic ETFs, the ETF issuer enters a total return swap with a counterparty, which involves the exchange of the total return of a reference asset or basket of assets against another cash flow. In most cases, only the difference between the two streams is actually transferred between the two parties (Morningstar ETF Research, 2012a, p. 6; Chorafas, 2008, p. 311).

3.2.2 The unfunded swap model

This structure was the first one used to implement the synthetic replication of ETFs in Europe and is still used by most synthetic ETFs. Under that construction, the money delivered by the market makers for the share creation is invested in a basket of securities, which is bought by the ETF provider from the swap counterparty. This portfolio can diverge completely from the underlying index and is usually referenced

to as substitute basket or fund holdings (Morningstar ETF Research, 2012a, p. 7). Figure 3 outlines the structure of the unfunded swap model.

Figure 3: Unfunded swap structure



Source: adapted from Morningstar ETF Research, 2012a, p. 7

The swap agreement takes place between the ETF issuer and the swap counterparty, which in most cases is the parent company of the issuer, often a bank. Both parties agree to exchange the performance of the fund holdings against the performance of the underlying index less swap fees. Therefore, the risk of divergent performance of both portfolios is passed to the swap counterparty, who commits itself to deliver the performance of the benchmark index, no matter how the substitute basket performs (Heidorn, et al., 2010, p. 7).

This structure exposes investors to a so called counterparty risk, meaning "the possibility that the party providing the swap will fail to fulfil its obligation to deliver the performance of the assets being tracked" (Morningstar ETF Research, 2012a, p. 7). Assuming that both the fund assets and the underlying index are on the same level, there are two possible scenarios. If the fund holdings perform better than the benchmark, the ETF provider has a payment claim against the swap counterparty. If the contrary is the case, the ETF provider creates a liability towards the swap counterparty. Regardless of how the swap develops, the investor will always get the performance of the benchmark index less fees (Kinateder, 2012, p. 78).

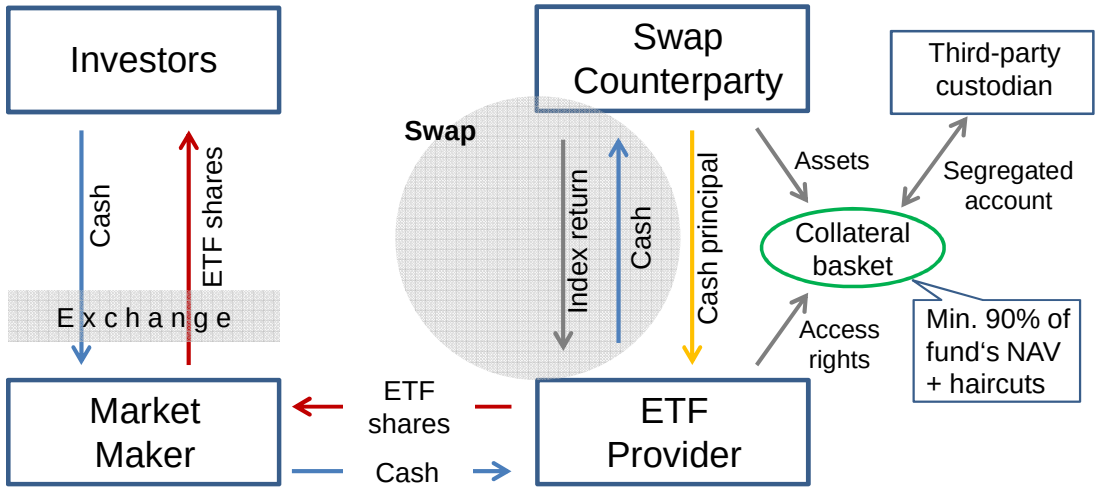
The counterparty risk is restricted to a maximum of 10% of the fund's assets by UCITS regulation, so that the swap has to be permanently monitored. The relevant measure is the so called "swap mark-to-market", which is the difference between the

value of the fund holdings and fund's net asset value[1] (Morningstar ETF Research, 2012a, pp. 7-8). Whenever the mark-to-market value of the swap reaches a level close to the 10% limit allowed, the swap has to be reset. In the case of a swap reset, the swap counterparty delivers additional securities to the ETF provider, so that the value of the substitute basket rises, reducing therefore the level of the swap (Lyxor Asset Management, 2010a, pp. 16-18). In fact, there is a large variety of swap reset policies practiced by synthetic ETFs. The majority of them apply more rigorous rules than those imposed by regulation and reset their swaps on a regular basis, some of them even daily (Morningstar ETF Research, 2012a, p. 8).

3.2.3 The funded swap model

This structure was later introduced in Europe in the year 2009 and differs substantially from the unfunded swap structure. In that construction, the ETF itself doesn't hold any securities like stocks or bonds. Instead, the fund consists solely of one or more swaps (Kinateder, 2012, p. 77). Investors' cash from the share creation is directly handed over to the swap counterparty instead of being used to set up a substitute basket. In exchange, the swap counterparty delivers the performance of the underlying index less swap fees and commits itself to deliver a principal in the future (Morningstar ETF Research, 2012a, p. 9). Figure 4 outlines the structure of the funded swap model.

Figure 4: Funded swap structure



Source: adapted from Morningstar ETF Research, 2012a, p. 9

[1] While the NAV of a physical ETF can derived directly from the assets held by the fund, the derivation of the NAV of a synthetic ETF is slightly more complicated and described in the appendix A.

The swap counterparty has to deposit securities into a segregated collateral account with a trustee. These assets have to be securely held and at the fund's disposal in case the counterparty defaults, which is ensured by using one of the following two alternatives. By using a transfer of title, the account is held in the name of the ETF and therefore is considered to be its property. Under this structure, the ETF issuer is able to take hold of the collateral basket without permission of the counterparty. The second option is a pledge structure, under which the account is only held in favour of the ETF and it has to arrogate the ownership of the assets before being able to actually access them (Morningstar ETF Research, 2012a, pp. 9-10).

The securities contained in the collateral basket have to comply with certain requirements. The "CERS's guidelines on risk measurement and the calculation of global exposure and counterparty risk for UCITS" prescribe particular criteria that the collateral assets must fulfil at any given time. The securities have to be sufficiently liquid, valued on a daily basis and stem from a highly rated issuer. They should not be correlated to the swap counterparty or among each other in terms of issuer, industry or country. Furthermore, the guidelines require an appropriate collateral management system and a third party custodian for the collateral, among further conditions (Committee of European Securities Regulators, 2010, p. 37).

The assets posted as collateral have to correspond to a minimum of 90% of the fund's NAV, in order to comply with UCITS regulation. In addition, regulation requires that haircuts have to be applied to the securities contained in the collateral (Kinateder, 2012, pp. 77-78). The level of the haircuts applied can range from 0% to 30%, depending on the quality of the collateral assets and the respective jurisdiction. "In Ireland, for example, equities posted as collateral are subject to a 20% haircut, whereas in Luxembourg it is up to the fund custodian and the fund management company to negotiate the haircut" (Ramaswamy, 2011, p. 9).

As a consequence of the application of haircuts, collateral baskets are in most of cases fully collateralised, meaning that the collateral corresponds to a 100% of the fund's NAV. This is why this structure is also often referred to as fully funded swap. Sometimes the collateral portfolio even outvalues the fund's NAV, leading to an actual over-collateralisation of the ETF. The swap counterparty and the ETF provider agree upon a level of collateralisation of the fund and additional collateral assets are

required whenever the value of the collateral portfolio falls below that level. In that case, there is no swap reset as in the unfunded swap structure, but only an adjustment of the collateral basket. The collateral manager, which can be the swap counterparty, the custodian or another third party, is responsible for monitoring the collateral portfolio and ensuring that the required level of collateralisation is fulfilled (Morningstar ETF Research, 2012a, pp. 9-10).

4 Comparison and evaluation of the replication methods

4.1 Recent developments

Still in June 2010, the Bank of England has warned about the potential risks of ETFs for the overall financial stability in its “Financial Stability Report” (2010). In April 2011, the International Monetary Fund (IMF), the Bank for International Settlements (BIS) and the Financial Stability Board (FSB) have then simultaneously published articles in which concerns about several risks arising from the ETF industry and its rapid growth were expressed. The IMF included in its “Global Financial Stability Report” (2011) an extra annex on exchange traded funds, in which the mechanics and risks of these products are analysed. The main points of criticism are the counterparty risk arising from swap-based structures and the lack of transparency in the process of security lending. A special focus lies on the concern that the counterparty risks might become systemic due to the growing number of synthetic ETFs. A systemic risk is “a risk of disruption to financial services that is caused by an impairment of all or parts of the financial system and has the potential to have serious negative consequences for the real economy” (Caruana, 2010, p. 2).

In its article “Potential financial stability issues arising from recent trends in Exchange-Traded Funds” (2011), the FSB also criticises the counterparty and collateral risk linked to synthetic ETFs and securities lending. The focus of the article lies on the consequences of the industry’s innovation rapidity and the coverage of new asset classes like fixed income, credit and commodities, “where liquidity is typically thinner and transparency lower” (Financial Stability Board, 2011, p. 1). Furthermore, the board expresses concerns regarding the conflict of interest of banks acting as ETF providers and swap counterparties simultaneously. According to the FSB, these banks could have an incentive to deposit illiquid titles into the collateral

baskets, which could lead to liquidity shortfalls in the case they face massive redemptions under stressed market conditions (Financial Stability Board, 2011, p. 4).

Finally, the monetary and economic department of the BIS also published a paper called “Market structures and systemic risks of exchange-traded funds”, in which the author shares the views of the IMF and FSB. Additionally, the ETF industry is compared to the pre-crisis market for structured products, which began with plain-vanilla physical structures and then developed complex synthetic structures as investors’ demand grew. During the financial crisis, the risk attached to these products proved to be much higher than previously assessed despite over-collateralization (Ramaswamy, 2011, p. 11).

These statements triggered an intense discussion among specialists, ETF providers and investors during the following months, later also called the “synthetic versus physical debate” (Morningstar ETF Research, 2012a, p. 12). Especially synthetic ETF providers have felt unfairly treated, since synthetic structures were accused to be “the most likely source of systemic risk for investors” (Morningstar ETF Research, 2012a, p. 17). In fact, investors reacted to the debate by transferring money from synthetic to physical ETFs. Directly after the start of the polemic, synthetic ETFs started to register asset outflows, which went in favour of physically replicating funds. In total, synthetic ETFs lost European market share from about 46% in the first quarter of 2011 to about 38% in the first quarter of 2012, while the European market share of physical ETFs rose respectively from about 54% to 62% in the same period (see Appendix B).

As a result, synthetic providers have made efforts to enhance the quality and transparency of their products and regain investors’ trust. Some providers using the unfunded swap model now strive for higher collateralisation of their funds by resetting swaps more frequently and keeping negative swaps, resulting in many cases in a full- or over-collateralisation of the ETFs. Transparency has also been improved through stricter disclosure policies (Morningstar ETF Research, 2012a, p. 11).

Regulators have also reacted to the debate. In early 2012, European Securities and Markets Authority (ESMA) launched draft guidelines with proposals for future ETF regulation. Simultaneously, it also launched an open consultation addressed to

stakeholders, who were encouraged to comment on the proposals (European Securities and Markets Authority, 2012).

4.2 Evaluation of risks

4.2.1 General risk profile of ETFs

As in the case of most investment products, the main risk for the ETF investor is the general market risk, which applies to all asset classes. Since financial markets are dynamic and ruled by the law of supply and demand, the rates of the assets contained in the underlying index of an ETF can vary strongly, having direct impact on the value of the index and consequently the ETF shares. The value of the underlying assets is influenced by external factors such as the overall economic development, political events and uncertainties, changes in the legal landscape or natural catastrophes (SIX Swiss Exchange, 2010, p. 19). The country risk affects especially country or region ETFs. It refers to the risk that one of the circumstances mentioned above leads to losses in the level of the underlying assets originated in a certain country (Etterer & Wambach, 2007, p. 36).

ETF investors might also face a correlation risk, which arises when the performances of the single securities contained in an index are highly correlated among each other. That is especially the case for industry ETFs, since occurring circumstances affecting a specific industry are likely to affect all or the majority of companies active in that industry. In that case, the diversification effect that indices and consequently ETFs fulfill by offering exposure to a portfolio of securities, is neutralised and investors are exposed to higher volatility (Etterer & Wambach, 2007, p. 39).

ETFs are very often traded in the local currency of the exchange they are listed in. However, they offer exposure to a wide range of indices, many of which are calculated in another currency. Investors of ETFs traded in a currency other than the one of the underlying index are additionally exposed to a currency risk. In the case that the basis currency loses value towards the trading currency, the ETF shares might lose value, although the underlying index has been stable or even risen. On the other hand, there is the chance of appreciation of the underlying currency, which would lead to the contrary effect for the ETF shareholder (SIX Swiss Exchange, 2010, p. 20; Etterer & Wambach, 2007, pp. 37-38).

Finally, the ETF investor is exposed to the risk of delisting and closure of the ETF. Although ETFs are open-ended vehicles, the issuer can decide to close and delist a fund, e.g. if it does not comprise enough AuM in order to cover its costs. In that case, the issuer buys investors' ETF shares back for the current net asset value. This scenario poses a risk, if the investor has bought the ETF shares at a higher value then the current one and has to reluctantly realise a loss, which has been until then only a book-loss (SIX Swiss Exchange, 2010, p. 21).

4.2.2 Critical assessment of the physical replication

It is often claimed that physical ETFs provide lower tracking quality than synthetic ETFs, primarily due to higher transaction costs caused by the more frequent portfolio reallocations (Heidorn, et al., 2010, p. 7; Meyer zu Drewer, 2011, p. 50). Deviations from the benchmark performance can be additionally caused by the "cash drag" effect. As stated in chapter 3.1.1, physically replicating ETFs usually hold a cash position in the portfolio in order to react to changes in the composition of the underlying index. This cash position leads to the so called cash drag, which causes a deviation of the ETF performance to the one of the benchmark. Due to the fact that the value of cash stays relatively constant on the short- and middle-term, a fund holding cash is likely to underperform its benchmark index when it rises and respectively outperform it when the index falls (Morningstar ETF Research, 2013, p. 5; Deutsche Bank AG, 2010, p. 5).

A special source of risk arises when physically replicating ETFs lend their securities as described in chapter 3.1.3. The securities lending practices of physical ETF providers were one of the points of criticism during the "synthetic versus physical debate". Thereby, not only the counterparty risk, but specially the lack of transparency and disclosure of standards has been criticized (Morningstar ETF Research, 2012b, p. 3). After the debate initiated in 2011, some physical ETF providers started to disclose information about their securities lending policies on their websites (Morningstar ETF Research, 2012b, p. 15). However, the information available is still sparse. Market leader iShares, for example, only provides fund specific information on the net return of the lending activity, the average and maximum levels of assets lent and the collateral. Further risk relevant information,

such as the current percentage of assets on loan or the borrower, is not published (see Appendix C).

Fact is that there is no Europe-wide regulatory limitation for the on-loan level of ETFs engaged in securities lending, meaning the percentage of the fund's assets that is allowed to be lent. Therefore, providers are let free to lend up to a 100% of the ETF assets. In practice, the on-loan levels, just like the disclosure practices, vary strongly among providers (Morningstar ETF Research, 2012b, pp. 7-8). Due to the lack of binding regulatory restrictions, most providers set an own limit for the on-loan level of their funds. The lowest limit was set by HSBC with 20%, while iShares restricts itself to 50%. Other providers however, e.g. Deka and UBS, allow themselves to lend up to a 100% of a fund's assets (Morningstar ETF Research, 2012b, p. 17).

The counterparty risk resulting from securities lending is eliminated by the collateral, since the ETF has access to the collateral basket in case the borrower defaults. Therefore, the risk that investors are actually exposed to during the lending period is the collateral risk, meaning that the collateral liquidation value is not enough to buy the lost lent securities. In order to mitigate this risk it is important that the posted collateral contains only high quality securities. "According to the new ESMA guidelines, "collateral should be sufficiently diversified in terms of country, markets and issuers" (Morningstar ETF Research, 2012b, p. 11). On September 13th 2013, the collateral for the lent securities from the portfolio of the iShares EURO STOXX 50 ETF consisted of 78.3% of US-American treasury notes, which doesn't seem to fulfil these diversification criteria (see Appendix C).

It is often claimed that the fees generated by securities lending help reduce the fund's TER and therefore enhance its performance (SIX Swiss Exchange, 2010, p. 67). In fact, revenue coming from securities lending is only partially attributed to the fund, while part of it is kept by the ETF issuer to cover costs (Heidorn, et al., p. 14). The practices regarding the distribution of fees vary strongly across providers and the share credited to the funds can range 45% to 70%. The new ESMA guidelines require "that all revenues arising from securities lending, net of direct and indirect operational costs should be returned to the fund". However, it still leaves room for providers to define costs in different ways and charge fees on several kinds of services (Morningstar ETF Research, 2012b, p. 13).

Finally, the physical replication offers only limited possibilities for index replication. Whereas the full replication works very well for the replication of compact indices, which contain a small number of very liquid titles, the sampling method can still manage to replicate very broad indices, though with reduced tracking quality (Heidorn, et al., 2010, p. 7; Liermann & Michalik, 2010, p. 287). However, when it comes to the replication of short and leveraged indices or certain asset classes such as money market, commodities and alternatives, the physical replication simply reaches its limits and cannot be applied (Meyer zu Drewer, 2011, p. 51).

4.2.3 Critical assessment of the synthetic replication

The counterparty risk resulting from the swap used in the synthetic structure is the main point of criticism against the swap-based replication method and was intensively discussed during the recent debate. Since then, many synthetic providers have modified swap agreements and strive towards a daily target of zero counterparty risk (Morningstar ETF Research, 2012a, p. 11). In its comprehensive global study about synthetic ETFs, Morningstar states that “in practice, […] most providers hold assets or collateral in amounts that are either near, equal to, or greater than their fund’s net asset values” (Morningstar ETF Research, 2012a, p. 5). In case of full or over-collateralisation of the ETF, investors would not suffer a lost if the swap counterparty defaults. However, it is important to keep in mind that the default of a swap partner, which in most cases is a big financial institution, would probably have a negative effect on the whole financial markets leading to a loss of value of the collateral or substitute baskets held by the ETFs (Kinateder, 2012, p. 80). Furthermore, ETFs using the funded swap model might face a delay until being able to access the collateral assets and liquidate them (Morningstar ETF Research, 2012a, p. 15).

On the other hand, the swap-based structure offers some advantages towards the physical replication. The most promoted ones are the alleged enhanced tracking quality in form of lower tracking error and lower costs of synthetic ETFs, which result from the fact that the swap-based products don’t need to reallocate assets every time the composition of the underlying index changes, causing therefore less transaction costs (Johanning, et al., 2011, p. 15). Tracking error is a common measure for the tracking quality of ETFs and will be explained in detail in the next chapter. Heidorn et

al. (2010) found that synthetic ETFs generally show lower tracking errors than physically replicating ones, especially when it comes to the replication of broader indices. In its analysis of 65 ETFs, Morningstar ETF Research (2013) also concluded that synthetic funds produced lower tracking error compared to physical products. However, there is also conflicting empirical evidence. Meinhardt et al. (2012) found that tracking errors of physical and synthetic ETFs listed in the Frankfurt stock exchange didn't differ substantially between 2010 and 2011.

With regards to transparency and disclosure standards, synthetic providers can be considered to be one step ahead of physical providers. Meanwhile, all synthetic providers make the composition of their collateral and substitute baskets public, most of them on a daily basis, which cannot be said about all physical providers engaged in securities lending (Morningstar ETF Research, 2012a, p.11). However, synthetic providers still have to improve transparency with regard to the disclosure of swap costs, since practices vary strongly across providers. Many ETF issuers simply include the swap fees charged by their counterparties in the fund's TER, while others, typically those who have their parent bank as swap counterparty, claim not to charge any swap fees at all (Morningstar ETF Research, 2012a, p. 14).

Finally, the swap-based replication allows the replication of indices, which otherwise cannot be tracked, including short and leveraged, money market, commodities and alternatives indices. Therefore, it has contributed for the rapid growth of the ETF product range (Johanning, et al., 2011, p. 17; Kinateder, 2012, p. 76).

4.3 Assessment of tracking quality

4.3.1 Methodology

In theory, the return of an ETF should correspond to the return of its underlying index minus the TER (Morningstar ETF Research, 2013, p. 9; Lyxor Asset Management, 2013, p. 23). However, there are many reasons for differences between the performance of the fund and the one of the benchmark other than the costs. These deviations can occur due to factors such as cash drag, income from securities lending, diverging tax treatment of dividends and the reinvestment time of dividends. The latter results from the fact that most indices are calculated based on the assumption that dividends are reinvested immediately on the ex-dividend dates,

while funds have to wait until dividends are actually paid out before being able to reinvest them (Morningstar ETF Research, 2013, pp. 5-7). Diverging tax treatment is widely used for dividend tax enhancement purposes, meaning that a fund is able to receive dividends at lower tax rates than the ones assumed in the index calculation, depending on its home domicile. In that case, the ETF is able to enhance its performance compared to its benchmark (Lyxor Asset Management, 2013, p. 14; Deutsche Bank AG, 2010, p. 5).

Since ETFs are passively managed investment funds, not the absolute returns are relevant, but how the index performs compared to its benchmark. The tracking quality of ETFs, meaning how accurately an ETF tracks its benchmark, is commonly measured by using two indicators: the tracking error (TE) and the tracking difference (TD). There are diverging methodologies across literature regarding the calculation of these figures and sometimes the term tracking error is even used when actually tracking difference is meant and vice versa. In the following analysis, the methodology adopted is the one used by Morningstar ETF Research in an extensive study on the tracking quality of 65 European ETFs launched in February 2013. Not only is this the most recent study published on the subject, but also the methodology used is compliant with the definition of TE and TD as defined by the International Organization of Securities Commissions (IOSCO).

"Tracking error measures how consistently an index-based ETF follows its benchmark underlying reference index. Tracking error is defined by the industry as the volatility (as measured by standard deviation) of the differences in returns between a fund and its underlying reference index" (IOSCO, 2013, p. 4). Therefore, the annualised TE of an ETF is calculated as follows.

Formula 1: Tracking error

$$TE = \sigma (TR_{ETF} - TR_{index}) * \sqrt{n}$$

Whereby:

TR_{ETF} = single period total return of the fund's NAV

TR_{index} = single period total return of the underlying index

n = number of observations per year

Source: Morningstar ETF Research, 2013, p. 29

The TE figures presented in the following chapters are calculated on a daily basis, meaning that the single period total returns considered are daily total returns. The

resulting tracking error can be considered low if it is lower than 1%, medium, if between 1% and 2% and high if higher than 2% (Deutsche Bank AG, 2010, p. 7).

On the other hand, the "tracking difference measures the actual under- or outperformance of the fund compared to the underlying reference index. Tracking difference is defined as the total return difference between a fund and its underlying reference index over a certain period of time" (International Organization of Securities Commissions, 2013, p. 4). The annualised tracking difference for a certain period is calculated as follows.

Formula 2: Tracking difference

$$TD = (1 + TR_{ETF} - TR_{index})^{1/N} - 1$$

Whereby:

TR_{ETF} = total return of the fund's NAV over the entire measurement period

TR_{index} = total return of the index over the entire measurement period

N = number of years

Source: Morningstar ETF Research, 2013, p. 29

The total return (TR) for both the ETF and the index is calculated as follows.

Formula 3: Total return

$$TR = (F / I) - 1$$

Whereby:

F = final value

I = initial value

Source: Morningstar, 2013, p. 10

The initial value represents the beginning of the measurement period and the final value respectively the end of the measurement period. For the calculation of the daily total returns, the initial value represents the previous day's value of the final value.

It is often assumed that a fund with a high tracking error is likely to underperform its benchmark (negative tracking difference), which is not necessarily the case. On the other hand, a low tracking error is just as little a guarantee for a low tracking difference. In general, there is a certain correlation between the two measures, though not a strong one (Morningtstar, 2013a, p. 20).

In the following chapters physical and synthetic ETFs tracking the EURO STOXX 50 and the MSCI Europe will be analysed with respect to their tracking error and tracking difference by using the methodology described above. The comparison of

ETFs becomes difficult when providers chose different benchmarks to give access to the same markets (Hassine & Roncalli, 2013, p. 16). That is why two popular European indices were chosen, which serve as the benchmark for several ETFs, both synthetically and physically replicating ones.

The data needed for the analysis are the price history of the benchmark indices and the NAV history of the respective ETFs. For income distributing funds, the adjusted NAVs are used, in which dividends are reinvested. Hence, distributing and capitalising funds can be directly compared. Once all funds are analysed on a total return basis (with reinvested dividends), the benchmark considered must also be the respective total return index, even if single ETFs claim to track the price index (Morningstar ETF Research, 2013, p. 8). All data used was retrieved from the providers' websites. Therefore, only funds for which the necessary data is published and can be downloaded were included in the analysis.

4.3.2 EURO STOXX 50 Index

The EURO STOXX 50® is a blue-chip stock index launched in 1998 and calculated by STOXX Limited. It contains titles from 50 leading companies in eight European countries, which are weighted according to their free-float market capitalisation. The index has become one of the most used barometers for the European stock market (Deutsche Bank AG, 2013). Six ETFs tracking the EURO STOXX 50 index, thereof three physical and three synthetic funds, were included in the analysis. The funds and their key data are presented in table 2. Table 3 shows the tracking errors for the six ETFs since 2010.

Table 2: Key information - EURO STOXX 50 ETFs

ETF	ISIN	Replication method	Inception
Deka EURO STOXX 50 UCITS ETF	DE000ETFL029	Physical (Full)	March 2008
EasyETF Euro Stoxx 50	FR0010129072	Physical (Full)	September 2005
iShares EURO STOXX 50 UCITS ETF	DE0005933956	Physical (Full)	December 2000
ComStage ETF EURO STOXX 50	LU0378434079	Synthetic (n/a)	September 2008
db X-trackers Euro Stoxx 50 UCITS ETF	LU0380865021	Synthetic (Unfunded)	August 2008
Lyxor UCITS ETF EURO STOXX 50	FR0007054358	Synthetic (Unfunded)	March 2001

Source: own compilation based on information from Deka Investment (2013); EasyETF (2013); iShares (2013a); ComStage (2013a); Deutsche Bank AG (2013b); Lyxor Asset Management (2013b)

Table 3 shows the tracking errors of the six ETFs since 2010.

Table 3: Tracking error – EURO STOXX 50 ETFs

ETF	YTD*	2012	2011	2010
Deka EURO STOXX 50 UCITS ETF	0.21%	0.38%	0.63%	0.39%
EasyETF Euro Stoxx 50	0.14%	0.16%	0.16%	0.17%
iShares EURO STOXX 50 UCITS ETF	0.34%	0.46%	0.60%	0.44%
Average physical replication	0.23%	0.33%	0.46%	0.33%
ComStage ETF EURO STOXX 50	0.12%	0.16%	0.10%	0.15%
db X-trackers Euro Stoxx 50 UCITS ETF	0.04%	0.09%	0.04%	0.09%
Lyxor UCITS ETF EURO STOXX 50	0.11%	0.17%	0.15%	0.60%
Average synthetic replication	0.09%	0.14%	0.10%	0.28%

* Data until August 30th 2013

Source: own calculation based on data from Deka Investment (2013); EasyETF (2013); iShares (2013a); ComStage (2013a); Deutsche Bank AG (2013b); Lyxor Asset Management (2013b)

If classified in the categories defined above, all ETFs can be considered to have a low tracking error in each period (< 1%). Out of all products, the db x-trackers ETF shows constantly the lowest TE, while the iShares fund has the highest TE in almost all periods. The relatively high TE of the Lyxor ETF in the year 2010 is striking, considering that it shows much lower values in the following years. In all periods analysed, the average tracking error of the physical replicating ETFs is higher than the one of the synthetically replicating funds. Thereby, one should emphasise that the EasyETF fund, although being a physical product, shows constantly low TE levels, which are comparable to those of the synthetic funds.

The tracking error can be visualised by the daily return differential patterns (Deutsche Bank AG, 2010, pp. 7-8). The daily differences between the total returns of the ETF and the benchmark index are the basis for the calculation of the tracking error over a certain period of time. The daily return differences of the db x-trackers EURO STOXX 50 UCITS ETF and the iShares EURO STOXX 50 UCITS ETF, which produced the lowest and the highest tracking error respectively, show very different levels of volatility, which are reflected in their tracking errors (see Appendix D.1 and D.2).

Table 4 shows the annualised tracking differences of the six ETFs for a one year, three years and five years period respectively.

Table 4: Tracking difference – EURO STOXX 50 ETFs

ETF	TER	1 Year TD*	3 Year TD*	5 Year TD*
Deka EURO STOXX 50 UCITS ETF	0.15%	0.51%	0.90%	0.68%
EasyETF Euro Stoxx 50	0.25%	0.69%	0.65%	0.53%
iShares EURO STOXX 50 UCITS ETF	0.16%	0.10%	0.50%	0.28%
Average physical replication	-	0.43%	0.68%	0.50%
ComStage ETF EURO STOXX 50	0.15%	0.65%	0.56%	0.48%
db X-trackers Euro Stoxx 50 UCITS ETF	0.10%	0.47%	0.47%	0.39%
Lyxor UCITS ETF EURO STOXX 50	0.25%	0.57%	0.45%	0.45%
Average synthetic replication	-	0.56%	0.49%	0.44%

* Data until August 30th 2013

Source: own calculation based on data from Deka Investment (2013); EasyETF (2013); iShares (2013a); ComStage (2013a); Deutsche Bank AG (2013b); Lyxor Asset Management (2013b)

Regarding the TD, there is no recognisable pattern differentiating physical from synthetic funds. That corresponds to the finding of the study conducted by Morningstar ETF Research (2013), where no correlation between the replication method and the TD could be found. In theory, the TD of the funds should be negative and correspond to the TER. However, all ETFs show a positive tracking difference, meaning that they outperform the benchmark. Reasons for positive TD can be income from securities lending, cash drag in periods of falling index rates and dividend tax enhancement. While the two first reasons affect mainly physical ETFs, dividend tax enhancement is also practiced by synthetic funds (Morningstar ETF Research, 2013, p. 16; Lyxor Asset Management, 2013, pp. 11-14).

Keeping in mind that ETFs are passively managed investment funds with the highest aim to replicate the respective benchmark index as accurately as possible, it is certainly valid to question whether it is desirable for an ETF to generate positive tracking differences. Although investors might welcome the outperformance, it is important to remember that any deviation from the benchmark, regardless whether in the positive or negative direction, represents a violation of this aim (Morningstar ETF Research, 2013, p. 28).

4.3.3 MSCI Europe Index

The MSCI Europe is stock market index, which contains titles from developed European countries. The components are weighted according to their free-float market capitalisation. Contrary to the EURO STOXX 50, the MSCI Europe is a broad index, containing a total of 442 titles from 16 European countries as of August 2013

(State Street Global Advisors, 2013). Five ETFs tracking the MSCI Europe index, thereof two physical and three synthetic funds, were included in the analysis.

Table 5: Key information – MSCI Europe ETFs

ETF	ISIN	Replication method	Inception
iShares MSCI Europe UCITS ETF	DE000A0YBR20	Physical (Full)	September 2009
SPDR® MSCI Europe ETF	FR0000001885	Physical (Full)	May 2001
ComStage ETF MSCI Europe TRN	LU0392494646	Synthetic (n/a)	December 2008
db x-trackers MSCI Europe Index UCITS ETF	LU0274209237	Synthetic (Funded)	January 2007
Lyxor UCITS ETF MSCI Europe	FR0010261198	Synthetic (Unfunded)	January 2006

Source: own compilation based on information from: iShares (2013b); State Street Global Advisor (2013b); ComStage (2013b); Deutsche Bank AG (2013c); Lyxor Asset Management (2013c)

Table 6 shows the resulting tracking errors for the five ETFs since 2010.

Table 6: Tracking error – MSCI Europe ETFs

ETF	TE YTD*	TE 2012	TE 2011	TE 2010
iShares MSCI Europe UCITS ETF	0.14%	0.12%	0.08%	0.12%
SPDR® MSCI Europe ETF	0.07%	0.12%	0.16%	0.19%
Average physical replication	0.11%	0.12%	0.12%	0.15%
ComStage ETF MSCI Europe TRN	0.06%	0.04%	0.03%	0.05%
db x-trackers MSCI Europe Index UCITS ETF	0.02%	0.04%	0.03%	0.06%
Lyxor UCITS ETF MSCI Europe	0.04%	0.06%	0.08%	0.36%
Average synthetic replication	0.04%	0.04%	0.05%	0.16%

* Data until August 30th 2013

Source: own calculation based on data from: iShares (2013b); State Street Global Advisor (2013b); ComStage (2013b); Deutsche Bank AG (2013c); Lyxor Asset Management (2013c)

Just like in the previous analysis, the TE of the five ETFs in all periods can be categorised as low (< 1%). Again, the average TE of the synthetic funds is lower than the one of the physical replicating funds in almost all periods. Only in 2010 the average TE of the synthetic ETFs is higher, which is due to the relatively high TE of the Lyxor fund in that year. The db x-trackers ETF can once again be seen as the one with the lowest tracking error, closely followed by the ComStage fund. The SPDR® ETF shows the overall highest TE, but has continuously improved over time. One can say that here, the overall TE of all analysed funds is lower than the one of the EURO STOXX 50 index, which is contradictory to the common notion that ETFs tracking indices with a lower number of components produce lower TE. The daily differential patterns of the ETFs with the lowest and the highest TE are attached in the appendix D.3 and D.4.

Table 7 shows the annualised tracking differences of the five ETFs.

Table 7: Tracking difference – MSCI Europe ETFs

ETF	TER	1 Year TD*	3 Year TD*	5 Year TD*
iShares MSCI Europe UCITS ETF	0.33%	-0.08%	-0.13%	-
SPDR® MSCI Europe ETF	0.30%	0.01%	0.00%	0.01%
Average physical replication	-	-0.03%	-0.07%	0.01%
ComStage ETF MSCI Europe TRN	0.25%	0.13%	0.01%	-
db x-trackers MSCI Europe Index UCITS ETF	0.30%	-0.08%	-0.04%	0.01%
Lyxor UCITS ETF MSCI Europe	0.35%	0.05%	-0.10%	-0.22%
Average synthetic replication	-	0.05%	-0.06%	-0.10%

* Data until August 30th 2013

Source: own calculation based on data from: iShares (2013b); State Street Global Advisor (2013b); ComStage (2013b); Deutsche Bank AG (2013c); Lyxor Asset Management (2013c)

Here, in contrast to the EURO STOXX 50 ETFs, there is a balance between negative and positive tracking differences, whereas the values move closely around the 0%, which would mean that the performance of the ETF corresponds exactly to the one of the benchmark. For the iShares and ComStage funds, there are no data for the five year period, since they were incepted in September 2009 and December 2008 respectively. In the one year period, the ComStage fund shows the highest outperformance with 13 bps. Even the negative tracking differences are not as high as the respective TER, meaning that here, funds also probably make use of activities to generate extra income, such as securities lending and dividend tax enhancement. Again, there is no clear relationship between the TD and the replication method. The average differences in the 5 year period can hardly be compared, since only one physical and two synthetic funds are regarded and the relatively high tracking difference of the Lyxor fund leads to an additional distortion.

Finally, a certain correlation between the TE and the TD can be confirmed, since the ETFs tracking the Euro STOXX 50 show a generally higher TE and TD, while the MSCI Europe ETFs produced overall lower TE and corresponding lower TD. Therefore, with respect to tracking quality, the MSCI Europe ETFs can be considered superior to the EURO STOXX 50 ETFs, since they show lower deviation from their benchmark index, both in terms of tracking error and tracking difference.

5 Conclusion

5.1 Summary

Since their introduction in the European market in the year 2000, exchange traded funds have grown extremely rapidly and gained not only popularity, but also complexity. ETFs are passively managed, open-ended investment funds, which replicate the performance of a specific underlying index and can be traded in an exchange like a stock. Meanwhile, the ETF product range covers indices across several asset classes and allows the implementation of different investment strategies. European ETFs are ruled under the UCITS regulation and offer therefore certain safeguards for investors such as segregation of assets and minimum diversification, which delimit them from similar financial products.

There are two main methods used by ETFs in order to replicate the performance of a given benchmark: physical and synthetic replication. Physically replicating ETFs hold assets corresponding to those contained in the underlying index. Thereby, either the full replication or the sampling method is applied. In the first and more common alternative, the ETF holds all index constituents in the respective weightings, while in the second alternative, a representative sample of the index components is chosen with the aim to create a portfolio with high correlation to the benchmark index. Physically replicating ETFs often lend part of their securities in exchange for fees and a collateral portfolio.

Synthetic replicating ETFs can make use of the unfunded and the funded swap models. Under the first structure, the ETF holds a portfolio consisting of diverging assets than those contained in the index. The performance of this portfolio is then exchanged against the performance of the benchmark via a total return swap with a swap counterparty. The value of the total return swap, and therefore the counterparty risk attached to it, is limited to a 10% of the fund’s assets by UCITS regulation. Under the funded swap model, the fund does not own a portfolio of securities but only one or more total return swaps. The swap counterparty has to deposit a collateral basket consisting of at least 90% of the fund’s assets in order to reduce the counterparty risk to the regulatory 10% limit. However, since additional haircuts are applied to the collateral, ETFs using this structure are usually fully or over-collateralised.

In the year 2011, leading financial regulators have expressed concerns regarding the synthetic structures and the securities lending practices of ETF providers. Besides of the general risk, ETFs can entail risks depending on the structure applied. Physical ETFs involved in securities lending expose investors to a borrower risk, which is eliminated via collateralisation. Besides, physical ETFs are alleged to replicate their benchmarks less accurately than synthetic ETFs due to different factors. On the other hand, synthetic ETFs expose investors to a counterparty risk, which is limited by law to 10% of the fund's assets. In practice, most providers keep levels of counterparty risk close to zero. In case of funds using the funded swap model, this can be reached by means of full- and over-collateralisation, while those applying an unfunded swap reach it by resetting swaps more frequently.

The tracking quality of 11 ETFs was assessed by analysing their tracking error and tracking difference. The tracking error measures the volatility of total return differences between the ETF and its underlying index and describes therefore how steadily an ETF tracks its benchmark. The tracking difference simply measures the under- or outperformance of a fund compared to its benchmark. All ETFs analysed, both physical and synthetic ones, show a high level of tracking quality with low tracking errors below 1% and tracking differences lower than the respective fund costs. In many cases, the ETFs even produced an outperformance. However, the results show that synthetic ETFs produce tendentially lower tracking errors than physically replicating ones, whereas a relationship between the level of tracking difference and the replication method cannot be recognised.

5.2 Critical acclaim

It seems that research could not keep up with the high pace of growth and innovation of the ETF industry, so that academic sources containing relevant, accurate and up-to-date information on the topic are scarce and sometimes contradictory. Some authors of relevant academic publications, e.g. T. Michalik, S. Lang and T. Meyer zu Drewer, were respectively working for db x-trackers, iShares and ComStage at the time of their publications. Therefore, these sources have to be treated with the same additional wariness with regard to potential conflicts of interest as the ones published directly by the ETF providers. This is especially the case when it comes to arguments promoting or contesting a specific replication method. Since the US American ETF

market operates under totally different conditions than the European market and the synthetic replication has as good as no relevance, US American sources could only be used to a very limited degree.

The main limitation with regard to the analysis of the tracking quality lays in the fact that it is based on data provided by the ETF providers. On the one hand, many providers don't give access to the data and their funds could therefore not be included. UBS and HSBC for instance, have physical ETFs tracking the MSCI Europe, but would not provide the necessary data even upon request. On the other hand, there is always the chance that the data provided might not be accurate or complete. For instance, the data downloaded from the iShares website contained some figures in the NAV series, in which the decimal separators were missing. Those mistakes could be easily corrected, since it was evident where a point had to be added. However, there might be other mistakes in the data basis that could not be verified. The relatively high level of tracking error of both Lyxor ETFs in the year 2010 could potentially be a result of data errors. However, since there is no possibility to verify these data, they were simply assumed to be correct. Therefore, an analysis based on data retrieved from a reliable and independent source, e.g. Bloomberg or Reuters, would be preferable. In that case, more ETFs could be included, allowing for more representative results.

5.3 Outlook

The outcome from the critics expressed towards the ETF industry and the following debate can be welcomed, since they resulted in enhanced practices and transparency among providers. However, there is still room for improvement with respect to the disclosure of standards, especially for physical ETFs involved in securities lending. Meanwhile, the specific risks entailed in each ETF depend rather on the practices of providers than on the replication method itself. Therefore, investors should be able to get the information needed in order to decide which risks they are willing to take.

One can expect that very soon, there won't be any purely physical or synthetic ETF provider left. The trend is that providers offer a mixed range of physically and synthetically replicating ETFs, depending on the characteristics of the benchmark.

Recently, some providers even started offering both replication methods for some popular benchmarks, leaving it up to investors to choose which one to prefer, which certainly is a very positive development. Further, innovation is expected to keep its high pace within the ETF industry leading to an even wider variety of products.

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VI. Appendix

A Derivation of the NAV of synthetic ETFs

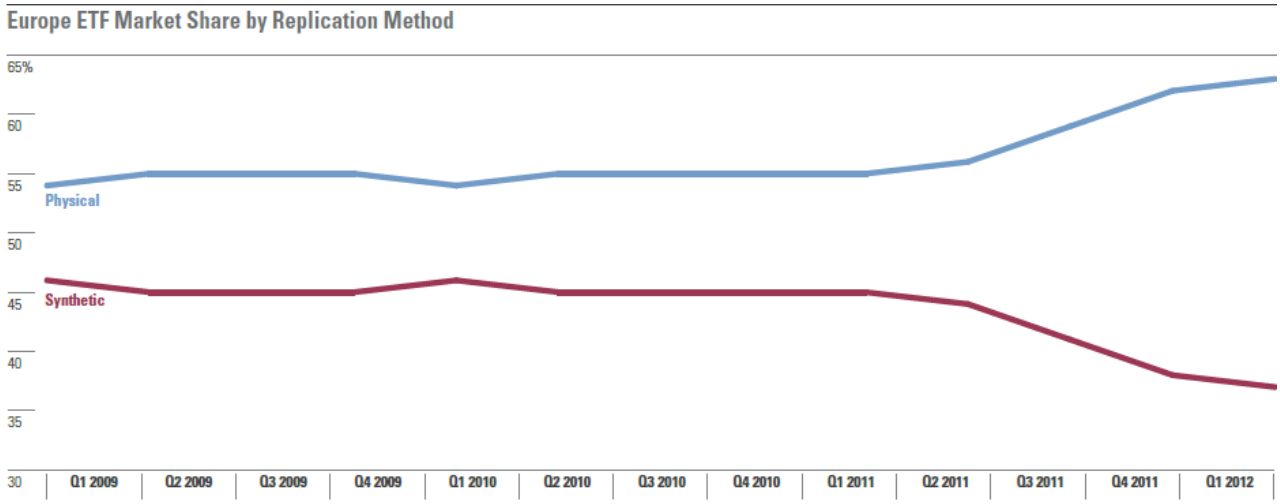
NAV =
value of substitute basket
+ net returns coming from the securities contained in the substitute basket
+ swap mark-to-market
- fees

Swap mark-to-market =
value of the underlying index
+ net returns coming from the securities contained in the index
- substitute basket
- net returns coming from the securities contained in the substitute basket
- replication costs

Therefore:
NAV =
value of the underlying index
+ net returns coming from the securities contained in the index
- fees
- replication costs

Source: Lyxor Asset Management, 2010b, p. 3

B Europe ETF market share by replication method from 2009 until March 2012



Source: Morningstar ETF Research, 2012a, p. 19

C Published securities lending information of the iShares EURO STOXX 50 UCITS ETF as of September 13th 2013

Der auf dieser Seite angezeigte Sicherheitenbestand wird für Tage angezeigt, an denen der Fonds, der Wertpapierleihgeschäfte durchführt, über ein offenes Leihgeschäft verfügte.

Gehaltene Sicherheit 16.08.13

	Wertpapier	ISIN	SEDOL	Land	Anlagekategorie	Gewichtung in %
1	FRANCE (REPUBLIC OF)	FR0010192997	B08HF85	Frankreich	Staatsanleihen	21,69
2	TREASURY NOTE 0.125 04/15	US912828UY44	B8XVLQ8	Vereinigte Staaten	Staatsanleihen	21,32
3	TREASURY NOTE 0.25 06/14	US912828TA86	B87LYP4	Vereinigte Staaten	Staatsanleihen	20,89
4	TREASURY NOTE	US912828PA23	n/a	Vereinigte Staaten	Staatsanleihen	19,45
5	TREASURY NOTE 0.75 10/17	US912828TW07	B8BR7L5	Vereinigte Staaten	Staatsanleihen	16,65

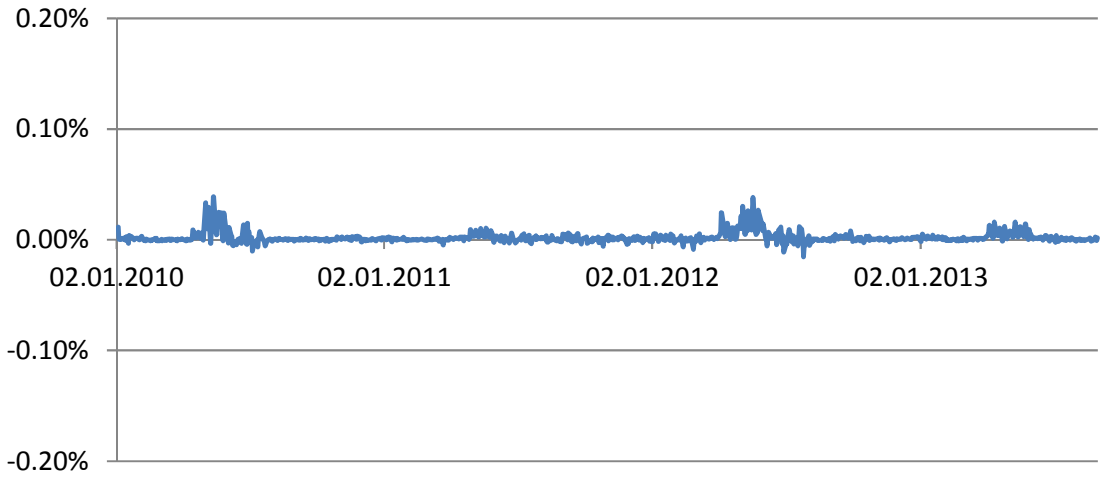
12-Monats-Übersicht der Wertpapierleihe zum~ 30.06.13

Rendite aus Wertpapierleihgeschäften*	0,16%
Durchschnittliches Leihvolumen (in % von AUM)	2,73%
Maximales Leihvolumen (in % von AUM)†	15,94%
Besicherung (in % vom Leihvolumen)	112,18%

Source: iShares (2013a)

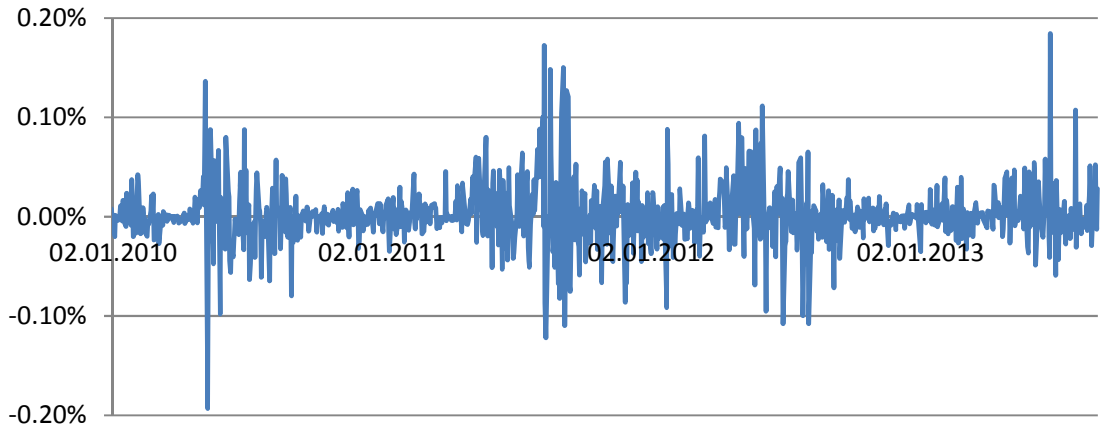
D Daily return differential patterns

D.1 Daily return differences – db x-trackers Euro Stoxx 50 UCITS ETF



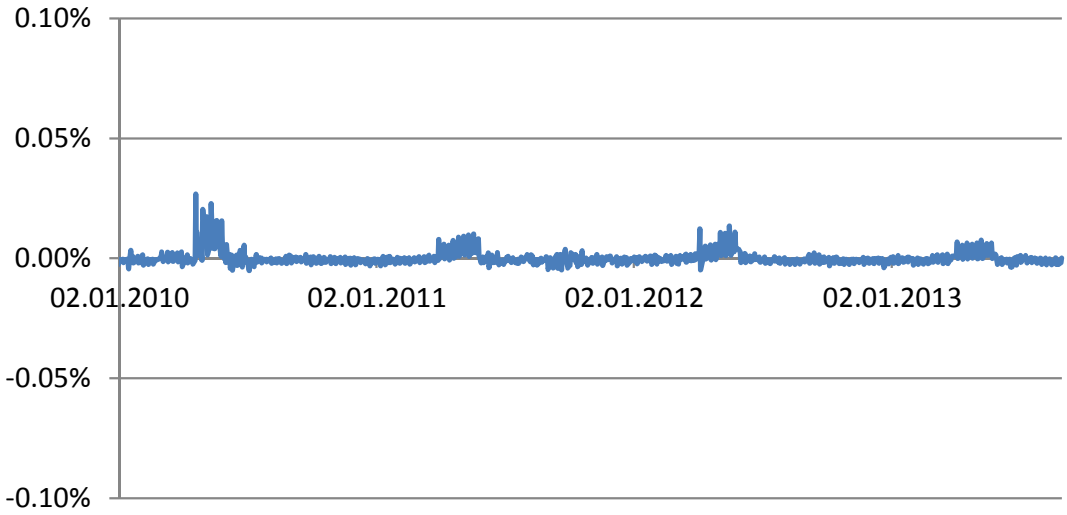
Source: own calculation and illustration based on data from Deutsche Bank (2013b)

D.2 Daily return differences - iShares EURO STOXX 50 UCITS ETF



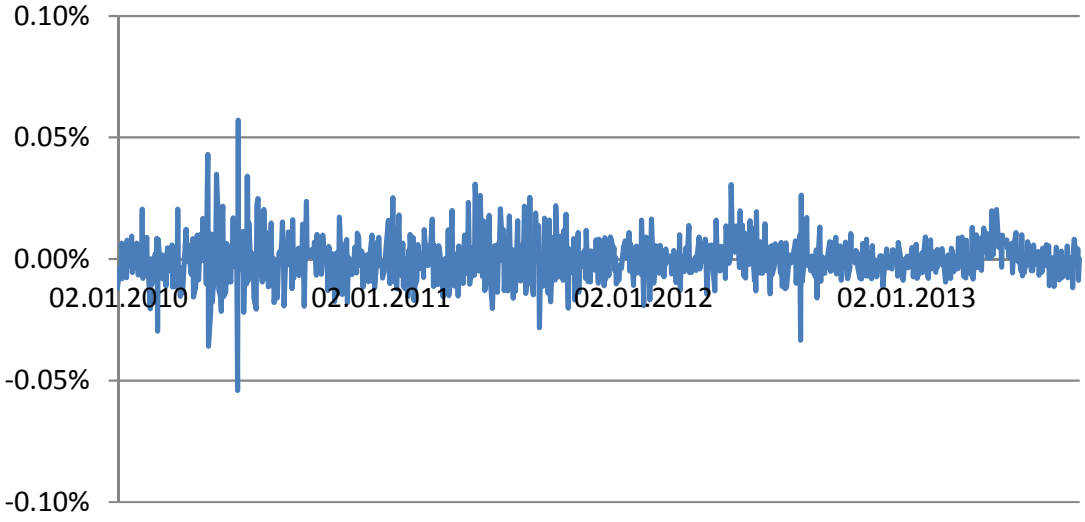
Source: own calculation and illustration based on data from iShares (2013a)

D.3 Daily return differences – db x-trackers MSCI Europe Index UCITS ETF



Source: own calculation and illustration based on data from Deutsche Bank (2013c)

D.4 Daily return differences – SPDR MSCI Europe ETF



Source: State Street Global Advisors (2013b)

VII. Declaration of originality

Ich versichere hiermit, dass ich die vorliegende Arbeit ohne fremde Hilfe selbständig verfasst und nur die angegebenen Quellen und Hilfsmittel benutzt habe. Wörtlich oder dem Sinn nach aus anderen Werken entnommene Stellen sind unter Angabe der Quelle kenntlich gemacht.

Hamburg, den 4. Oktober 2013

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Gisela Widing