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# **ETFs tracking errors on global markets with consideration of regional diversity**

**Peter Dobson**

**Abstract:** This study evaluates the performance of Exchange Traded Funds (ETFs) by using various tracking error calculation approaches. The aim of the paper is on the one hand the evaluation of the relative performance of ETFs to their benchmarking indexes and on the other the endeavour to specify any relationship between this performance and both geographical location and the degree of market development. The research was conducted on the basis of 18 different ETFs issued by iShares, six for each of the three regions: both Americas, Asia and Europe. The results indicate that ETFs do not mimic their corresponding indexes well. Calculated tracking errors are different from zero and often significantly negative. Furthermore the value of tracking errors depends on the region and market development.

**Key words:** ETF, tracking error, passive fund, emerging market, developed market.

**JEL:** G15 - International financial markets

## **1. Introduction**

The dynamic development of ETFs in recent years confirms the position of researchers who consider this type of fund the largest and most successful financial innovation in the field of investment (Deville, 2008; Antoniewicz i Heinrichs, 2014; Amenc i in., 2017). Although ETFs are regarded as relatively young financial product there appear more and more elaborations concerning their functioning in the world-wide literature. Previous studies refer to one of three thematic categories (Charupat i Miu, 2013). In the first the performance of ETFs is analysed, which is understood as the degree of achievement of investment objective by the fund. In case of ETFs which are passive funds, it consists in most accurate mimic the return rate of index on which the fund operates. The second group of studies refers to the effectiveness of ETF fund valuations, which consists in determining the differences between the market valuation of ETFs shares and their NAV value. The consequence of this approach is to determine the factors affecting these differences and the pace at which arbitration between the various levels of ETF share price and fund value of assets disappears (Bas i Sarioglu, 2015). Finally, in the third - the subject of interest of researchers remains the relationship between ETF participation titles placed on the market and financial instruments (shares, futures contracts, etc.) that are included in the index, which is the basis for the functioning of a given fund. Available studies focus in particular on attempts to determine the

impact of ETFs on trading volume and the exchange rate margin of related financial instruments (Quadan i Yagil, 2012).

This article is devoted to the first of the areas listed above. The subject of the research focuses on calculation of tracking errors for 18 ETFs operating on the basis of global stock exchange indices, half of which appear in developed markets and the other half in developing ones. This allows to assess the degree of implementation of the investment objective not only in terms of geographical differentiation (18 different national stock indexes listed in 17 countries in Asia-Pacific, Europe and both Americas), but also in the division within developing and developed markets. The study sample is derived from a selection of country funds from one leading ETF issuer, namely iShares. By retaining ETFs from only one fund sponsors, the sample limits the variability of fund performance due to diverse management styles. In addition, fund valuations are presented in one currency unit - US dollar. It controls the exchange differences that may influence the obtained results.

The motivation of this study is then twofold: Firstly, an analysis of the mimic of the rate of return obtained by various global indexes based on which selected ETFs operate will be carried out. In this regard, an attempt will be made to answer the research question, whether the degree of implementation of the investment objective by the fund depends on the location of the market? Secondly, although the global success of ETFs has arisen interest of researchers, the number of studies in emerging markets focused on ETFs is very limited. This study dealing with ETFs operating on the basis of stock exchange indices of countries included in emerging markets contributes in filling this gap.

The structure of the paper is as follows: section two describes the current state of knowledge on Exchange Traded Funds as a form of passive funds. The third section presents the tools of ETFs' performance measurement, namely tracking errors. The fourth section deals with the results of the empirical analysis. In the last section, the main conclusions are discussed and the suggestions for future research are made.

## **2. The theoretical basics**

Although, considering all types of investment funds, the greatest importance should be attributed to collective investment funds, commonly known as mutual funds, it is noteworthy that the increase in popularity of ETFs is especially visible in recent years. While in 2009 ETFs' NAV accounted for about 4% collective investment funds' NAV, in 2018 it was already over 11% (Investment Company Institute, 2019). This is the consequence of an increase in interest in passive forms of investment, which include the majority of ETFs.

The development of passive management of investment portfolio deeply rooted in efficient market hypothesis (EMH), which assumed consideration all available information at the specified moment in financial instruments valuation (Fama, 1970).<sup>1</sup> Translating EMH into the market of investment funds should be understood in this way, that based on all available market information it is not possible to achieve higher rates of return in the case of investments made through actively managed funds, compared to financial instruments reflecting the stock index (Dębski, 2010; Chlebisz, 2018). Such instruments include passively managed ETFs, for which the investment portfolio modelling strategy on the selected index has been employed (Nawrot, 2007).

Among the studies on the scope of implementation by the fund of the investment objective, understood as the degree of mimic the rate of return obtained by the index, based on which the ETF operates, there are in particular those referring to the US market. They draw attention to the lower rates of return generated by the possession of ETFs compared to the benchmark. As a reason of such underperformance there are indicated both transaction costs related to purchasing/selling ETFs (Kotsovetzky, 2003; Bernstein, 2004; Agapova, 2011) and adopting by fund managers passive management strategies while attempting to reduce tracking error (Gastineau, 2004).

Beyond the US market reference should be made to the ETFs operating in Europe. Also in this case, the results of passive investment products are worse compared to the benchmark. As the main reasons for undervaluation of ETFs, reference is made to management costs and the fiscal aspect regarding the differentiated methods of income tax settlement by European investors. (Blitz, Huij & Swinkels, 2012).

In addition to these, a rare, though occurring practice is to undertake research on the implementation of the investment objective in developing countries that are characterized by high dynamics of economic growth. This case applies both to ETFs that are introduced to trading on the stock exchanges of individual countries, as well as funds operating on the basis of stock indexes of these countries, but listed on the markets in the United States or Western Europe. In studies on this area, attention is drawn to the occurrence of higher levels of tracking errors in developing countries compared to developed ones. The source of this state of affairs indicates among others foreign exchange risk, or generally less liquidity for emerging markets (Shin & Soydemir, 2010; Blitz & Huij, 2012). Among the studies on this

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<sup>1</sup> Despite numerous studies both foreign (Basu 1977; Malkiel 2003; Sewell 2012; Konak & Seker 2014), and Polish (Czekaj et al. 2001; Szyszka 2003; Witkowska & Żebrowska-Suchodolska 2008, Goczek & Kania-Morales 2015), in which authors based on EMH assess the effectiveness of financial markets, there are voices questioning the validity of the hypothesis of effective markets, taking into account in particular the changes taking place in the modern world of finance (Straffin, 2001; Evans & Honkapohja, 2005; Ambroziak, 2014; Zawadzki, 2018).

research area, several should be cited that refer to the Polish ETF market (Gierałtowska, 2015; Marszk 2016; Chlebisz, 2018; Marszk, 2018; Miziołek & Feder-Sempach, 2018). So far, however, no research has been done to compare the tracking errors developed and emerging markets of ETFs due to geographical diversity.

### **3. Miary efektywności stopnia realizacji celu inwestycyjnego**

The basic tools for measuring the effectiveness of the degree of implementation of an investment objective include those related to the estimation of the tracking difference and tracking error. Although the assumption is that ETFs should accurately mimic the changes of market prices, in practice the rates of return on investment in ETFs differ from the rates of return on the replicated index (benchmark). The difference between the investment results achieved by ETF fund and at the same time the results of the replicated index is referred to as tracking difference. For example, if the return rate of fund's investment is calculated at ten per cent per annum, whereas the return rate of benchmark equals eleven per cent, it means that the tracking difference was minus1 per cent. The formula for determining the tracking difference (TD) at time t is as follows (Madhavan, 2016):

$$TD_t = (p_t - p_{t-1}) - (I_t - I_{t-1})$$

where:

$p_t$  - ln NAV values of ETF fund at the end of period t,

$p_{t-1}$  - ln NAV values of ETF fund at the end of period t-1,

$I_t$  - ln value of the income index (adjusted for dividend payment) at the end of the period t,

$I_{t-1}$  - ln value of the income index (adjusted for dividend payment) at the end of the period t-1.

Even if the return rate on the index deviates from the return rate generated by ETF's NAV, this should not be a significant difference. The tracking difference is used to identify potential revenues and costs that determine the occurrence of deviations from the index value.

Tracking difference is frequently confused with the term tracking error (TE). In reality, however, these terms are not the same, as the tracking error allows the determination of the volatility of differences in return rates generated by the ETF compared to the index on which the fund operates. It is therefore more a qualitative measure. In addition, the tracking error may be subject to ex post and ex ante measurements. The tracking difference applies only to ex-post evaluation. In the analysis of historical data, the tracking error is calculated as the standard deviation of differences in the rates of return achieved by the ETF and a given benchmark, or as the variation of the tracking difference. Usually, calculations are made

based on the formula above using daily rates of return (Madhavan, 2016). For tracking error forecasts, the covariance matrix of a particular risk model is used. It is defined as the volatility or standard deviation of the ex ante risk of the difference between the ETF and the benchmark.

It follows from the above that assessment of tracking error is a bit more complicated. There is no single, universal method of measuring effectiveness in this area. In practice, several different measures are used (Roll, 1992; Pope i Yadav, 1994; Cresson, Cudd, i Lipscomb, 2002). In terms of tracking error, these include measures described by the following three formulas:

1. The difference in return rates between the ETF and the benchmark:

$$TE_1 = \frac{\sum_{t=1}^n e_i}{n}$$

where:

$e_i$  – i-th ETF tracking error,

$n$  – numer of observations

$$e_i = NR_{i,t} - ER_{i,t}$$

where:

$NR_{i,t}$  – ln of return rates of net assets of i-th ETF at time t,

$ER_{i,t}$  – ln of return rates of benchmark (index), on the basis of which i-th ETF at time t operates.

2. Arithmetic average of the absolute values of the daily tracking error levels:

$$TE_2 = \frac{\sum_{t=1}^n |e_i|}{n}$$

3. The standard deviation of the differences between the rates of return of the i-th ETF and the rates of return of the benchmark:

$$TE_3 = \sqrt{\frac{1}{n-1} \sum_{t=1}^n e_i^2}$$

**Table 1. ETF funds utilized in the study**

Fund name	Ticker	Benchmark	Incep. year	Net assets [mln]	Gross expense	Market
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				USD]	ratio [%]	
<b>Asia Pacific</b>						
iShares MSCI India ETF	INDA	MSCI India Index	2012	5,622	0.69	emerging
iShares MSCI China ETF	MCHI	MSCI China Index	2011	4,891	0.59	emerging
iShares MSCI S.Korea ETF	EWY	MSCI Korea 25/50	2000	4,728	0.74	emerging
iShares MSCI Japan ETF	EWJ	MSCI Japan Index	1996	13,191	0.49	developed
iShares MSCI H. Kong ETF	EWH	MSCI Hong Kong	1996	2,025	0.49	developed
iShares MSCI Australia ETF	EWA	MSCI Australia Index	1996	1,552	0.5	developed
<b>Europe</b>						
iShares MSCI Russia ETF	ERUS	MSCI Russia 25/50	2010	632	0.59	emerging
iShares MSCI Turkey ETF	TUR	MSCI Turkey Invest.	2008	367	0.59	emerging
iShares MSCI Poland ETF	EPOL	MSCI Poland IMI	2010	295	0.61	emerging
iShares MSCI UK ETF	EWU	MSCI UK Index	1996	2,663	0.5	developed
iShares MSCI Germany ETF	EWG	MSCI Germany Index	1996	2,282	0.49	developed
iShares MSCI Switzerland	EWL	MSCI Switz. 25/50	1996	1,181	0.5	developed
<b>Americas</b>						
iShares MSCI Brazil ETF	EWZ	MSCI Brazil 25/50	2000	10,248	0.59	emerging
iShares MSCI Mexico ETF	EWX	MSCI Mexico IMI	1996	726	0.49	emerging
iShares MSCI Chile ETF	ECH	MSCI Chile IMI	2007	512	0.59	emerging
iShares Core S&P 500 ETF	IVV	S&P 500 Index	2000	219,585	0.04	developed
iShares Russell 1000 Growth	IWF	Russell 1000 Growth	2000	52,535	0.19	developed
iShares MSCI Canada ETF	EWC	MSCI Canada Custom	1996	2,775	0.49	developed

Source: Author's own on the basis of: <https://www.ishares.com>.

From the investor's point of view, the values characterizing both the tracking difference and the tracking error should be as small as possible. The lower value of tracking error the better projecting of benchmark results, which mean that the risk is lower. In turn, the higher the tracking error value, the worse the ETF fund mimic the results achieved by the benchmark, so the risk is higher.

In this study, the tracking error is calculated taking into account each of the above three approaches. Table1 reports the profiles – including name of fund, ticker, benchmark (stock market index), inception year, total net assets, gross expense ratio and market type – of the 18 iShares Country Funds, six for each region (Asia-Pacific, Europe and Americas ) regarding the division into developed and emerging markets. That means that for each market type there are 9 ETFs, 3 for each region.

All data are collected in daily frequency using logarithmic returns of net asset value in the case of funds and logarithmic returns of index value. They range from January 2013 to December 2019. It is caused by inception day of iShares MSCI India ETF in 2012. Extending

the research period prior to 2012 would result in a differentiation in the number of observations, which was to avoid in this study. If the ETF fund does replicate the benchmark (index) well, then the average tracking error is expected to be close to zero. In order to test the relationship between the performance of ETFs and their benchmarks. t-test was employed.

#### 4. Results and discussion

Tracking errors were estimated using three different methods as presented in section 3. Table 2 reports tracking errors for 18 ETFs and categorizes these funds depending on the region and the development level of national economy. Generally it can be seen that North America's ETFs (developed market) exhibit the lowest level of tracking errors. At the same time the tracking errors for emerging markets are higher comparing to developed markets for each of the three regions. In general, the largest problems with index mimicing occur on European markets. This also applies to the Polish ETF, for which the daily tracking errors are in the range of 0.047% to 0.258% depending on the adopted calculation method.

In addition in table 2 the sum of daily tracking errors was computed for each fund including the positive and negative errors as presented in Harper et al (2006) and t-statistic was utilised to perform its statistical significance. All ETFs have negative sum of daily tracking errors. It means that it should be given more importance to negative tracking errors in comparison to the positive ones irrespective of the either level of market development or the region. Negative tracking errors lead investors to expect negative risk premium in testing the performance of ETFs. Fourteen out of eighteen ETFs have statistically significant negative sum of daily errors. The highest negative values of sum of daily errors appear in case of European markets, whereas the lowest concern developed American markets. It confirms earlier findings on the basis of tracking errors that ETFs underperform their benchmarks for each market, although it differs according to both the market development and location.

**Table 2. The results of tracking errors**

Ticker	TE <sub>1</sub> [%]	TE <sub>2</sub> [%]	TE <sub>3</sub> [%]	Sum of daily errors [%]	t-Stat
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Asia Pacific					
INDA	0,068	0,153	0,155	-11,12	-2,87
MCHI	0,075	0,277	0,281	-4,55	-3,23 <sup>b</sup>
EWY	0,043	0,265	0,280	-7,81	-0,98 <sup>b</sup>
Emerging total	0,059	0,217	0,229	-8,10	-1,90
EWJ	0,035	0,099	0,099	-4,59	-2,16 <sup>a</sup>
EWH	0,026	0,111	0,115	-5,16	-3,12 <sup>c</sup>
EWA	0,033	0,167	0,168	-5,55	-2,50 <sup>b</sup>
Developed total	0,030	0,127	0,130	-4,88	-2,98
Europe					
ERUS	0,084	0,222	0,324	-13,12	-0,65 <sup>c</sup>
TUR	0,034	0,314	0,311	-11,18	-1,88 <sup>b</sup>
EPOL	0,047	0,258	0,210	-9,73	-2,90
Emerging total	0,055	0,287	0,298	-10,88	-1,87
EWU	0,045	0,198	0,200	-7,84	-3,12 <sup>a</sup>
EWG	0,021	0,201	0,200	-8,27	-2,15 <sup>c</sup>
EWL	0,013	0,150	0,152	-6,77	-2,95
Developed total	0,027	0,177	0,188	-7,59	-2,44
Americas					
EWZ	0,039	0,295	0,301	-11,10	-1,66 <sup>b</sup>
EWW	0,044	0,333	0,335	-9,75	-2,12 <sup>b</sup>
ECH	0,056	0,239	0,240	-8,58	-1,43
Emerging total	0,047	0,280	0,281	-10,17	-1,75
IVV	0,029	0,063	0,065	-3,23	-1,12 <sup>b</sup>
IWF	0,018	0,075	0,077	-2,88	-0,66 <sup>a</sup>
EWC	0,033	0,103	0,105	-4,12	-1,11 <sup>c</sup>
Developed total	0,027	0,089	0,090	-3,45	-0,84

<sup>a</sup> statistical significance at 1% level

<sup>b</sup> statistical significance at 5% level

<sup>c</sup> statistical significance at 10% level

Source: Author's own.

Sources of deviations may vary. Finding them would require from the researcher to use regression analysis taking into account the determinants affecting the size of tracking errors depending on developed and developing markets and geographical location. The use of such a solution was beyond the scope of this study. According to a world-wide literature it may be assumed, that the one of possible reason is the high price volatility observed in developing markets (Quadan & Yagil, 2012). Others underlying reasons are identified as the differences between trading hours of stock exchanges, exchange rate fluctuations and different transaction costs (Shin & Soydemir, 2010; Bař & Sariođlu, 2015).

## 5. Summary

In this study, the performance of 18 exchange-traded funds over their benchmark indexes was estimated. Tracking errors were found to be statistically significant and negative. The findings prove that investing in ETFs does not provide a considerable benefit compared to their benchmark returns irrespective of the level of market development and location.

The findings indicate that larger divergence between market prices and NAVs of ETFs appear in case of emerging markets comparing to developed ones. At the same time assessing the degree of performing the intended investment objective, which is accurate replication of the index, it can be stated that the geographical criterion determines the level of the tracking error. Its lowest values among the analyzed ones were characterized by American markets classified as developed markets (USA and Canada). The largest, reaching 0.3% appeared in emerging European markets.

This study is the first to assess the effectiveness of the ETF investment objective in developed and developing markets, taking into account geographical diversity while attempting to determine the statistical significance of the obtained results. Despite the signs of originality, the work is not free from shortcomings. In this regard, first of all, it should be indicated that there is a relatively small number of ETFs that are issued by one global institution – iShares. On the one hand, such an action was related to the Author's attempt to limit various management styles implemented by different ETFs' issuers. On the other hand, the results obtained give only partial knowledge about the total population of passive funds. Secondly, the paper points out the discrepancies between NAVs of ETF and the value of stock indexes, but this does not allow determining the reasons for these deviations. To achieve this aim, this study should be expanded by testing an econometric model in which the impact of adopted dependent variables, such as the exchange rate or liquidity of a given market, on the tracking error would be analyzed.

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