Tracking ability of exchange-traded funds. Evidence from Emerging Markets Equity ETFs

Tomasz Miziołek[*], Ewa Feder-Sempach[#]

Abstract

In recent years asset growth of passively managed funds, including ETFs, has been substantial all over the world. The main purpose of an ETF is to replicate both the return and risk characteristics of the underlying index. The efficiency of an ETF is usually evaluated by analyzing tracking errors (TEs), i.e. the difference between the movement of its price and the benchmark. The main aim of the article is to examine the tracking efficiency of 14 ETFs listed on European exchanges that try to mirror the performance of the MSCI Emerging Markets Index in 2012–2017. The study has revealed that ETFs are quite effectively managed as TE values were generally lower than those presented in the literature. The results also show that the TE values achieved by the standard deviation of the difference between the return of the fund and that of its benchmark index were similar to those obtained via the method of standard error of regression. Besides, the lowest TE values were observed at weekly intervals, whereas the highest at daily ones.

---

[*] University of Lodz, Faculty of Economics and Sociology, Department of International Finance and Investments; e-mail: tomasz.miziolek@uni.lodz.pl.
[#] University of Lodz, Faculty of Economics and Sociology, Department of International Finance and Investments.

1 Introduction

Exchange-traded funds are hybrid investment vehicles sharing properties of exchange-listed securities and open-ended mutual funds (Bernstein 2002). They are publicly traded on stock exchanges or other trading platforms (such as multilateral trading facilities) and usually passively managed, i.e. they strive to imitate the performance of a selected index. Most ETFs are designed to closely track the return and risk characteristics of various financial indexes such as equity, fixed income, currency, commodity and alternative, as well as multi-asset indexes, using physical (direct) or synthetic (swap) replication methods.

ETFs are one of the most important innovations in financial markets in the last decades (Charupat, Miu 2013). Although the first funds of this kind were launched in Canada and the United States already in the early '90s, their truly dynamic development began in the last decade. Since then, especially since the financial crisis, the global ETFs market has grown rapidly. These financial instruments have fundamentally changed the way in which many investors, both institutional and retail ones, construct their investment portfolios. They have become very popular and they constitute widely recognised and applied investment vehicles, as they offer many advantages to various investor groups, enabling them to achieve different goals. According to ETFGI (2018a), at the end of July 2018 assets invested in 5649 exchange-traded funds reached the level of USD 4.96 trillion. ETFs, together with exchange-traded products (ETPs), are listed on 70 platforms in 57 countries worldwide.

The first equity ETFs were launched on stock exchanges in developed countries and had exposure to equity markets covering this group of economies. However, the desire to diversify investment portfolios internationally resulted in launching the first two equity ETFs with exposure to single emerging market (EM) countries (Mexico and Malaysia) on the American Stock Exchange (AMEX) in 1996. In the following years, more country-specific or regional EM ETFs were launched on stock exchanges in USA, Hong Kong, South Korea, Taiwan, South Africa, Israel and India. The first ETFs with broad EM exposure were launched in the United States in November 2002 (BLDRS Emerging Markets 50 ADR Index listed on NASDAQ) and April 2003 (iShares MSCI EMF listed on AMEX) (Fuhr 2003). The use of ETFs and ETPs (exchange-traded products) for broad emerging market exposure in particular has become very popular among institutional asset managers investing internationally, since it is often difficult to achieve such an exposure due to the requirement of having a foreign investor status in many EM markets and because of a limited selection of futures contracts offering such an exposure (Black Rock 2011).

The iShares MSCI ETF (at present iShares MSCI Emerging Markets ETF) was the first ETF tracking the performance of the most important EM index – the MSCI Emerging Market Index (Meziani 2016). This widely recognized benchmark for emerging market countries, launched in 1988, in subsequent years has become the basis for the creation of many ETFs all over the world, including Europe. In particular, at the turn of the past and present decade many new ETFs offered by different providers and replicating the return of the MSCI Emerging Market Index debuted on various European exchanges. These instruments allow investors to obtain a simple and convenient broad exposure to twenty four EM countries in a single transaction, hence a large part of them has gained considerable popularity in recent years. Concerning the fact that European ETF market is highly fragmented and many asset managers (European and American alike) cannot afford not to offer passive funds based on this benchmark, ETFs – replicating the performance of the MSCI EM Index – are also likely to become the most widely represented financial instruments of this type (emerging markets equity ETFs) not only in Europe but also in the world.

The main objective of the article is to examine the quality of replication for 14 European ETFs tracking the performance of the MSCI Emerging Markets Index, listed both in US dollars and in euro. All selected ETFs are listed on European stock exchanges and were launched at least 6 years ago. The calculations were made for the 2012–2017 period and they involved the use of the most widely recognized measures such as the tracking error (TE) and the tracking difference (TD), various tracking error calculation techniques and three different return intervals – daily, weekly and monthly. The MSCI Emerging Markets TRN (Total Return Net) indexes calculated in US dollars and in euro were used as benchmarks to take into account the exchange rate dynamics.

Although it is not the first study where the tracking efficiency of equity emerging market ETFs, based on the MSCI EM Index has been analysed, it may still contribute to the existing literature in three aspects. Firstly, we explored tracking errors for as many as 14 funds from 10 asset managers, using three time intervals, while in earlier studies a much smaller number of funds was examined and the studies were generally based on one time interval only. Secondly, we calculated tracking errors and tracking differences on the basis of the NAV (net asset value) per share data, not market prices. Thirdly, we provided researchers' and investment professionals' views on the emerging economies which started to gain greater importance in the global investment landscape.

The primary findings of this paper can be summarized as follows: exchange-traded funds listed on the European exchanges, replicating the performance of the MSCI Emerging Markets Index, are quite effectively managed so as to mimic the performance of the underlying index, though not as perfectly as ETFs replicating the performance of indexes consisting of blue chip companies from developed countries. ETFs listed in US dollars kept the TE values below 0.5% and TEs for ETFs listed in euros were even lower (below 0.12%). The values turned out to be generally lower than those presented in the literature so far. Furthermore, the results were quite similar regardless of the applied calculation methods and time intervals, although the lowest values of TEs were observed for weekly intervals.

The article is organized as follows. The subsequent section presents a review of the related literature. Section 3 describes the MSCI Emerging Markets Index and European ETFs replicating this benchmark (including the detailed characteristics of the research sample covering 14 ETFs). In the next section we describe our research methods. i.e. calculation methods for the tracking difference and the tracking error. Section 5 presents the results of the study and its main findings, and in the last section we draw conclusions from the presented research.

2 Literature review

The mainstream of exchange-traded fund research comprises the replication quality of ETFs, the effectiveness of their stock market valuations in relation to the net asset value (NAV) as well as the impact of ETF transactions on the related securities and index derivatives. Since the main purpose of the vast majority of ETFs is to replicate the performance of an index (excluding management costs), the research conducted in this area generally involves comparing the investment performance of an ETF with the replicated index and determining the variability of differences in the return rates between the ETF and the index it replicates.

The research related to the quality of index replication by ETFs has been conducted for over 15 years. Initially, in the first years of the last decade, these studies focused almost exclusively on funds

listed on American stock exchanges and on replicating the performance of the indexes from the domestic stock market (for example Elton et al. 2002; Poterba, Shoven 2002). It was justified by the fact that the American ETF market was the best-developed one, while in other regions of the world ETF markets were either relatively small or even non-existent.

In subsequent studies, conducted mostly over the past 10 years, the replication quality of equity ETFs investing in other developed markets has been extensively examined. Gallagher and Segara (2006) examined 4 ETFs tracking Australian equity indexes (S&P/ASX 200, S&P/ASX 50 and ASX 100) and listed on the ASX, Milonas and Rompotis (2006) computed tracking errors of 34 equity ETFs listed on the SIX Swiss Exchange and tracking various European, US and Asian (regional and single country) indexes. Rompotis (2008) investigated the tracking efficiency of 62 ETFs listed in Germany. Hassine and Roncali (2013) studied the performance of 31 European ETFs tracking, among others, the Euro Stoxx 50 Index and the customised MSCI Japan/Topix Index, Johnson et al. (2013) examined the tracking differences and tracking errors of 65 ETFs aiming to mirror, among others, single country indexes (S&P 500, FTSE 100, DAX, MSCI, Japan) and the Euro Stoxx 50 Index. Yiannaki (2015) analysed the performance of 24 equity ETFs domiciled in two main European hubs (Luxembourg and Ireland) and listed on three major European exchanges (London Stock Exchange, Euronext Paris, Deutsche Boerse), tracking, among others, the indexes of developed markets.

The development of equity ETFs with an exposure to emerging markets, particularly in the current decade, encouraged researchers to start analysing the tracking ability of these funds as well. Most of these studies refer to the ETFs that aim to replicate the investment performance of individual domestic indexes. Examples of such studies are listed in Table 1.

The second group of research on tracking the quality of emerging markets equity ETFs involves the funds that try to replicate, as closely as possible, the returns of broad EM indexes. Although there exists studies in which only a single fund of this type was analysed, the first extensive study was carried out by Blitz and Huij (2012). They believed that comprehensive research into the performance of global emerging markets (GEM) ETFs was necessary because it was not certain whether the results found in the literature for US and European equity ETFs could be applied to GEM ETFs. They examined ETFs listed on US (3 funds) and European (4 funds) exchanges with exposure to two conventional broad EM indexes (the MSCI Emerging Market Index – 6 funds and the S&P EM BMI Index – 1 fund) and with a live track record of minimum one year in the period since their inception through December 2010. Upon analysing the annualised tracking errors of these ETFs based on monthly, quarterly and even annual data (when market prices for 7 funds and additionally NAVs for 3 funds were used), it turned out that TE levels were substantially higher compared to passive funds tracking broad equity indexes for developed markets[1] and fluctuated between 3.4% and 6.1% (for monthly returns), 2.4% and 4.6% (for quarterly returns) and 1.4% and 4.4% (for annual returns). Such high values led them to the conclusion that it was arguable whether these ETFs should actually be classified as passive funds. Besides, in their opinion tracking errors based on short-term data were higher as a result of bid-ask effects, stale prices and time zone differences; hence may overestimate the TEs experienced by investors over longer

---

[1] There are many explanations for this phenomenon. For example, Bakaert and Harvey (1995) analysed market integration; as a result of that, we can expect low tracking errors in highly integrated financial markets and high tracking errors in poorly integrated financial markets. However, Johnson (2008) stated that the market segmentation or integration did not explain the differences in tracking errors between ETFs and the underlying indexes, but hours of operations and trading momentum were significant when explaining tracking errors. This conclusion is important for all ETFs that underlie foreign indexes listed on international exchanges, mostly in emerging markets.

holding periods. They also stated that the techniques used by ETFs to track their benchmark indexes were crucial in emerging markets. They found that the ETFs relying on the physical (but not full) replication (when funds hold only a subset of index constituents) were prone to relatively high levels of the tracking error, especially in the periods of high return dispersion. At the same time there was no evidence that these funds had higher returns than the ETFs applying full replication.

Johnson et al. (2013) studied, among others, the tracking ability of 8 European ETFs that aim to mirror the performance of the MSCI Emerging Markets Index. For all these funds they measured tracking differences and daily and weekly tracking errors (in the period of December 2010 – September 2012) and compared the results of ETFs using physical and synthetic replication. The average annualised tracking difference for MSCI EM ETFs amounted to -0.95 p.p. (a negative value means that ETFs, as expected, underperformed the benchmark index), while in the case of funds using synthetic replication the average tracking difference was lower than in physical replication (-0.91 p.p. and -1.03 p.p. respectively). In turn, the average daily tracking error was 0.77% (the average weekly tracking error was 0.57%), but for synthetic ETFs it was only 0.12%. Considerably higher daily TEs for three ETFs using physical replication (the average of 1.77%) stem from various factors, including the number and liquidity of underlying constituents. Physical replication funds apply optimised sampling (they invest in a basket of selected securities from the benchmark, the characteristics of which are the closest to the entire index) – this technique is usually employed when the replicated index has rather illiquid members, a large number of constituents or when there are legal restrictions on investing in certain securities (all these cases may occur in EM ETFs). They also pointed out another reason for higher TEs in funds using physical replication – many of them invest in ADRs (American Depository Receipts) or GDRs (Global Depository Receipts) (instead of stocks), the prices of which do not accurately reflect the prices of the underlying securities. Johnson et al. (2013) also confirmed two other findings by Blitz and Huij (2012). Firstly, they found that tracking errors for EM ETFs were relatively high in comparison to other analysed ETFs linked to indexes from developed markets (FTSE 100, S&P 500, DAX, Euro Stoxx 50). Secondly, tracking errors calculated on the basis of longer intervals (weekly data) were lower than at shorter intervals (daily data). Contrary to Blitz and Huij results, the TE values turned out to be much lower, which resulted from a different sample, a different research period (not covering the financial crisis), lower expense ratios and – perhaps – also from a better quality of replication due to asset managers' longer experience.

Hassine and Roncalli (2013) analysed the tracking efficiency of, inter alia, 5 European ETFs (only those listed in euro), replicating also the MSCI EM Index in the period from December 2011 to November 2012. Calculations were based on daily NAV data, which – in some cases – were adjusted by dividends distributed by funds. They developed a new tracking efficiency measure ζ_α. It is a value--at-risk measure, based on three parameters: the performance difference between the fund and the index, the volatility of the tracking error and the liquidity spread. They discovered a negative value of the efficiency measure for all the examined ETFs replicating the returns of the MSCI EM Index. The average value of ζ_α amounted to -263.0 bps, ranging from -125.3 bps to -484.5 bps.

The research carried out by Khan, Bacha and Masih (2015) covered, among others, 18 emerging markets ETFs listed on the NYSE. Among them there were mostly funds with single country and regional exposure, yet three ETFs mirroring broad EM indexes (the BNY Mellon Emerging Markets 50 ADR Index, the MSCI Emerging Markets Index and the FTSE Emerging Market Index) were also examined. On the basis of weekly data and with the use of three methods, tracking errors were estimated in the

period between January 2007 and December 2014, and in two subperiods (2007–2009 and 2010–2014). The average values of the TE for the entire sample were 0.48%, 0.47% and 1.10% (depending on the calculation method), while in the first subperiod they were higher (ranging from 0.99% to 1.50%) than in the second subperiod (ranging from 0.52% to 0.78%). They confirmed that EM ETFs exhibited higher TEs than DM ETFs and that TEs were higher during the crisis period. Furthermore, they indicated that one of the factors complicating the performance replication in emerging markets was the difference in time zones of the underlying markets, owing to the geographical location in which those ETFs were listed. Another factor that could impact the quality of replication were foreign exchange rates. Besides, it turned out that the lowest average TEs were obtained (in all three examined periods) when the tracking error was estimated by measuring the absolute value of the difference between the ETF and benchmark returns. Slightly higher TE values were achieved when using the standard error of regression and the highest in the case of using the average difference in ETFs and the underlying index returns.

3 Benchmark index and research sample

3.1 MSCI Emerging Markets Index

The MSCI Emerging Markets Index was launched in 1988 by the index provider MSCI Barra as the first comprehensive and consistent investable benchmark index for countries classified as emerging markets.[2] It was designed to represent the performance of countries with favorable demographics, education and employment patterns (MSCI 2016). At the moment of its inception, it was one of the first such indexes in the world.[3] Its portfolio then consisted of stocks from 8 countries, but over the next 30 years the index has evolved along with a progressive inclusion of successive markets, opening up their capital markets to international investors[4] (MSCI Barra 2008). Even though the country composition of the index has evolved over time, it is still heavily concentrated on the top 10 country constituents, making up at least 80% of the overall index. Now the MSCI EM Index reflects the performance of almost 1140 large-cap and mid-cap companies from 24 countries.[5] The largest weights in the MSCI EM Index portfolio belong to companies from China (32.7%), South Korea (14.6%), Taiwan (11.6%) and India (8.6%). The index covers approximately 85% of the free-float adjusted market capitalization of each country and its market capitalization equaled USD 5,243.3 billion at the end of June 2018 (MSCI 2018a). The total weight of its constituents in the MSCI All Country World Index (ACWI)[6] amounts to about 11.6% (30 years ago it was less than 1%) (Johnson 2017).

---

[2] Its base date is 31 December 1987.

[3] The first emerging markets index – the IFC (International Finance Corporation) EM Index – was launched in 1987 (in 2000 it was acquired by S&P). A few years later, in 1992, Barings launched the BEMI EM Index (in 2001, it was acquired by FTSE).

[4] During this period some countries were also removed from the MSCI EM Index, some were promoted to developed markets and others were downgraded to frontier market status.

[5] Emerging market countries now include: Brazil, Chile, China, Colombia, the Czech Republic, Egypt, Greece, Hungary, India, Indonesia, Korea, Malaysia, Mexico, Pakistan, Peru, Philippines, Poland, Russia, Qatar, South Africa, Taiwan, Thailand, Turkey and the United Arab Emirates.

[6] The MSCI ACWI captures large and mid-cap representation across 23 developed market and 24 emerging market countries. It has nearly 2,500 constituents and covers approx. 85% of the global investable equity opportunity set.

Among constituents, the most important role in the index is played by companies representing the information technology sector: Tencent Holdings (5.46%), Alibaba Group (4.09%), Samsung Electronics (3.84%) and Taiwan Semiconductor (3.34%). IT, together with financials, dominates the sectoral distribution of the index constituting just over 50% of its capitalization (their weights amount to, respectively, 27.9% and 22.8%). Other important sectors in MSCI EM Index are: consumer discretionary (9.8%), materials (7.6%), energy (7.2%) and consumer staples (6.7%) (MSCI 2018a).

It is calculated in different variants: depending on the way in which company income is taken into account and how the company dividend is taxed (price, gross return, net return), as well as in relation to the currency (USD, EUR, CAD and other ones). The index is reviewed quarterly (in February, May, August and November), with the objective to reflect a change in the underlying equity markets in a timely manner, while limiting undue index turnover. During comprehensive, semi-annual index reviews – carried out in May and November – the index is rebalanced and large and mid-capitalization cut off points are recalculated (MSCI 2018a).

On the basis of the MSCI Emerging Market Index, many subindexes or derived indexes have been created. These are, for example:

– indexes including shares of companies from a specific region (e.g. the MSCI EM Europe Index), country (e.g. the MSCI Brazil Index), sector (e.g. the MSCI EM Financials Index), capitalization (the MSCI EM Small-Cap Index) or indexes with a specific number of constituents (e.g. the MSCI EM 50 Index);

– indexes excluding from their portfolio shares from selected region (the MSCI EM ex-Asia Index), group of countries (e.g. the MSCI EM Beyond BRIC Index) or country (e.g. the MSCI EM ex China Index);

– style indexes (e.g. the MSCI EM Growth Index);

– dividend indexes (e.g. the MSCI EM High Dividend Yield Index);

– socially responsible indexes (e.g. the MSCI EM ex-Controversial Weapons Index);

– thematic indexes (e.g. the MSCI Emerging + Frontier Markets Workforce Index);

– factor and multifactor indexes (e.g. the MSCI EM Diversified Multiple-Factor Index);

– indexes with alternative method of weighing (e.g. the MSCI EM Equal Weighted Index);

– currency hedged indexes (e.g. the MSCI EM US Dollar Hedged Index);

– leveraged indexes (e.g. the MSCI EM Leveraged 2x Daily Net Index);

– short leveraged indexes (e.g. the MSCI EM Index (-200%)).

The MSCI Emerging Markets Index is the most popular equity benchmark for emerging market countries and one of the most widespread regional equity indexes in the world. As of 31 December 2017, total assets under management (AUM) benchmarked globally to the MSCI Emerging Markets Index suite amounted to over USD 1.9 trillion (MSCI 2018b). Besides, financial institutions – mainly investment banks, asset managers and stock exchanges – use this index to create diverse financial instruments, including futures contracts, options, structured products, exchange-traded notes (ETNs) and ETFs.[7] Many of them are listed on stock exchanges and MTFs all over the world (primarily in the United States). The MSCI Emerging Markets Index, as well as its different versions, is also a benchmark for a lot of actively managed investment funds with exposure to the equity emerging markets.

---

[7] The world's largest exchange-traded fund replicating the MSCI Emerging Markets Index performance is the iShares MSCI Emerging Markets ETF (EEM), whose assets under management at the beginning of July 2018 amounted to about USD 31 billion.

The huge popularity of this flagship MSCI index results, among others, from its excellent performance, much better than the performance of developed market indices. Over the last three decades (1988–2017), the MSCI EM Index increased by 2,422% (in USD terms), which gives the annual compound rate of 11.4%. Meanwhile, developed markets delivered 8.0% annually over the same time horizon. Although the volatility of the MSCI EM Index was significantly higher (22.7% vs. 14.6% in developed markets), the implied Sharpe ratio for this emerging market index (with US Treasuries as a risk-free asset) was substantially higher than for the developed index (0.24 vs. 0.14) (Topa-Serry, Ghotgalkar 2018).

3.2 Research sample

Out of the 1,610 ETFs listed on European stock exchanges and multilateral trading facilities (MTFs) at the end of 2017 (ETFGI 2018b), fifteen aim to replicate the return of the MSCI Emerging Markets Index.[8] Concerning the fact that some of them have different reference currencies and treat dividend income from shares differently (some pay it to investors in the form of dividend, while others reinvest it), twenty share classes, in total, of ETFs tracking the MSCI EM Index are listed on European trading platforms.[9] They are listed – as the primary listing – on the Euronext Paris, the Deutsche Boerse (Xetra), the London Stock Exchange and the SIX Swiss Exchange; furthermore, most ETFs are cross-listed on other exchanges and MTFs such as the Borsa Italiana, the Boerse Stuttgart, the Euronext Amsterdam, the Bolsa de Madrid, the Stockholmsbörsen and the BATS Chi-X Europe.[10] Umbrella funds including these ETFs are registered in Ireland, Luxembourg, France, Germany and Spain. The providers of these funds are 10 asset managers, including 7 European (Amundi, Commerzbank, Deka Investment, HSBC, Lyxor, UBS and Deutsche Bank) and 3 American institutions (BlackRock, Invesco and State Street).

Out of 20 share classes, our research sample includes 14 of them,[11] divided into two panels. The first one (Panel A) includes share classes for which the base currency is USD (12 ETFs) and the second one (Panel B) includes 2 ETFs for which the base currency is EUR. ETFs with the base currency in USD were referenced to the MSCI Emerging Markets Net Total Return Index (USD), while funds with the base currency in EUR were referenced to the MSCI Emerging Markets Net Total Return Index (EUR). The choice was dictated by the intention to achieve the highest possible comparability of the analyzed data. The research sample comprises funds with both accumulating share classes (designated as A, C or Acc) and distributing share classes (marked as D or Dis). An overview of the sample is presented in Table 2 and the evolution of ETFs' NAVs and MSCI values scaled to 100 at the beginning of the sample period is provided in Figure 1 (Panel A) and Figure 2 (Panel B).

NAVs for all of the examined ETFs and the closing values of MSCI Emerging Markets indexes were collected from the Thomson Reuters EIKON Database. Tables with descriptive statistics of NAVs and quotes time series of the rates of return are shown in the appendix in Table 3 and Table 4, respectively.

---

[8] One ETF tries to mirror the return of the MSCI Emerging Markets Investable Market Index.

[9] Different share classes are in fact separate financial products, so they are analysed separately. They have sometimes different management fees and use different replication methods, among others, hence they may have a different tracking quality.

[10] One ETF is also listed outside Europe – on the stock exchange in Mexico (Bolsa Mexicana de Valores, BMV) (listing currency – MXN).

[11] Six funds excluded from the research sample are mostly ETFs that have been operating for less than six years (4 funds) – they were launched in 2014, 2016 or 2017. In two cases, there were no available data on the valuation of their units.

All funds in the sample have continuous data availability over the study period. Depending on time intervals, we have used 1565 observations (daily data), 313 observations (weekly data) and 72 observations (monthly data).

4 Research methods

The investment aim of most exchange-traded funds is to achieve the returns commensurate to those of the benchmark index. Although passively managed ETFs are designed to closely track the performance of the underlying index, in practice their returns usually differ from the returns of their benchmarks. The most widely used measures to determine the quality of index replication by passively managed funds are the tracking difference and the tracking error.

The tracking difference (TD) depicts the difference in the performance between the ETF and the underlying index. It is commonly calculated as a difference between the return of the fund and the return of its benchmark over a specific period of time. The TD tells us whether an ETF has underperformed or overperformed against the benchmark in a given period. Therefore, we have calculated the tracking difference using the formula below:

$$TD_{i,t} = R_{i,t} - R_{INDEX,t} \tag{1}$$

where:

$TD_{i,t}$ — tracking difference,
$R_{i,t}$ — fund i return in t period,
$R_{INDEX,t}$ — benchmark return in t period.

Following the literature, we have calculated logarithmic rates of return, using, respectively, the net asset values (NAVs) of ETFs and the closing values of the MSCI Emerging Markets index. The calculation of the fund return is given as:

$$R_{i,t} = \ln(P_{i,t}) - \ln(P_{i,t-1}) \tag{2}$$

where:

$R_{i,t}$ — fund i logarithmic return in t period,
$P_{i,t}$ — NAV price of fund i in period t,
$P_{i,t-1}$ — NAV price of fund i in period $t-1$,

Similarly, the equation to calculate index return is:

$$R_{INDEX,t} = \ln(P_{INDEX,t}) - \ln(P_{INDEX,t-1}) \tag{3}$$

where:

$R_{INDEX,t}$ — index logarithmic return in period t,
$P_{INDEX,t}$ — closing value of index in period t,
$P_{INDEX,t-1}$ — closing value of index in period $t-1$.

The tracking error (TE) provides information about the volatility of differential returns between the fund and the underlying index. Although it also measures the quality of index replication, it fails to measure the absolute difference in returns between a fund and its underlying index, as it only reflects the volatility of differential returns. The main factors that affect the tracking error are as follows: management fees, AUM (assets under management), cash drag, securities lending, earnings on dividends ('dividend effect'), foreign/domestic exchange-traded funds status, index composition changes and the volatility of the benchmark (Frino et al. 2004). Rebalancing costs are also crucial for ETFs which use physical replication. In this kind of situation, index's methodology requires a reweighting of its constituents or market events could force the ETF to rebalance. The TE could be also caused by the fund management making an error in the quantity of securities being bought or sold (Johnson et al. 2013).

The literature shows many different techniques of calculating the tracking error (Roll 1992; Pope, Yadav 1994). In this article, we have employed three of them, the ones most often used in practice, with the following formulas.

According to the first method, the TE is the standard deviation of the difference between the return of the fund and that of its benchmark index. The equation below presents the formula for the tracking error 1 (TE_1):

$$TE_1 = \sqrt{\frac{1}{N-1}\sum_{t=1}^{N}\left(TD_{i,t} - \overline{TD}\right)^2} \tag{4}$$

where:

TE_1 – tracking error calculated with the use of the first method,

$\overline{TD}$ – average tracking difference.

The second method estimates the tracking error by taking the absolute value of the difference between fund and benchmark returns. The equation below shows this estimation:

$$TE_2 = \frac{\sum_{t=1}^{N}\left|TD_{i,t}\right|}{N} \tag{5}$$

where:

TE_2 – tracking error calculated with the use of the second method.

The third method uses the residuals from the regression of ETF's return on the benchmark return. The TE_3 is derived from the equation below.

$$R_{i,t} = \alpha_i + \beta_i R_{INDEX,t} + \varepsilon_{i,t} \tag{6}$$

where:

α_i – alfa coefficient (excess return),

β_i – beta coefficient (systematic risk of the fund),

ε_i – regression residuals,

TE_3 – tracking error calculated with the third method.

The tracking error TE_3 is equal to the standard deviation of residuals $\varepsilon_{i,t}$.

5 Results and discussion

The general tracking ability of emerging market equity exchange-traded funds listed on European exchanges within the sample period was good. Detailed results of the study – separately for the tracking difference and the tracking error – are presented below and in Tables 5 and 6. All results are presented separately for ETFs with US dollar base currency (Panel A) and euro base currency (Panel B).

5.1. Tracking difference

Table 5 provides estimates for the tracking differences for emerging market equity ETFs in six annual periods over 2012–2017 and in the overall sample period for Panel A (base currency USD) and B (base currency euro) ETFs. For Panel A the absolute value of the tracking differences in annual periods are usually less than 4 p.p. In 80% of the examples, annual TDs are even below 2 p.p. All but one of TDs are negative, which means that ETFs perform worse than the underlying index regardless of the bearish or bullish market trend. Differences between ETFs returns and the MSCI Emerging Markets Total Return Net Index (USD) return for the overall sample period of 2012–2017 range from 2.73 p.p. to 15.59 p.p.

The highest values of TDs (above 10 p.p.) are observed for three ETFs – the HSBC MSCI Emerging Markets UCITS ETF, the iShares MSCI Emerging Markets UCITS ETF (Dist) and the UBS ETF (LU) MSCI Emerging Markets UCITS ETF (USD) A-dis. The three funds use the physical replication method and distribute dividends. The use of those two factors – physical replication and distributing dividends – seems to be underperforming in terms of quality replication.

Panel B Table 5 provides the same estimates for the tracking differences for ETFs with euro base currency in six annual periods over 2012–2017 and in the overall sample period. The absolute values of tracking differences in annual periods are usually lower than 1.1 p.p. In the vast majority of cases (91%), annual TDs are below 1 p.p. All of TDs are negative, which means that ETFs underperformed the underlying index. Differences between ETFs returns and the MSCI Emerging Markets Total Return Net Index (EUR) return for the overall sample period of 2012–2017 range from 3.22 p.p. to 4.40 p.p.

With respect to the previous study by Johnson et al. (2013) for 8 European ETFs that aim to mirror the MSCI Emerging Markets Index, the average annualised tracking difference was also negative (-0.95 p.p.), which means that they underperformed the benchmark index, and the average tracking difference for ETFs using physical replication was also higher than in funds using synthetic replication.

5.2 Tracking error

Tracking errors were calculated using three different calculation methods with three return intervals: daily, weekly and monthly. An average tracking error for the whole period (2012–2017) is provided in the last column of each table. The results are presented separately for ETFs with the US dollar (Panel A) and euro base currencies (Panel B) in Table 6. The results of each of the three methods are shown in three columns of the table, while the name of the ETF in question is provided in the first one. The results are as follows.

TEs calculated from the first and third method are very similar. It can therefore be concluded that it is not important whether one uses the standard deviation of the difference between the return of an ETF and that of its benchmark index or the standard error of regression residuals. The figures obtained with the use of the second method – the average of the absolute difference between the return of an ETF and that of the index – are usually much lower than those obtained from the first or third method. Usually the highest values of the TE were obtained for daily data and the lowest values for weekly ones. This could be explained by the fact that for daily data all information is included and the TE is more precise (Smith 1978). Generally, we can observe that ETFs with the synthetic replication method have lower average TEs than those with the physical replication method. The three highest average TEs in Panel A are observed for the iShares MSCI Emerging Markets UCITS ETF (Acc), the UBS ETF (LU) MSCI Emerging Markets UCITS ETF (USD) A-dis and the ComStage MSCI Emerging Markets UCITS ETF, with the first two using the physical replication method.

All the studied ETFs kept the TEs below 0.5% in 2012–2017 for all three calculation methods, which equals the internationally accepted level of 0.5% for passively managed funds (Banerjee 2015b). However, when we split the sample into ETFs with USD and euro base currencies, it turns out that the latter funds achieve better results – the TE is below 0.2%. The lowest level of TE is observed for the Lyxor MSCI Emerging Markets UCITS ETF C-USD and the highest for the iShares MSCI Emerging Markets UCITS ETF (Acc) for calculations made in USD. For euro calculations, the lowest level of the TE is observed for the Lyxor MSCI Emerging Markets UCITS ETF C-EUR and the highest for the Amundi ETF MSCI Emerging Markets UCITS ETF – EUR.

After summarizing the data from Table 6, we can claim that the EM equity ETFs under study are capable of tracking the underlying index quite efficiently by keeping the TEs below 0.5%. The calculated values are generally lower than those presented in earlier studies described in section 2. They are much lower, in particular, than those in the study conducted by Blitz and Huij (2012), wherein they varied from 3.4% to 6.1% for monthly returns intervals. Also, the TEs in the research carried out by Johnson et al. (2013), covering 8 European ETFs that aim to mirror the performance of the same MSCI Emerging Markets Index, were higher: the average daily tracking error was 0.77%, while the weekly error stood at 0.57%. Our research also confirmed the findings made by Johnson et al. (2013) showing that tracking errors calculated at longer intervals were lower for weekly data than for daily data and that ETFs using synthetic replication method had lower TEs.

Having examined the figures, we can conclude that EM equity ETFs do not replicate the MSCI Emerging Markets Index ideally, still we have to bear in mind that ETFs tracking emerging market equities tend to exhibit higher tracking error than those based on developed market indexes like the Euro Stoxx 50, the DAX or the S&P 500 (Johnson et al. 2013). It seems that ETFs with synthetic replication have better results and a lower average TE.

6 Conclusions

In this paper, we have examined the tracking difference and the tracking error for 14 emerging markets equity ETFs in the period of 2012–2017. The majority of the tracking differences in annual periods for ETFs with USD as the base currency were negative and below 2 p.p. and they ranged from 2.73 p.p. to 15.59 p.p. for the overall sample period. A better performance was observed for the ETFs with euro as

the base currency – tracking differences in annual periods were also negative but below 1 p.p. and for the overall sample period they ranged from 3.22 p.p. to 4.40 p.p. These figures show that the European MSCI EM ETFs perform worse in the longer term (6 years) than the underlying index.

The results indicate that emerging markets equity ETFs do not replicate their corresponding indexes perfectly, yet they have done a good job of reducing the tracking error in most cases. All ETFs from Panel A kept the TE below 0.5% in the period of 2012–2017, taking into account three different calculation methods. The results obtained for ETFs from Panel B are much lower – below 0.12%. It did not matter whether we used the standard deviation or the standard error of the regression technique – the results were almost the same. We found that EM ETFs exhibited higher levels of the tracking error than developed markets ETFs, which we relate to the cross-sectional dispersion in stock returns being structurally larger in the emerging markets (Blitz, Huij 2012). In general, we can assume that the analysed ETFs with synthetic replication achieve better results and a lower average TE.

To conclude, the results of the research showed that, in the first place, the TE values obtained using the standard deviation of the difference between the return of the fund and that of its benchmark index and the method based on the standard error of regression, were very similar. Secondly, the study confirmed that the lowest TE values occurred when using weekly intervals and the highest usually at daily intervals. Thirdly, MSCI Emerging Markets ETFs displayed higher levels of the tracking error than developed markets ETFs and they did not perform as well as their benchmark.

The limitations of this study consist in that it covers a relatively short time period (excluding the financial crisis) and a small number of funds. Yet, this is not unusual as there are a lot of similar studies conducted on a few ETFs only. Further research is required in terms of extending the sample to the funds tracking the performance of other emerging market indexes and funds listed on non-European exchanges. Furthermore, factors affecting the tracking error of ETFs replicating the return of the MSCI Emerging Markets Index – such as the replication method, assets under management (AUM), the total expense ratio (TER), volume, volatility and fund's age – should be carefully examined.

Overall, our results have implications both for investors and ETF providers. Investors should be concerned with relatively high tracking errors and tracking differences of some ETFs as these can lead to worse performance of emerging market ETFs, compared to the ETFs with exposure to developed economies. The research presented in this paper should help them better understand the ETF they invest in if they chose to use ETFs as an additional tool to diversify their investment portfolio. On the other hand, the results of the study may prove useful for the providers of analysed ETFs in assessing their managers. They can also be an indication for asset managers who intend to launch such funds in the future.

References

Banerjee S. (2015a), Effectiveness of ETFs in indexing: the mean for equity investments by employees' provident funds in India, *American Journal of Business. Economics and Management*, 3(5), 300–304.

Banerjee S. (2015b), Measurement of tracking error based on category index – the hidden cost of index funds, *American Journal of Theoretical and Applied Business*, 1(1), 37–40.

Bekaert G., Harvey C. (1995), Time varying world market integration, *The Journal of Finance*, 50(2), 403–444.

Bernstein P.J. (2002), A primer on exchange-traded funds, *Journal of Accountancy*, 193(1), 38–41.

Black Rock (2011), ETF landscape, *Emerging Market ETFs Industry Review*, May, Global ETF Research and Implementation Strategy Team.

Blitz D., Huij J. (2012), Evaluating the performance of global emerging markets equity exchange-traded funds, *Emerging Markets Review*, 13(2), 149–158.

Elton E.J., Gruber M.J., Comer G., Li K. (2002), Spiders: Where are the bugs?, *Journal of Business*, 75(3), 453–472.

ETFGI (2018a), *ETFGI reports assets invested in ETFs and ETPs listed globally reached a new high of $5.12 trillion at the end of July 2018*, https://etfgi.com/news/press-releases/2018/08/etfgi-reports-assets-invested-etfs-and-etps-listed-globally-reached-new.

ETFGI (2018b), *Europe ETF and ETP industry insights – December 2010*, https://etfgi.com/research/report/17917/europe-etf-and-etp-industry-insights-december-2017.

Fuhr D. (2003), *ETFs for Emerging Markets Exposure*, Morgan Stanley Equity Research Europe.

Gallagher D.R., Segara R. (2006), The performance and trading characteristics of exchange-traded funds, *Journal of Investment Strategy*, 1(2), 49–60.

Hassine M., Roncalli T. (2013), Measuring performance of exchange traded funds, *Journal of Index Investing*, 4(3), 57–85.

Johnson W.F. (2008), Tracking errors of exchange traded funds, *Journal of Asset Management*, 10(4), 253–262.

Johnson B., Bioy H., Kellett A., Davidson L. (2013), *On the right track: measuring tracking efficiency in ETFs*, February, Morningstar.

Johnson B. (2017), *The evolution of emerging markets (part 1)*, http://my.morningstar.com/ap/news/ETF-Education/163357/The-Evolution-of-Emerging-Markets-(Part-1).aspx.

Kayali M., Unal S. (2009), Tracking accuracy of large and small-CAP ETFS: an empirical analysis of the Istanbul Stock Exchange, *South East European Journal of Economics and Business*, 4(1), 107–112.

Khan A.P., Bacha O.I., Masih A.M. (2015), Performance and trading characteristics of exchange traded funds: developed vs emerging markets, *Capital Markets Review*, 23(1&2), 40–64.

Kuok-Kun Chu P. (2011), Study on the tracking errors and their determinants: evidence from Hong Kong exchange traded funds, *Applied Financial Economics*, 21(5), 309–315.

Lin A., Chou A. (2006), The tracking error and premium/discount of Taiwan's First Exchange Traded Fund, *Web Journal of Chinese Management Review*, 9(3), 1–20.

Meziani A.S. (2016), *Exchange-Traded Funds. Investment Practices and Tactical Approaches*, Palgrave Macmillan.

Milonas N.T., Rompotis G.G. (2006), *Investigating European ETFs: the case of the Swiss exchange traded funds*, The Annual Conference of HFAA, Thessaloniki.

MSCI (2016), *Global indexes. Delivering the modern index strategy*, https://www.msci.com/documents/1296102/1362201/GlobalIndexes-cbr-en.pdf/ed3a08b3-84bb-4e71-8d2e-8b267213cb44.

MSCI (2018a), *MSCI Emerging Markets Index (USD) factsheet*, https://www.msci.com/documents/10199/c0db0a48-01f2-4ba9-ad01-226fd5678111.

MSCI (2018b), *Emerging markets. Looking to expand your investment horizon?*, https://www.msci.com/documents/1296102/1362201/MSCI-MIS-EM-May-2018.pdf/b1b05adf-4bf3-9acc-404c-9865da3e9997.

MSCI Barra (2008), *Emerging markets: a 20-year perspective*, https://www.msci.com/documents/10199/dbc19f82-595d-4a2c-bd2d-22b593d611e5.

Pandya F., Desai D. (2016), Evaluating index fund performance and measuring tracking error in India, *Pacific Business Review International*, 1(1), 204–218.

Pope P., Yadav P. (1994), Discovering errors in tracking error, *The Journal of Portfolio Management*, 20(2), 27–32.

Poterba J.M., Shoven J.B. (2002), *Exchange traded funds: a new investment option for taxable investors*, NBER Working Paper, 8781, National Bureau of Economic Research.

Roll R. (1992), A mean/variance analysis of tracking error, *The Journal of Portfolio Management*, 18(4), 13–22.

Rompotis G.G. (2008), Performance and trading characteristics of German passively managed ETFs, *International Research Journal of Finance & Economics*, 15, May, 210–223.

Shin S., Soydemir G. (2010), Exchange-traded funds, persistence in tracking errors and information dissemination, *Journal of Multinational Financial Management*, 20(4–5), 214–234.

Singh J., Kaur P. (2016), Tracking efficiency of Exchange Traded Funds (ETFs): empirical evidence from Indian equity ETFs, *Paradigm*, 20(2), 176–190.

Smith K. (1978), The effect of intervaling on estimating parameters of the capital asset pricing model, *Journal of Financial & Quantitative Analysis,* 13(2), 313–332.

Strydom B., Charteris A., McCullough K. (2015), The relative tracking ability of South African exchange traded funds and index funds, *Investment Analysts Journal*, 44(2), 117–133.

Topa-Serry I., Ghotgalkar V. (2018), *You're fully developed when you hit thirty*, Research and Investment Insights, AXA Investment Managers, https://www.axa-im.com/documents/20195/859236/You%27re+fully+developed+when+you+hit+thirty+20180207+fr/6e470154-e1b4-41c6-c81a-540a8b70eb5f.

Yiannaki S.M. (2015), ETFs performance Europe – a good start or not?, *Procedia Economics and Finance,* 30, 955–966.

Acknowledgements

Appendix

Table 1
Description of selected studies concerning the tracking performance of exchange-traded funds replicating single-country EM indexes

Authors	Number of examined ETFs (including equity ETFs with EM exposure)	EM countries' exposure	Research period	Values of the tracking difference (TD) and the tracking error
Lin, Chou (2006)	1	Taiwan	2003–2005	9.63E-05 p.p. (mean TD for TTT ETF) (for daily data)
Kayali, Unal (2009)	2	Turkey	2006–2007	6.96 p.p. (TD for DJIST ETF for whole research period); -1.28 p.p. (TD for SMIST ETF for whole research period)
Shin, Soydemir (2010)	26 (5)	Brazil, Mexico, Taiwan, South Korea, Malaysia	2004–2007	0.63% (average TE (calculated using three different methods) for EWZ ETF); 0.12% (average TE for EWW ETF); 0.08% (average TE for EWT ETF); 0.15% (average TE for EWM ETF); 0.09% (average TE for EWY ETF) (all values for the whole research period)
Kuok-Kun Chu (2011)	18 (11)	China, India, Taiwan, South Korea, Russia	2004–2008	TEs ranged from 0.65% to 2.17% (calculated using the first method), from 1.02% do 3.52% (calculated using the second method) and from 0.99% to 3.09% (calculated using the third method) (all values for the whole research period)
Khan, Bacha, Masih (2015)	43 (18)	Brazil, China, Malaysia, Mexico, South Africa, China, Russia, Chile	2007–2014	TEs (calculated using three different methods) ranged between 0.30% and 2.44%; average 1.00% (all values for the whole research period)
Banerjee (2015a)	7	India	2012–2015	annualized TD ranged from -6.23% to 1.56% (for a one-year period) and from -0.82% to 1.42% (for a three years' period); annualized TE (daily) from 0.02% to 0.37%
Strydom et al. (2015)	3	South Africa	2001–2012	TEs ranged between 0.81% and 1.44%
Singh, Kaur (2016)	12	India	2011–2015	TEs ranged between 0.22% and 1.95% (calculated using the first method), from 0.31% to 2.92% (calculated using the second method) and from 0.30% to 2.74% (calculated using the third method) (all values for the whole research period)
Pandya, Desai (2016)	40 (24)	India	2013–2014	TEs ranged between 0.24% and 4.93%

Source: own elaboration.

Table 2
Description of ETFs under study

Full name of the fund (EIKON ticker)	Short name of the fund	Management company (domicile of the fund)	Type of share class – Accumulation (A)/ Distribution (D)	Share class inception date	Index replication method	Primary exchange (trading currencies)	Other exchanges and MTFs	Ongoing charges p.a.	Assets under management (AUM)
Panel A – funds with share classes with USD as the base currency									
Amundi ETF MSCI Emerging Markets UCITS ETF – USD (AUEM.PA)	Amundi ETF (1)	Amundi (France)	A or D	21.12.2010	synthetic (unfunded swap)	Euronext Paris (USD)	London Stock Exchange, SIX Swiss Exchange	0.20%	USD 6,755.66 million
ComStage MSCI Emerging Markets UCITS ETF (CBMINEM.DE)	ComStage ETF	Commerzbank (Luxembourg)	D	28.09.2011	synthetic (unfunded swap)	Deutsche Boerse (Xetra) (EUR)	Boerse Frankfurt, Boerse Stuttgart, Borsa Italiana	0.25%	USD 330 million
Deka MSCI Emerging Markets UCITS ETF (ETFEMMA.DE)	Deka ETF	Deka Investment (Germany)	A	1.07.2010	synthetic (unfunded swap)	Deutsche Boerse (Xetra) (EUR)	Boerse Stuttgart	0.65%	USD 32.77 million
HSBC MSCI Emerging Markets UCITS ETF (HMEM.L)	HSBC ETF	HSBC (Ireland)	D	5.09.2011	physical (optimised sampling)	London Stock Exchange (GBP, USD)	SIX Swiss Exchange, Borsa Italiana	0.40%	USD 424.12 million
Invesco MSCI Emerging Markets UCITS ETF Acc(MXFS.L)	Invesco ETF	Invesco (Ireland)	A	26.04.2010	synthetic (unfunded swap)	London Stock Exchange (USD, GBP)	Deutsche Boerse (Xetra), Borsa Italiana, SIX Swiss Exchange	0.29%	USD 723.09 million

Table 2, cont'd

Full name of the fund (EIKON ticker)	Short name of the fund	Management company (domicile of the fund)	Type of share class – Accumulation (A)/ Distribution (D)	Share class inception date	Index replication method	Primary exchange (trading currencies)	Other exchanges and MTFs	Ongoing charges p.a.	Assets under management (AUM)
iShares MSCI Emerging Markets UCITS ETF (Dist) (IDEM.L)	iShares ETF (1)	BlackRock (Ireland)	D	18.11.2005	physical (optimised sampling)	London Stock Exchange (USD, GBP)	Deutsche Boerse (Xetra), Borsa Italiana, SIX Swiss Exchange, Euronext Amsterdam, BATS Chi-X Europe	0.75%	USD 6,294.16 million
iShares MSCI Emerging Markets UCITS ETF (Acc) (IEAM.L)	iShares ETF (2)	BlackRock (Ireland)	A	25.09.2009	physical (optimised sampling)	London Stock Exchange (USD, GBP)	Deutsche Boerse (Xetra), Borsa Italiana, SIX Swiss Exchange, Euronext Amsterdam, Borsa Mexicana de Valores	0.68%	USD 1,102.36 million
Lyxor MSCI Emerging Markets UCITS ETF C-USD (LYLEM.S)	Lyxor ETF (1)	Lyxor (France)	A	24.04.2007	synthetic (unfunded swap)	SIX Swiss Exchange (USD)	London Stock Exchange, BATS Chi-X Europe	0.55%	USD 267.37 million
SPDR MSCI Emerging Markets UCITS ETF (EMRD.L)	SPDR ETF	State Street (Ireland)	A	13.05.2011	physical (optimised sampling)	Deutsche Boerse (Xetra) (EUR)	London Stock Exchange, Euronext Paris, Borsa Italiana, SIX Swiss Exchange	0.42%	USD 323.22 million

Table 2, cont'd

Full name of the fund (EIKON ticker)	Short name of the fund	Management company (domicile of the fund)	Type of share class – Accumulation (A)/Distribution (D)	Share class inception date	Index replication method	Primary exchange (trading currencies)	Other exchanges and MTFs	Ongoing charges p.a.	Assets under management (AUM)
UBS ETF (LU) MSCI Emerging Markets UCITS ETF (USD) A-dis (EMMUSA.S)	UBS ETF (1)	UBS (Luxembourg)	D	12.11.2010	physical (stratified sampling)	SIX Swiss Exchange (USD, CHF)	London Stock Exchange, Deutsche Boerse (Xetra), Borsa Italiana, Euronext Amsterdam	0.45%	USD 1,290.86 million
UBS ETF (IE) MSCI Emerging Markets SF UCITS ETF (USD) A-acc (EGUSAS.S)	UBS ETF (2)	UBS (Luxembourg)	A	27.04.2011	synthetic	SIX Swiss Exchange (USD)	Borsa Italiana	0.32%	USD 3,496.73 million
Xtrackers MSCI Emerging Markets Swap UCITS ETF 1C (XMMD.L)	Xtrackers ETF	Deutsche Bank (Luxembourg)	A	22.06.2007	synthetic (unfunded swap)	Deutsche Boerse (Xetra) (EUR)	London Stock Exchange, Boerse Stuttgart, Stockholmsbörsen, SIX Swiss Exchange, Borsa Italiana	0.49%	USD 2,289.66 million

Table 2, cont'd

Full name of the fund (EIKON ticker)	Short name of the fund	Management company (domicile of the fund)	Type of share class – Accumulation (A)/ Distribution (D)	Share class inception date	Index replication method	Primary exchange (trading currencies)	Other exchanges and MTFs	Ongoing charges p.a.	Assets under management (AUM)
Panel B – funds with share classes with EUR as the base currency									
Amundi ETF MSCI Emerging Markets UCITS ETF – EUR (AEEM.PA)	Amundi ETF (2)	Amundi (France)	A	30.11.2010	synthetic (unfunded swap)	Euronext Paris (EUR)	Deutsche Boerse (Xetra), Borsa Italiana	0.20%	EUR 5,539.01 million
Lyxor MSCI Emerging Markets UCITS ETF C-EUR (LYXLEM.PA)	Lyxor ETF (2)	Lyxor (France)	A	18.04.2007	synthetic (unfunded swap)	Euronext Paris (EUR)	Deutsche Boerse (Xetra), Borsa Italiana, Bolsa de Madrid	0.55%	EUR 1,608.57 million

Notes: The table reports the sample of European exchange-traded funds replicating the MSCI Emerging Markets Index examined in this study. All information as at the end of February 2018, except the AUM of the Invesco MSCI Emerging Markets UCITS ETF Acc and the SPDR MSCI Emerging Markets – as at the end of May 2018. The total cost of the Invesco MSCI Emerging Markets UCITS ETF is 0.54% and includes the swap fee. Prior to 25 May 2018, the Invesco MSCI Emerging Markets UCITS ETF Acc was the Source MSCI Emerging Markets UCITS ETF.

Source: own elaboration based on information from funds' prospectuses, monthly factsheets and Key Investor Information Documents (KIIDs).

Table 3
Descriptive statistics of NAV's rates of the return in 2012–2017 (daily data)

Full name of the fund (EIKON ticker)	Mean	Median	Standard deviation	Kurtosis	Skewness	Range	Minimum	Maximum
Panel A – funds with share classes with USD as the base currency								
Amundi ETF MSCI Emerging Markets UCITS ETF – USD (AUEM.PA)	0.02	0.00	0.87	2.09	-0.25	8.45	-5.11	3.34
ComStage MSCI Emerging Markets UCITS ETF (CBMINEM.DE)	0.02	0.00	0.88	2.65	-0.09	8.94	-5.11	3.83
Deka MSCI Emerging Markets UCITS ETF (ETFEMMA.DE)	0.02	0.02	0.89	2.33	-0.23	9.03	-5.30	3.73
HSBC MSCI Emerging Markets UCITS ETF (HMEM.L)	0.02	0.01	0.88	2.10	-0.28	8.34	-5.02	3.32
Invesco MSCI Emerging Markets UCITS ETF Acc (MXFS.L)	0.02	0.05	0.87	2.14	-0.25	8.44	-5.11	3.33
iShares MSCI Emerging Markets UCITS ETF (Dist) (IDEM.L)	0.01	0.00	0.88	2.27	-0.34	8.48	-5.09	3.39
iShares MSCI Emerging Markets UCITS ETF (Acc) (IEAM.L)	0.02	0.01	0.88	2.32	-0.32	8.50	-5.09	3.41
Lyxor MSCI Emerging Markets UCITS ETF C-USD (LYLEM.S)	0.02	0.06	0.87	2.14	-0.25	8.46	-5.12	3.33

Table 3, cont'd

Full name of the fund (EIKON ticker)	Mean	Median	Standard deviation	Kurtosis	Skewness	Range	Minimum	Maximum
SPDR MSCI Emerging Markets UCITS ETF (EMRD.L)	0.02	0.04	0.87	2.06	-0.24	8.52	-4.94	3.57
UBS ETF (LU) MSCI Emerging Markets UCITS ETF (USD) A-dis (EMMUSA.S)	0.01	0.03	0.86	1.98	-0.25	8.33	-5.06	3.28
UBS ETF (IE) MSCI Emerging Markets SF UCITS ETF (USD) A-acc (EGUSAS.S)	0.02	0.02	0.87	2.39	-0.19	9.52	-5.11	4.41
Xtrackers MSCI Emerging Markets Swap UCITS ETF 1C (XIMMD.L)	0.02	0.02	0.87	2.03	-0.22	8.45	-5.12	3.33
Panel B – funds with share classes with EUR as the base currency								
Amundi ETF MSCI Emerging Markets UCITS ETF – EUR (AEEM.PA)	0.03	0.00	0.95	3.69	-0.36	12.29	-7.40	4.90
Lyxor MSCI Emerging Markets UCITS ETF C-EUR (LYXLEM.PA)	0.03	0.02	0.95	3.79	-0.35	12.32	-7.41	4.91

Table 4
Descriptive statistics of quote's rate of the return in 2012–2017 (daily data)

Full name of the fund (EIKON ticker)	Mean	Median	Standard deviation	Kurtosis	Skewness	Range	Minimum	Maximum
Panel A – funds with share classes with USD as the base currency								
Amundi ETF MSCI Emerging Markets UCITS ETF – USD (AUEM.PA)	0.02	0.03	1.12	2.32	-0.06	12.06	-5.98	6.07
ComStage MSCI Emerging Markets UCITS ETF (CBMINEM.DE)	0.03	0.06	1.14	9.50	-0.08	15.14	-7.93	7.22
Deka MSCI Emerging Markets UCITS ETF (ETFEMMA.DE)	0.02	0.03	1.15	3.46	-0.08	15.27	-7.97	7.30
HSBC MSCI Emerging Markets UCITS ETF (HMEM.L)	0.01	0.04	1.10	2.39	-0.13	12.10	-6.20	5.89
Invesco MSCI Emerging Markets UCITS ETF Acc (MXFS.L)	0.02	0.04	1.11	2.55	-0.14	12.45	-6.46	5.99
iShares MSCI Emerging Markets UCITS ETF (Dist) (IDEM.L)	0.01	0.02	1.11	2.26	-0.15	12.08	-6.25	5.83
iShares MSCI Emerging Markets UCITS ETF (Acc) (IEAM.L)	0.02	0.03	1.12	2.94	-0.04	12.55	-6.20	6.35
Lyxor MSCI Emerging Markets UCITS ETF C-USD (LYLEM.S)	0.02	0.00	1.07	2.75	-0.26	12.04	-6.05	5.99
SPDR MSCI Emerging Markets UCITS ETF (EMRD.L)	0.02	0.04	1.09	2.03	-0.12	11.0	-5.87	5.22

Table 4, cont'd

Full name of the fund (EIKON ticker)	Mean	Median	Standard deviation	Kurtosis	Skewness	Range	Minimum	Maximum
UBS ETF (LU) MSCI Emerging Markets UCITS ETF (USD) A-dis (EMMUSA.S)	0.01	0.05	8.76	630.29	0.03	461.23	-230.42	230.81
UBS ETF (IE) MSCI Emerging Markets SF UCITS ETF (USD) A-acc (EGUSAS.S)	0.02	0.03	1.13	2.47	-0.18	12.51	-6.53	5.98
Xtrackers MSCI Emerging Markets Swap UCITS ETF 1C (XMMD.L)	0.02	0.03	1.12	2.52	-0.10	12.45	-6.34	6.12
Panel B – funds with share classes with EUR as the base currency								
Amundi ETF MSCI Emerging Markets UCITS ETF – EUR (AEEM.PA)	0.03	0.03	1.15	3.33	-0.08	14.83	-7.93	6.90
Lyxor MSCI Emerging Markets UCITS ETF C-EUR (LYXLEM.PA)	0.03	0.03	1.15	3.23	-0.08	15.03	-7.93	7.09

Table 5

The tracking difference – ETFs with USD/EUR as the base currency (p.p.)

Fund	2012	2013	2014	2015	2016	2017	2012–2017
Panel A							
Amundi ETF (1)	-0.96	-0.76	-0.45	-0.39	-0.25	-0.32	-3.19
ComStage ETF	-0.39	-0.54	-0.49	0.00	0.03	-0.90	-2.73
Deka ETF	-0.67	-1.12	-1.54	-1.66	-0.85	-0.84	-6.89
HSBC ETF	-1.68	-2.64	-3.26	-2.74	-1.87	-1.96	-14.17
iShares ETF (1)	-2.67	-3.16	-2.69	-2.81	-1.96	-2.13	-15.43
iShares ETF (2)	-0.81	-1.49	-0.82	-0.65	-0.22	-0.55	-4.55
Lyxor ETF (1)	-0.74	-0.77	-0.83	-0.75	-0.59	-0.66	-4.40
Invesco ETF	-0.64	-1.00	-1.06	-0.87	-0.75	-0.58	-4.92
SPDR ETF	-0.81	-0.65	-0.62	-0.95	0.39	-0.48	-3.14
UBS ETF (1)	-2.40	-2.48	-2.26	-2.91	-3.18	-2.22	-15.59
UBS ETF (2)	-1.03	-1.04	-0.94	-0.90	-0.82	-0.69	-5.44
Xtrackers ETF	-0.97	-0.96	-0.87	-0.83	-0.79	-0.87	-5.31
Panel B							
Amundi ETF (2)*	-1.07	-0.52	-0.60	-0.39	-0.25	-0.32	-3.22
Lyxor ETF (2)*	-0.74	-0.77	-0.83	-0.75	-0.59	-0.66	-4.40

* ETFs with EUR as the base currency.

Source: own calculations.

Table 6

The tracking error calculated using three different methods for 2012–2017 – ETFs with USD/EUR as the base currency (%)

Fund	1. method			2. method			3. method			Average
	daily	weekly	monthly	daily	weekly	monthly	daily	weekly	monthly	
Panel A										
Amundi ETF (1)	0.10	0.09	0.08	0.05	0.05	0.06	0.10	0.09	0.08	0.08
ComStage ETF	0.30	0.31	0.17	0.10	0.11	0.09	0.30	0.31	0.17	0.21
Deka ETF	0.19	0.20	0.25	0.13	0.16	0.21	0.19	0.20	0.25	0.20
HSBC ETF	0.16	0.19	0.31	0.06	0.10	0.26	0.16	0.19	0.31	0.19
iShares ETF (1)	0.21	0.19	0.32	0.07	0.09	0.25	0.21	0.19	0.31	0.20
iShares ETF (2)	0.39	0.43	0.35	0.12	0.13	0.15	0.38	0.43	0.34	0.30
Lyxor ETF (1)	0.03	0.03	0.01	0.01	0.02	0.06	0.03	0.02	0.01	0.02
Invesco ETF	0.06	0.04	0.04	0.01	0.02	0.08	0.06	0.04	0.04	0.04
SPDR ETF	0.16	0.16	0.24	0.09	0.11	0.18	0.16	0.16	0.24	0.17
UBS ETF (1)	0.15	0.23	0.43	0.05	0.09	0.23	0.15	0.23	0.43	0.22
UBS ETF (2)	0.19	0.05	0.05	0.04	0.03	0.08	0.19	0.04	0.05	0.08
Xtrackers ETF	0.11	0.08	0.06	0.02	0.03	0.08	0.11	0.08	0.06	0.07
Panel B										
Amundi ETF (2)*	0.11	0.11	0.10	0.06	0.07	0.07	0.11	0.11	0.10	0.10
Lyxor ETF (2)*	0.03	0.03	0.01	0.01	0.02	0.06	0.03	0.03	0.01	0.02

* ETFs with EUR as the base currency.

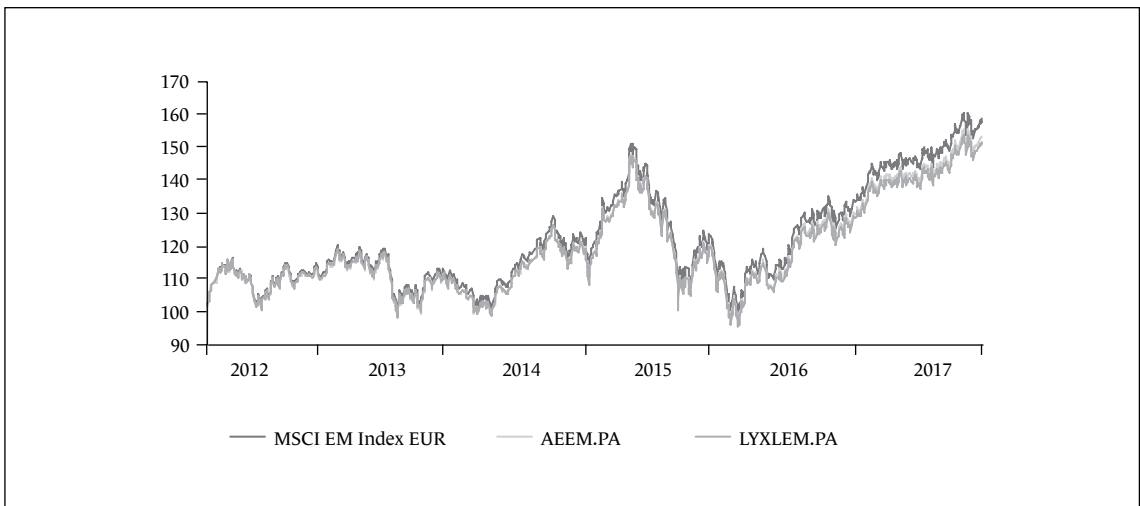Source: own calculations.

Figure 1

Evolution of ETFs (Panel A) NAVs and MSCI Emerging Markets Index (USD) values scaled to 100
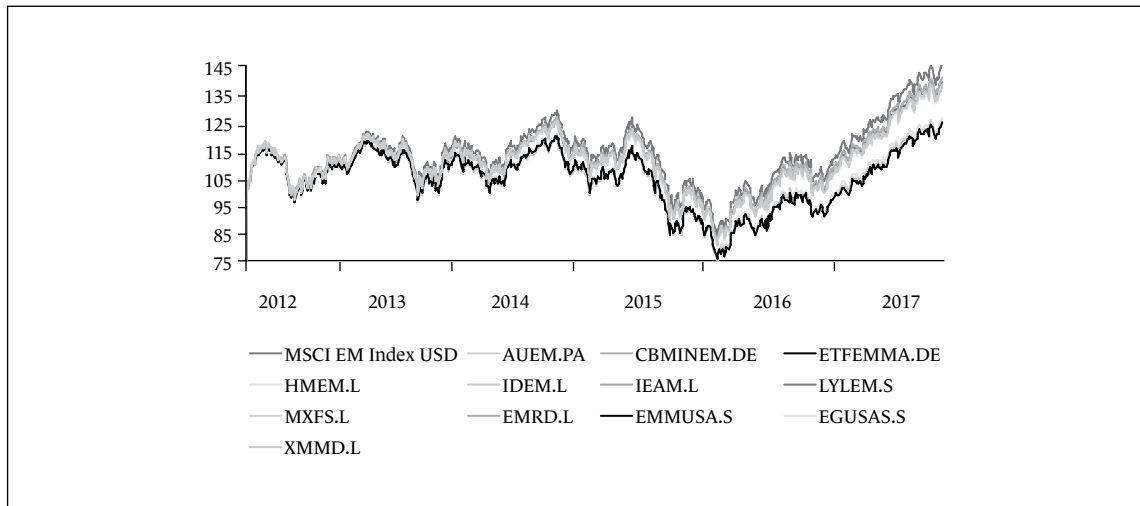
Source: own calculations.

Figure 2

Evolution of ETFs NAVs (Panel B) and MSCI Emerging Markets Index (EUR) values scaled to 100

Source: own calculations.