Measuring the performance of Exchange-traded funds

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ABSTRACT

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The purpose of this thesis is to measure the performance of exchange-traded funds (ETFs) from the year 2012 to 2016. I include 312 ETFs from developed markets and 61 ETFs from emerging markets in the sample. I compare the performance of the ETFs with their corresponding benchmark indices and compare the performance of the developed market ETFs with the emerging market ETFs and I find that all of the ETFs underperform their underlying benchmark indices. I use the tracking error of the ETF as a measure of its performance and I define the tracking error as the difference between the return of the ETF and the return of its underlying benchmark index and I expect the tracking error to be significant. Using the absolute value of the difference between the return on ETFs and their underlying benchmark indices and the standard errors of regression models which measure the relationship between those returns as the estimate of tracking error, the results indicate that the tracking error is significantly different from zero. However there is no evidence that ETFs in developed markets have better performance than ETFs in emerging markets. I use the 3-month U.S Treasury bill rate as an estimate of the risk-free rate and determine the risk-adjusted performance of both ETFs and their underlying benchmark indices. Finally, I analyze the impact of different variables on the ETF's tracking error using a regression analysis, the results indicate that both daily volatility and dividend yield exert significant influence on tracking errors of ETFs in both developed markets and emerging markets.

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1. Introduction

The first exchanged-traded fund (ETF), S&P Depository Receipts, which was also called SPDRs, was launched in 1993. It was designed to track the Standard & Poor's 500 index and it is still one of the most actively traded passively managed funds. In contrast to actively managed funds under which fund managers need to pick investments with better performance, ETFs are designed to mirror the components of a market index. This strategy, which is termed a "passively-managed" strategy, gained popularity and attention in a relatively short period of time, following which the market share of ETFs has grown rapidly. The total net asset value of ETFs has grown from USD 1.4 trillions in 2000 to nearly USD 4.4 trillions in 2017 and the total net asset value of ETFs is expected to reach nearly USD 7.6 trillions in 2020 according to an analysis done by Morningstar Direct [1]in 2017.

Blume and Edelen (2004) and Svetina and Wahal (2008) have focused on the comparison of the performance of passively-managed funds with those of actively-managed funds. They conclude that actively-managed funds usually underperform the market portfolio because of their high expense ratio. They also find that those funds usually charge a higher management fee, shareholder accounting cost which used to track shareholder transactions and other such paperwork and shareholder transaction cost which are the commissions on transactions, but for most passively managed funds, their shareholder accounting and transaction cost are nearly no-existent. Those findings contributed a lot to the increasing popularity of investing in passively-managed funds. According to the survey on the development of global ETFs in 2017 conducted

[1] The source for total net asset value before 2018 and expected total net asset value in the future is http://cawidgets.morningstar.ca/ArticleTemplate/ArticleGL.aspx?culture=en-CA&SAL=false&id=851345

by Ernst & Young, the market share of passively-managed funds grew from 14% in 2011 to nearly 24% in 2017, the market share of actively-managed funds dropped from 86% to 76% over the same period[2]. This indicates that investors tend to invest more in passively-managed funds since they can achieve better performance with lower cost.

I summarize some advantages of ETFs. First, ETFs offer high liquidity because investors can purchase, sell and even short-sell shares of ETFs, whenever the market is open, however investors of mutual funds can only buy or sell shares of mutual funds at the net asset value (NAV) at the close of the market. So investors of ETFs always have more flexibility to conduct transactions (Poterba & Shoven, 2002; Charupat & Miu, 2011).

Second, Ramaswamy (2011) indicates that ETFs can trade in-kind, which means that authorized participants (APs) can exchange ETF shares for baskets of securities rather than for cash. This allows the ETFs to avoid selling securities to raise cash in order to meet redemptions and also prevent capital gain distributions. Whenever the share price of the ETF is too high or too low with reference to its NAV, investors can arbitrage through redemption with in-kind transactions, which prevents the price of the ETF moving far away from its NAV.

Third, ETFs usually charge lower management fees and nearly no transaction costs in comparison to mutual funds, since most mutual funds conduct active management. (Blume & Edelen, 2004; Charupat & Miu, 2011).

However, most ETFs cannot fully replicate the performance of their underlying indices. For example, the first ETF, S&P Depository Receipts (SPDRs), was designed to track the S&P 500

[2] The source for the market shares of both passively-managed funds and actively-managed funds is http://www.ey.com/gl/en/industries/financial-services/asset-management/ey-global-etf-survey-2017

stock index, but the return of SPDRs is not exactly equal to the return on the S&P 500 index at all times. The difference between the return on the ETF and the return on the benchmark index that it is designed to track is known as tracking error. Ramaswamy (2011) and Shin and Soydemir (2010) have concluded that tracking error is significantly different from zero for different ETFs and also displays persistence. Tracking error can be influenced by many factors such as the expense ratio of the ETF, the dividend paid on the underlying securities and the value of the exchange rate, among other variables. They find that the depreciation of the U.S dollar may increase the dispersion between NAV returns and benchmark index returns especially for ETFs in Asian markets, which means that international investors that invest in ETFs in Asian markets can benefit from a depreciating dollar.

Charupat and Miu (2011) have examined the tracking error of ETFs in different markets and find that tracking errors of ETFs from developed markets are usually lower than tracking errors of ETFs from emerging markets. Blume and Edelen (2004) evaluate the performance of global emerging market equity ETFs and conclude that tracking errors of ETFs in emerging markets are higher than that of ETFs in developed markets. Several reasons can explain this difference, of which one widely accepted explanation is that the cross-sectional dispersion in stock returns of emerging markets are larger than the cross-sectional dispersion of stock returns of developed markets, thus a larger standard deviation of return will result in a large tracking error. Another explanation is that emerging markets are generally less liquid, so the expenses associated with emerging market ETFs, which are passed on to investors, will be higher due to the higher liquidity risk (Charupat & Miu, 2011). Time zone differences and price pressure effects are also considered by Poterba and Shoven (2002). All in all the different investment environment of emerging markets and developed markets can explain most of the difference in tracking errors.

My thesis focuses on the comparison of the tracking errors of ETFs in developed markets and the tracking errors of ETFs in emerging markets. I compare ETF performance in both markets by using both closing prices and NAVs per share to calculate ETF returns and then I compare the returns of ETFs to their underlying benchmark indices' returns using Jensen's model.

I estimate the tracking error using two different methods: 1) absolute value of the difference between the return on the ETF and its underlying benchmark index; 2) the standard error of a regression of the ETF's return on the return of its underlying benchmark index.

The remainder of this thesis is structured as follows. Section 2 reviews the literature. Section 3 describes the data used and provides descriptive statistics. Section 4 describes the methodology of the empirical tests. Section 5 reports the results of the empirical tests and section 6 provides the conclusions and limitations.

2. Literature review

2.1 The development of ETFs

The performance of exchanged-traded funds (ETFs) has received much attention in recent years with an accompanying high popularity of passive investments. Especially for investors who prefer stable returns, ETFs would be good choice. Ramaswamy (2011) describes ETFs as closed-ended mutual funds that allow investors to gain diversified exposure to financial assets across different regions, sectors or asset classes. Deville (2008) describes the aim of ETFs as to replicate the performance of their underlying benchmark indices as closely as possible. ETFs can be innovative in many ways. Madura and Richie (2004) and Richie (2004) point out that ETFs differ from individual stocks because they represent composites of stocks, so investors can gain the return of a whole basket of stocks. They are also different from stock indices because they can be traded

continuously in an open market and can be sold short, thus the ETF structure is unique because it combines features of both open-end funds and closed-end funds.

ETFs have developed over many years. Harper and Schnusenberg (2006) introduce a detailed development history of ETFs. The very first ETF was Standard & Poor's Depository Receipts (SPDRs), which was constructed and commenced trading on the American Stock Exchange in 1993 and is composed of the stocks in the S&P 500 stock index. As Poterba and Shoven (2002) explained, each ETF is like a claim on a trust that holds a pool of assets, unlike actively-managed funds, ETFs aim to provide a more efficient investment method by tracking indices actively with relatively lower expenses. The performance of ETFs can be predicted with high accuracy since they are designed to stay close to their underlying benchmark indices. Gastineau (2004) points out that creation and redemption take place without attracting unusual attention because most indices change their composition infrequently.

Poterba and Shoven (2002) explain the creation process of ETFs. In the primary market, authorized participants (APs) are allowed to create or redeem ETF shares in large quantities and receive ETF shares which also called creation units. Then in the secondary market, the APs can conduct transactions on the exchange through market making or arbitrage. The investors cannot buy or sell shares directly from the issuers but can conduct transactions in the ETF shares on the stock exchange. Interestingly, both institutional investors and retail investors can buy and sell ETF shares in the secondary market at any time during the day, secondary market transactions are only subject to regular brokerage commissions, because there is no fee payable to any secondary market purchases or sales.

2.2 Characteristics of ETFs

ETFs can be described as innovations in many ways. For example, unlike mutual funds, investors in shares of ETFs have the opportunity to trade throughout the trading day, hence the ETFs are suitable for short-term investors who need high liquidity. As Charupat and Miu (2011) note, the prices of ETFs are determined through intraday trading in the stock exchange, and hence should usually mirror the ETFs' intraday NAVs, however, since ETF shares are traded on the stock exchange, their trading prices should also be influenced by supply and demand, which may cause the ETF share price to trade at a premium or discount to its NAV. Svetina and Wahal (2008) also report that ETFs permit investors to invest in portfolios that offer passive exposure to a variety of asset classes, while providing intraday pricing and efficient tax management. Deville (2008) describes ETFs as more tax efficient investments than traditional equity mutual funds since they reduce the tax burden of investors.

With the increasing popularity of passive investments, many studies compared the performance of ETFs with those of actively-managed funds. Harper and Schnusenberg (2006) compare the performance of ETFs with 29 closed end country funds from 14 countries over the period 1996 to 2001 and they find that ETFs exhibit higher and more stable returns. Deville (2008) compares the performance of European index funds with ETFs which are listed on European stock markets and they find that, as passive investments, ETFs can be an ideal substitute for closed-end funds (CEFs) or mutual funds, especially when investing in an internationally diversified portfolio, because ETFs exhibit higher mean returns and even higher risk-adjusted returns. Agapova (2011) compares the performance of conventional mutual funds and ETFs. She finds that conventional mutual funds and ETFs can be substitute, but they cannot perfectly substitute for another. Svetina and Wahal (2008) report that ETFs underperform their underlying benchmark indices and are not free from tracking error. Poterba and Shoven (2002) point out that ETFs and mutual funds mainly

differ on expense ratio. ETFs, as recent financial innovations, may satisfy different needs of investors. More and more research has focused on the performance measurement of ETFs. Poterba and Shoven (2002) explain that ETFs can be described as more tax efficient in comparison to traditional mutual funds, since ETFs can offer taxable investors a method of holding a basket of stocks that deliver returns comparable to those of low-cost index funds. Gallagher and Segara (2005) measure the characteristics of ETFs based in Australia and conclude that ETFs closely track their respective benchmark indices.

Performance measurement of ETFs is different from the traditional method used to measure the performance of actively-managed funds. As Poterba and Shoven (2002) explain, the goal of ETFs is to track their underlying indices, so when the returns of ETFs follow the returns of their underlying indices, the performance of ETFs can be viewed as ideal. Roll (1992) points out that ETFs provide returns very close to those of their underlying benchmark indices because both management fees and transaction costs are low for most ETFs. If the ETF share price rises above or falls below the NAV of the ETF's underlying portfolio, the ETF manager will take some actions in order to keep the ETF share price close to its NAV. Tracking error is designed to measure the difference between the return on the ETF and the return on its benchmark index, when the stock market is truly efficient, all relevant information should be immediately and fully reflected in the stock price. Hence, as Madura and Richie (2004) report, the market is more efficient when the difference between the ETF's share price and its NAV is smaller, besides they also indicate that ETFs should always be priced properly by the market because they are not subject to constraints on intraday trading and short sales.

2.3 Relevant research on performance measurement.

The measurement of tracking error has also received much attention from previous researchers. As Frino and Gallagher (2001) describe, tracking error is unavoidable due to the existence of market frictions, so many researchers use tracking error to measure the performance of ETFs. Harper and Schnusenberg (2006) conclude that ETFs have relatively low and statistically insignificant tracking error relative to their underlying benchmark indices. Gastineau (2002) points out that investors may have different attitudes towards tracking errors. Some passive investors may be willing to accept tracking errors, but some investors may prefer lower tracking errors when they chose passively-managed funds.

Results of tracking error may differ when using different databases. Blitz and Huij (2012) indicate that ETFs underperform their underlying benchmark indices by 50 to 150 basis points per annum. He also finds that the underperformance is not only due to the expense ratio, but may also be due to the annual dividend. When the annual dividends are taken into account, most of the underperformance of the passively-managed funds can be explained. He finds that the expense ratio contributes -56 basis points per year to the underperformance of ETFs, while the annual dividend contributes -48 basis points.

After comparing the performance of ETFs with other traditional actively-managed indices, most papers conclude that ETFs can be an ideal replacement of actively-managed investments. Even though small tracking errors may persist because of the expense ratio and dividend payment, the low level of cost is mainly because ETFs will not usually buy or sell their underlying investments frequently.

As Agapova (2011) reports, the expense ratio can be an important factor when comparing the performance of ETFs in developed markets with those of ETFs in emerging markets. Blitz and

Huij (2012) focus their research on ETFs in global emerging equity markets and they find that tracking errors of these funds are higher than that previously reported for ETFs in developed markets. Their results show that ETFs that use statistical replication techniques, which only include parts of the underlying portfolios, tend to have higher tracking error in comparison to ETFs that use full-replication techniques, which include all of the underlying portfolios. In emerging markets, they find it is more difficult to closely track their underlying benchmark indices in comparison to developed markets. One reason is most investors hold the opinion that cross-sectional dispersion in stock return is structurally larger in emerging markets than developed markets, hence investors who invest in emerging markets have to bear higher expense ratios due to lack of liquidity and higher volatility in these markets.

However, to the best of my knowledge, no research directly focuses on the comparison of the performance of ETFs in emerging markets with those in developed markets. In order to test whether the degree of development of markets influences the performance of ETFs or not, I focus my research on the comparison of the performance of ETFs in developed markets and emerging markets.

Blitz and Huij (2012) evaluate the performance of equity ETFs in emerging markets, with those of ETFs listed on the US and Europe stock markets which track a conventional broad emerging markets index. Shin and Soydemir (2010) study the performance of 26 ETFs. Harper and Schnusenberg (2006) address 12 ETFs which focus on emerging markets. Ramaswamy (2011) notes that six sponsors, iShares, State Street Global Advisors, Vanguard, Lyxor Asset Management, DB x-trackers and Power Shares, control nearly 80% of the whole ETF markets. The above papers only address specific ETFs chosen from the whole database. In my thesis, I

include all the available equity ETFs with valid data during the period of 2012-2016 into the sample.

Motivated by Shin and Soydemir (2010), I also adopt tracking error to measure the performance of ETFs. The tracking error can be measured by the average of the absolute difference between the return on the ETF and the return on its underlying benchmark index. The smaller the absolute difference, the better the ETF performance. Svetina and Wahal (2008) describe the tracking error as the average absolute difference between the daily return of the ETF and its benchmark index. Charupat and Miu (2011) define tracking error as how well the fund's return based on NAV reflects the underlying benchmark index's return. Blitz and Huij (2012) measure the fund return by using the closing share price at which the funds were actually traded. However, Svetina and Wahal (2008) and Charupat and Miu (2011) use NAV per share instead of closing share price because they believe that the NAV per share can be an ideal substitute for the closing share price of the ETFs, since they are designed to track their underlying indices. I use both closing share price and NAV per share to calculate the returns on ETFs in order to compare the results for two different estimates.

Charupat and Miu (2011) test the tracking error of leveraged ETFs and find that the results on tracking error are different for different periods. The tracking errors become larger when they use monthly return rather than weekly return. Therefore, I use daily return to estimate the tracking error in my thesis in order to get a more accurate result.

With regard to the variables that may influence tracking error, Blitz and Swinkels (2012) explain that the expense ratio, which includes management fees, registration fees, fees payable to auditors, legal fees and custodian fees, affects the performance of ETFs. However, the expense ratio cannot explain all the underperformance, so they also test the effect of annual dividend on tracking error.

They find that the dividend paid by the underlying securities can explain most of the passive funds' underperformance. Shin and Soydemir (2010) find that the NAV of SPDRs tracks the S&P 500 index very closely when excluding the influence of both management fees and dividends obtained from the underlying securities. Since ETFs cannot re-invest the dividends, they expect that dividends affect not only the performance of ETFs but also the tracking errors.

Madura and Richie (2004) include trading volume and volatility as variables which affect the performance of ETFs. They find that for a more liquid ETF, the share price is less susceptible to mispricing because of sufficient liquidity. So they find that ETFs in more volatile markets are more likely to exhibit greater mispricing. Shin and Soydemir (2010) find that ETFs are better at tracking their benchmark indices than off-market index funds because of higher market efficiency. They also investigate the pricing of ETFs and find that the mispricing of ETFs is mainly related to momentum, liquidity and size effects. These factors disturb the market efficiency and cause mispricing.

Motivated by Shin and Soydemir (2010) and Blitz and Swinkles (2012), I also test the effect of relevant factors which may contribute to the tracking error by including the expense ratio, dividend yield, average trading volume and daily volatility.

Harper and Schnusenberg (2006) use mean returns and risk-adjusted returns to measure the performance of ETFs, hence I also use the mean returns and risk-adjusted returns in my performance measurement of ETFs.

3. Data

My sample includes 312 ETFs which focus on developed markets and 79 ETFs which focus on emerging markets, over the period January 2012 to December 2016.

Table 1 shows the data selection process at each stage. In order to compare the performance of ETFs in developed markets with ETFs in emerging markets, I first collect the list of all available ETFs from ETF.com and obtain a total 1594 ETFs. Since ETFs can focus on equity, fixed income, currency, commodity, alternative investment and so on, I only include ETFs which focus on equity in order to make a better comparison with their corresponding benchmark indices, then I delete ETFs introduced after 2012, which results in a list of 406 ETFs from developed markets and 79 ETFs from emerging markets, finally I delete ETFs which have missing data, for example, we cannot find valid net asset values or annual dividends for some of the ETFs. This leaves me with a list 312 ETFs from developed markets and 61 ETFs from emerging markets.

Table 1

Data selection process at each stage

	ETFs from developed markets	ETFs from emerging markets	Total
Initial sample of ETFs	1,386	208	1,594
ETFs which focused only on equity	995	177	1,172
ETFs with available data for 2012-2016	406	79	485
Final sample of ETFs	312	61	373

Table 2 reports the characteristics of the final sample of ETFs used in my research. The average NAV of all ETFs is $ 6,177,164.546, with ETFs in developed markets exhibiting higher average NAV than ETFs in emerging markets, this is because the average investment scale of ETFs in developed markets is larger than ETFs in emerging markets.

Table 2 also shows the average expense ratios of all ETFs. ETFs in emerging markets exhibit a higher average expense ratio of 0.00671 than ETFs in developed markets, which have an average expense ratio of 0.00443. These results are consistent with those of Shin and Soydemir (2010), who find that ETFs which focused on emerging markets tend to charge higher expense ratios due to their higher risk arising from a relatively unstable financial environment, compared to ETFs in

developed markets. Besides, the average size of ETFs in emerging markets are smaller, so their expense ratios might be relatively high, because these ETFs have a restricted asset base from which to meet their expense.

Table 2

Average NAVs and expense ratios of the final sample of ETFs

	Number	Average NAV	Average expense ratio
Developed market	312	4,014,882.367	0.00443
Emerging market	61	2,162,282.179	0.00671

Table 3 provides a list of ETF issuers in developed markets, the number of ETFs that they manage, their average NAVs and their average expense ratios. Most of the ETFs in developed markets are issued by iShares, Power shares, SPDR and First Trust. ETFs issued by SPDR have the highest average NAV. ETFs issued by Schwab and Vanguard also have higher average NAVs compared to the other ETFs and most of the ETFs in developed markets set their expense ratio to 0.004 while ETFs issued by First Trust and Ultra exhibit average higher expense ratios.

Table 3

Average NAVs and expense ratios of ETF issuers in developed markets

ETFs issuers	Number	Average NAV	Average expense ratio
First Trust	29	515,476.266	0.00484
Guggenheim	16	1,354,099.515	0.00441
iShares	67	3,703,387.896	0.00417
Power shares	50	2,576,342.707	0.00441
Schwab	8	3,804,375.347	0.00329
SPDR	33	4,723,692.474	0.00413
Ultra	21	494,071.282	0.00490
Vanguard	19	3,822,453.010	0.00402
Wisdom Tree	19	1,007,502.682	0.00445
Other	50	1,769,815.635	0.00452
Total	312	4,014,882.367	0.00443

Table 4

Average NAVs and expense ratios of ETF issuers in emerging markets

ETFs issuers	Number	Average NAV	Average expense ratio
First trust	2	315,535.274	0.00700
Global X China	5	41,146.833	0.00705
Guggenheim	4	66,094.643	0.00722
iShares	20	1,403,743.285	0.00683
Power shares	2	222,000.314	0.00711
SPDR	3	553,424.402	0.00736
VanEck	9	449,968.861	0.00704
Wisdom Tree	3	1,571,792.693	0.00645
Other	13	2,275,942.016	0.00672
Total	61	2,162,282.179	0.00671

Table 4 provides a list of ETF issuers in emerging markets, the number of ETFs that they manage, their average NAVs and their average expense ratios. ETFs issued by iShares exhibit the highest average NAV. A comparison of Tables 3 and 4 indicates that nearly all the ETFs in emerging markets have average higher expense ratios (around 0.007) than ETFs in developed markets (around 0.004).

I collect the fund's name, inception date, daily trading volume, expense ratio and annual dividend from the Center for Research in Security Prices (CRSP) database using the WRDS platform. The daily closing price, high price, low price and NAV per share are collected from Bloomberg for the period January 2012 through December 2016. I collect information on each ETF's corresponding benchmark index from its profile and obtain data on daily closing price for the index from Bloomberg.

I also collect data on the daily 3-month US T-bill rate from Bloomberg for the same period.

4. Methodology

4.1 Testable hypothesis.

My hypothesis is that statistically significant tracking errors exist in both markets and that ETFs in developed markets have better performance than ETFs in emerging markets. Using tracking error as the measure of performance, this implies that the average tracking error of ETFs focused on developed markets should be smaller than the average tracking error of ETFs focused on emerging markets. The tracking error is the absolute difference between the return on the ETF and the return on its benchmark index. The explanation for a lower tracking error for ETFs in developed markets is that these ETFs operate in a mature financial environment with lower liquidity risk and therefore should have better ability to track their underlying benchmark indices.

4.2 Estimation of tracking error

I use three estimates of the tracking error. 1) the absolute value of the difference between the return on the ETF and its benchmark index, following Shin and Soydemir (2010) and Harper and Schunsenberg (2006); 2) the standard error of a regression of the return on the ETF on the return on its benchmark index, following Shin and Soydemir (2010); 3) the standard error of a regression of the excess return of the ETF (over the risk-free rate) on the excess return of the benchmark index, using the concept of the capital asset pricing model (CAPM).

4.2.1 Tracking error based on the absolute value of the difference between the return on the ETF and the return on its benchmark index.

The daily returns on each ETF and its benchmark index are estimated by two methods: the percentage change in the closing share price and the percentage change in the NAV per share. Harper and Schnusenberg (2006) calculate the return by using the closing share price of ETFs. Jares and Lavin (2004) and Charupat and Miu (2011) use the NAV per share to calculate the return

of the ETF. Since the NAV per share is calculated using real-time data, previous researchers assume that the NAV per share cannot be changed by market manipulation easily, unlike the trading price of the ETF which can be influenced by supply and demand, however, the trading price always moves closely with the NAV per share. Hence, while the estimates of those two returns may not be identical, the differences are likely to be small.

The average tracking error for each group of ETFs, those from developed markets and those from emerging markets, is calculated for each day t, using the two estimates of return. Four estimates of average tracking error are obtained, the first two estimates are based on closing share prices and are for the ETFs from developed markets and from emerging markets, respectively and the third and fourth estimates are based on NAVs and are for the ETFs from developed markets and emerging markets, respectively.

4.2.2 Tracking error based on the standard error of a regression of the return on the ETF on the return on its benchmark index

I regress the return on the ETF on the return on its benchmark in the following equation:

$$\text{Return on the ETF}_t = \alpha + \beta \text{ Return on the benchmark}_t + \varepsilon_t \qquad (4.1)$$

α and β represent the intercept and the slope, respectively, while ε represents the error term. The standard error of the regression represents the variation in the return on the ETF which cannot be explained by variation in the return on the underlying benchmark index. As noted by Shin and Soydemir (2010), the standard error in such a regression model can proxy tracking error. If the ETF can replicate its benchmark index perfectly, the β will be close to 1, but if the return on the ETF is unrelated to the return on its benchmark, the β will be close to zero. If the return on the ETF is significantly higher (lower) than the return expected, based on the return of its benchmark,

then α will be positive (negative), this represents over performance (underperformance) of the ETF.

4.3 Estimate of tracking error based on the CAPM and measure of under- or over-performance of the ETF

I regress the excess return on the ETF on the excess return on its benchmark index using the following equation:

$$\text{Return on the ETF}_t - \text{Risk free rate}_t = \alpha + \beta\,(\text{Return on the benchmark}_t - \text{Risk free rate}_t) + \varepsilon_t \quad (4.2)$$

The tracking error of the ETF is estimated by the standard error of the regression, which incorporates an adjustment for systematic risk. β represents the systematic risk of the ETF, ε represents the error term and α is Jensen's alpha, which is an estimate of the under- or over-performance of the ETF. If α is significantly positive (negative), this is an indication that the ETF over-performs (under-performs) based on its systematic risk, but if α is not significantly different from 0, the ETF neither over-performs or under-performs, based on its systematic risk. I use the 3-month U. S. Treasury bill rate as an estimate of the risk-free rate at time t.

4.4 Factors that influence the tracking error

Next, I address the factors that may influence the tracking error. Based on previous research, I choose the ETF's annual expense ratio, the volatility of the ETF's daily share price, the log-transformed daily trading volume and the annual dividend yield obtained by the ETF from its underlying stock portfolio, as independent variables of a cross-sectional-time series regression, in which the tracking error of the ETF at time t is the dependent variable. The regression model is presented by equation 4.3 which follows:

$$\text{Tracking error}_{i,t} = \alpha_0 + \alpha_1 \text{ Expense ratio}_{i,t} + \alpha_2 \text{ Volatility}_{i,t} + \alpha_3 \text{ Log (Trading Volume)}_{i,t} + \alpha_4 \text{ Dividend yield}_{i,t} + \varepsilon_i \quad (4.3)$$

In the above equation, i stands for ETF i and t stands for time. The expense ratio is the total percentage of fund assets which are used to meet management, administrative, advertising and other expenses, and represents annual fees which the fund company charges in order to manage the funds.

Harper and Schnusenberg (2006) assume that the differences in the performance of ETFs between developed markets and emerging markets are mainly due to differences in their expense ratio. ETFs in emerging markets have to bear higher risk faced with an unstable financial environment, which may prevent these ETFs from tracking their underlying indices accurately. Hence, I expect a significantly positive influence of expense ratio on tracking error, which means that ETFs in emerging markets (with higher expense ratios) tend to have larger tracking errors than ETFs in developed markets (with lower expense ratios).

The volatility of ETF i at time t is estimated as:

$$\text{Volatility}_{i,t} = (\text{High price}_{i,t} - \text{Low price}_{i,t}) / \text{Closing price}_{i,t} \quad (4.4)$$

$\text{High price}_{i,t}$ is the highest price, $\text{Low price}_{i,t}$ is the lowest price and $\text{Closing price}_{i,t}$ is the closing price of ETF i on day t. A higher volatility implies that the price of the ETF can change dramatically over a short period, since the share price may not fully reflect the real value of the ETF in a highly volatile market, which may increase the difference between the share price and NAV and also prevent ETFs from tracking their underlying benchmark indices, I assume that the higher the volatility, the higher the tracking error.

The log-transformed trading volume measures the liquidity of each ETF, the coefficient measures the influence of the daily trading volume of ETF i on day t, upon tracking error. Shin and Soydemir

(2010) note that trading volume can reflect the behaviour of the market. Investors may use trading volume to update their beliefs, hence if they believe that a higher level of trading volume indicates huge differences in beliefs, this may result in greater discounts or premiums and also higher tracking errors. Hence a significantly positive relationship between trading volume and tracking error is expected.

Dividend $_{i, t}$ captures the influence of the dividend yield from the underlying portfolio upon tracking error. The dividend yield is calculated by dividing the dollar value of dividends paid per share by the dollar value of one share of stock. A higher dividend yield implies that the securities that the ETF owns in the portfolio have a better performance, which may attract more investors and also increase the trading liquidity. This may also encourage the performance of ETFs and minimize the tracking error.

5. Empirical Results

This section reports my empirical results. I first measure the tracking errors of 312 ETFs which focus on developed markets and 61 ETFs which focus on emerging markets during the five-year period from 2012 to 2016. I estimate tracking error by three different methods which are: 1) absolute value of the difference between the return of the ETF and the return on its underlying benchmark index; 2) standard error of a regression of the daily return of the ETF on the daily return of its benchmark index; 3) standard error of a regression of the daily excess return of the ETF on the daily excess return of its benchmark index. I use Jensen's alpha to determine if the ETF under- or over-performed based on its benchmark index. Finally, I test the influence of several factors upon tracking error by using regression models.

5.1. Daily return of the ETF and its underlying benchmark index

I first calculate the daily returns of both ETFs and their underlying benchmark indices. I use both daily closing share prices and NAVs per share to measure the returns, as described in section 4.2.1.

Table 5 shows the average returns of the ETFs, their benchmark indices and the difference between the average return on the ETFs and the average return on the benchmark indices, on a yearly basis for each of the years 2012-2016 and for the overall period 2012 to 2016, separately for the group of ETFs focusing on developed markets and for the group of ETFs focusing on emerging markets.

Panel (A) shows the results when return is calculated using daily closing prices of ETF shares. For the ETFs focusing on developed markets, the differences between the average ETF returns and benchmark index returns are negative for the years 2012 to 2014, which indicates that the ETFs underperform their underlying indices during those years. The average returns of ETFs focusing on developed markets are higher than their underlying benchmark indices for the years 2015 and 2016. However the result of the overall period indicate that ETFs underperform their underlying benchmark indices in developed markets.

For the ETFs focusing on emerging markets, the differences between the average ETF returns and average index returns are negative for 2012 and 2015, indicating that the emerging market ETFs underperform their underlying indices in those years. However, the emerging markets ETFs have better performance compared to their underlying indices in years 2013, 2014 and 2016. The result of the overall period still indicates that ETFs in emerging markets underperform their underlying benchmark indices.

Panel (B) shows the results when the daily return is calculated using the NAVs per share of the ETFs. Both developed market ETFs and emerging market ETFs underperform their underlying

indices in 2012 and 2016. Though the results of difference between the average ETF returns and average index returns measured by NAVs per share in 2016 are totally different compared with results measured by closing price, their overall results are consistent in that ETFs underperform their underlying benchmark indices.

Table 6 shows the average standard deviations of the returns on ETFs and their underlying benchmark indices. The standard deviation, which is a proxy for risk, can reflect the dispersion of returns. The average standard deviations of returns on ETFs which focus on developed markets are larger than the corresponding figure of the ETFs which focus on emerging markets, for the overall period, for both measures of daily return. The average standard deviations of the difference between the returns on ETFs and the returns on the indices are also higher for ETFs in developed markets than for ETFs in emerging markets, for both measures of return. According to Shin and Soydemir (2010), they believe that ETFs with high average returns may display high risk while ETFs with low average returns display low risk which appear to be consistent with the Markowitz type risk-return trade-off. Similarly, I find the result that ETFs in developed markets display higher return and also higher standard deviation.

Table 5

Average returns of ETFs and their underlying indices over the period 2012-2016

Panel (A)	2012			2013			2014			2015			2016			Overall		
Using the daily closing share price of the ETF																		
	Return on ETF	Return on index	ETF return - benchmark return	Return on ETF	Return on index	ETF return - benchmark return	Return on ETF	Return on index	ETF return- benchmark return	Return on ETF	Return on index	ETF return- benchmark return	Return on ETF	Return on index	ETF return- benchmark return	Return on ETF	Return on index	ETF return- benchmark return
ETFs focusing on developed markets	0.800	0.933	-0.133	-0.620	-0.157	-0.460	0.000	0.900	-0.900	-0.552	-0.792	0.240	0.172	0.161	0.010	-0.200	0.330	-0.520
ETFs focusing on emerging markets	-0.590	0.093	-0.683	0.000	-0.670	0.670	0.813	-0.934	1.747	-1.387	0.073	-1.460	1.560	0.667	0.890	0.100	0.350	-0.250
Panel (B)	2012			2013			2014			2015			2016			Overall		
Using the daily NAV per share																		
	Return on ETF	Return on index	ETF return - benchmark return	Return on ETF	Return on index	ETF return - benchmark return	Return on ETF	Return on index	ETF return- benchmark return	Return on ETF	Return on index	ETF return- benchmark return	Return on ETF	Return on index	ETF return- benchmark return	Return on ETF	Return on index	ETF return- benchmark return
ETFs focusing on developed Markets	0.000	0.933	-0.930	0.010	-0.157	0.160	0.000	0.900	-0.912	0.000	-0.792	0.790	0.012	0.161	-0.153	0.000	0.330	-0.330
ETFs focusing on emerging markets.	-0.022	0.093	-0.115	0.000	-0.670	0.678	0.010	-0.934	0.940	0.000	0.073	-0.080	0.012	0.667	-0.655	0.012	0.350	-0.341

Table 6

Standard deviations of ETF returns and their underlying indices over the period 2012-2016

Panel (A)	2012			2013			2014			2015			2016			Overall		
Using the daily closing share price of the ETF																		
	Return on ETF	Return on index	ETF return - benchmark return	Return on ETF	Return on index	ETF return - benchmark return	Return on ETF	Return on index	ETF return- benchmark return	Return on ETF	Return on index	ETF return- benchmark return	Return on ETF	Return on index	ETF return- benchmark return	Return on ETF	Return on index	ETF return- benchmark return
ETFs focusing on developed Markets	2.753	3.771	4.613	2.983	1.716	3.400	3.350	21.700	21.979	3.521	2.727	4.385	3.686	5.300	6.434	3.278	10.236	10.780
ETFs focusing on emerging markets.	1.368	1.475	1.931	1.369	1.590	2.074	1.318	1.376	1.883	1.748	1.551	2.307	1.555	1.248	1.967	1.480	1.455	2.038
Panel (B)	2012			2013			2014			2015			2016			Overall		
Using the daily NAV per share																		
	Return on ETF	Return on index	ETF return - benchmark return	Return on ETF	Return on index	ETF return - benchmark return	Return on ETF	Return on index	ETF return- benchmark return	Return on ETF	Return on index	ETF return- benchmark return	Return on ETF	Return on index	ETF return- benchmark return	Return on ETF	Return on index	ETF return- benchmark return
ETFs focusing on developed markets	0.128	3.771	3.206	0.073	1.716	1.652	0.036	21.700	21.736	0.022	2.727	2.730	0.036	5.300	5.314	0.070	10.236	10.223
ETFs focusing on emerging markets.	0.029	1.475	1.476	0.012	1.590	1.589	0.011	1.376	1.375	0.015	1.551	1.551	0.013	1.248	1.248	0.017	1.455	1.450

5.2. Results on tracking error based on the absolute value of the difference between the return on the ETF and the return on its benchmark index

First I measure the tracking error as the absolute value of the difference between the ETF's return and its benchmark index return.

Table 7

Average and standard deviation of the tracking errors estimated by the absolute value of the difference between the ETF return and its benchmark index return for the overall period 2012-2016

Focus of ETF/ Estimate of return of ETF based on	Average tracking error	Standard deviation of the tracking error	t-Stat
Developed markets/ ETF share closing price	0.901	10.692	51.745**
Developed markets/ ETF NAV per share	0.654	10.152	39.691**
Emerging markets/ ETF share closing price	1.385	1.496	249.396**
Emerging markets/ ETF NAV per share	0.897	1.146	213.364**

** Statistically significant at the 1% confidence level

Table 7 reports average tracking errors, standard deviations of tracking error and t-statistics of the test of the null hypothesis that tracking error is no different from zero, for both developed market ETFs and emerging market ETFs.

The t-statistics are significantly different from zero for all 4 combinations of the type of ETF (developed market ETFs or emerging market ETFs) and the method of calculating the ETF return (using ETF share closing price or using NAV per share). These results indicate that the tracking

errors are significantly different from zero, which means that both types of ETFs cannot mimic their corresponding indices perfectly. The emerging market ETFs exhibit higher tracking errors than the developed market ETFs for both methods of estimating ETF returns. Tracking errors based on ETF returns calculated using NAVs per share are always lower than tracking errors based on ETF returns calculated using ETF share closing price, for ETFs in developed markets and for ETFs in emerging markets.

Table 8 reports the average tracking errors and t-statistics of the test of the null hypothesis that the average tracking error is no different from zero, on a yearly basis and for the overall period 2012 to 2016. These results show that the tracking errors are significantly different from zero, for each year and for the overall period, for both groups of ETFs and for the two estimates of returns.

Average tracking errors of the emerging market ETFs are higher than the average tracking errors of the developed market ETFs for each year and for the overall period, for both estimates of the ETF returns. Tracking errors based on estimating ETF returns using NAVs per share are lower than the tracking errors based on estimating ETF returns using the ETF's share closing price.

5.3. Results on tracking error based on the standard error of a regression of the return on the ETF on the return on its benchmark index.

Table 9 shows the results when the tracking error is estimated as the standard error of a regression of the ETF return on its corresponding index return. The results show that the tracking error is significantly different from zero for all ETFs in emerging markets, for both measures of return, and for ETFs in developed markets, when ETF returns are measured by share closing price only. Tracking error of ETFs in developed markets (when the ETF return is measured by NAV per share) is not significantly different from zero.

Tracking errors calculated using share closing prices are always larger than the tracking errors calculated using NAVs per share for ETFs in both markets, these results are consistent with the results reported in subsection 5.2. The standard errors of the regression for ETFs in developed markets are larger than the standard errors of the regression for ETFs in emerging markets, for both measures of return, which are contrary to the results reported in subsection 5.2 and also my initial hypothesis.

Blume and Edelen (2004) conjecture that larger standard deviations of returns of ETFs will result in larger tracking errors. Table 6 indicates that standard deviations of returns of ETFs in developed markets are larger than the standard deviations of returns of ETFs in emerging markets for both measures of returns. This may result in the tracking errors of ETFs in developed markets being higher than the tracking errors of ETFs in emerging markets.

Shin and Soydemir (2010) also calculate the tracking errors by using both the absolute value of the difference between returns on ETFs and returns on their underlying benchmark indices, and the standard error of regressions of the ETFs returns on their underlying indices returns, for ETFs based in Asia, Europe, America and US. They find that the results differ depending on the method used.

So I can only conclude that tracking errors are significantly different from zero, which implies that ETFs can not mimic their corresponding indices well, however I cannot conclude that ETFs in developed markets have a better performance than ETFs in emerging markets.

Table 8

Average tracking errors and associated t statistics of the test of the null hypothesis that the average tracking error is no different from 0 on a yearly basis and for the overall period 2012-2016,when tracking errors are estimated as the absolute value of the difference between the ETF return and its benchmark index return

	2012		2013		2014		2015		2016		Overall	
Focus of ETF/ Estimate of return of ETF based on	Average tracking error	t-Stat	Average tracking error	t-Stat	Average tracking error	t-Stat	Average tracking error	t-Stat	Average tracking error	t-Stat	Average tracking error	t-Stat
Developed markets												
ETF share closing price	0.780	46.457**	0.790	65.448**	0.936	11.749**	0.989	63.380**	1.019	43.665**	0.901	51.745**
Developed markets												
ETF NAV per share	0.645	56.156**	0.550	96.804**	0.671	8.514**	0.698	72.550**	0.713	36.992**	0.654	39.691**
Emerging markets												
ETF share closing price	1.286	107.340**	1.340	102.849**	1.254	108.848**	1.597	115.324**	1.454	130.105**	1.385	249.396**
Emerging markets												
ETF NAV per share	0.898	93.363**	0.877	81.320**	0.800	87.202**	1.007	103.429**	0.906	127.603**	0.897	213.364**

** Statistically significant at the 1% confidence level

Table 9

Average tracking errors and t statistics of the null hypothesis that the average tracking error is no different from 0 when tracking error is estimated by the standard error of a regression of the ETF return on its benchmark index return on a yearly basis and for the overall period 2012-2016

	2012		2013		2014		2015		2016		Overall	
Focus of ETF/ Estimate of return of ETF based on	Average tracking error	t-Stat	Average tracking error	t-Stat	Average tracking error	t-Stat	Average racking error	t-Stat	Average tracking error	t-Stat	Average tracking error	t-Stat
Developed markets												
ETF share closing price	2.647	74.525**	2.914	166.98**	3.287	12.121	3.423	132.809**	3.600	31.378**	3.196	35.573**
Developed markets												
ETF NAV per share	0.127	2.593	0.073	5.112	0.035	0.283	0.020	2.450	0.035	1.455	0.070	2.787
Emerging markets												
ETF share closing price	0.927	117.463**	0.946	87.595**	0.925	86.929**	1.252	217.392**	1.078	125.989 **	1.480	106.496**
Emerging markets												
ETF NAV per share	0.028	11.608	0.008	111.608**	0.008	85.489**	0.011	169.146**	0.009	176.846**	0.015	258.389**

** Statistically significant at the 1% confidence level

Table 10

Results of the regression of the ETF return on the benchmark index return using the regression equation

Return on the ETF $_t = \alpha + \beta$ Return on the benchmark $_t + \varepsilon_t$ (4.1)

	2012		2013		2014		2015		2016		Overall	
Type of ETF / Dependent variable is ETF return based on	Intercept α	Coefficient β	Intercept α	Coefficient β	Intercept α	Coefficient β	Intercept α	Coefficient β	Intercept α	Coefficient β	Intercept α	Coefficient β
Developed markets												
ETF share closing price	-0.799**	0.023**	-0.678**	0.084**	-0.750**	0.001	-0.856**	0.055**	-0.892**	0.014**	-0.815**	0.003**
Developed markets												
ETF NAV per share	-0.016 **	0.000	0.010**	0.000	0.008**	3.183E-6	0.009**	0.000	0.010**	9.443E-5	0.011**	1.873E-6
Emerging markets												
ETF share closing price	0.934**	0.076**	0.94**	0.055 **	0.888**	0.063 **	1.083**	0.130**	1.015**	0.119**	0.973**	0.088**
Emerging markets												
ETF NAV per share	0.008**	0.001	0.008**	0.001	0.008**	0.001**	0.009*	0.001**	0.009**	0.001**	0 .008**	0.001**

** Statistically significant at the 1% confidence level

Table 10 shows the results of the regression of the return on the ETF on the return on its underlying benchmark index, using equation 4.1, for the two types of ETFs (developed markets and emerging markets) and the two estimates of ETF return (based on ETF share closing price and NAV per share).

If the ETF's return can replicate its benchmark index return perfectly, then α should equal 0 and β should equal 1. However, except for the ETFs in developed markets when returns are measured using share closing prices, the αs are all significantly positive. All the alphas are significantly different from zero while the βs are statistically significantly different from zero for 3 of the 4 cases, which means the returns of ETFs can only be predicted by returns on their underlying benchmark returns partially. Based on the results that the alphas are significantly different from zero, I concluded that both developed markets and emerging markets ETFs are not able to replicate their underlying indices perfectly.

5.4. Results on risk-adjusted tracking error estimated by the standard error of a regression of the excess return on the ETF on the excess return on its benchmark index.

Table 11 shows the results on average tracking error, when the tracking error is estimated as the standard error from a regression of the excess return on the ETF on the excess return on the benchmark index, using equation 4.2, on a yearly basis as well as for the overall period 2012-2016. The results indicate that the tracking errors are significantly different from zero for both types of ETFs (developed markets and emerging markets) when the ETF's returns are measured by share closing price. When ETF returns are calculated using NAVs per share, the standard errors are not significantly different from zero. The standard errors when returns are measured by share closing prices are always higher than when returns measured by NAVs per share and ETFs in developed markets always exhibit higher standard errors than ETFs in emerging markets. These results are

similar to the results reported in subsection 5.3, under which no adjustment is made for systematic risk.

Table 12 reports regression results of the intercept α and the slope β after adjusting for systematic risk. All of the alphas are significantly different from zero, but in contrast to the results of Table 10, the alpha is significantly positive only when the developed market ETF returns are measured by closing prices, at the same time the results on betas are consistent with the results from Table 10.

After adjusting the systematic risk, most of the alphas become significantly negative which are consistent with the previous results that most ETFs underperform their underlying indices, but there is still no evidence that ETFs can replicate their underlying benchmark indices perfectly.

Table 11

Results on the average risk-adjusted tracking errors when tracking error is estimated by the standard error of the regression of the excess return on the ETF on the excess return of the benchmark index using the regression equation:

$$\text{Return on the ETF}_t - \text{Risk free rate}_t = \alpha + \beta\,(\text{Return on the benchmark}_t - \text{Risk free rate}_t) + \varepsilon_t \qquad (4.2)$$

	2012		2013		2014		2015		2016		Overall	
Focus of ETF/ Estimate of return of ETF based on	Average tracking error	t-Stat	Average tracking error	t-Stat	Average tracking error	t-Stat	Average tracking error	t-Stat	Average tracking error	t-Stat	Average tracking error	t-Stat
Developed markets												
ETF share closing price	2.693	55.508**	2.975	132.128**	3.360	0.947	3.497	113.198**	3.648	15.531**	3.258	26.517**
Developed markets												
ETF NAV per share	0.131	0.005	0.081	5.32	0.041	0.357	0.066	93.880**	0.084	2.204	0.134	8.162
Emerging markets												
ETF share closing price	0.918	145.155**	0.946	86.789**	0.926	87.709**	1.257	114.379 **	1.080	140.865**	1.038	117.376**
Emerging markets												
ETF NAV per share	0.035	1.600	0.024	104.380**	0.014	3.796	0.063	2.120	0.077	56.900**	0.114	3.869

** Statistically significant at the 1% confidence level

Table 12

Results of the regression of the ETF excess return on the benchmark index excess return using the regression equation

Return on the ETF $_t$ – Risk free rate $_t$ = α + β (Return on the benchmark $_t$ - Risk free rate $_t$) + ε_t (4.2)

	2012		2013		2014		2015		2016		Overall	
Type of ETF / Dependent variable is ETF return based on	Intercept α	Coefficient β	Intercept α	Coefficient β	Intercept α	Coefficient β	Intercept α	Coefficient β	Intercept α	Coefficient β	Intercept α	Coefficient β
Developed markets ETF share closing price	0.820**	0.020**	-0.690**	0.077**	-0.759**	0.001	0.877**	0.052**	1.000**	0.010**	0.847**	0.003**
Developed markets ETF NAV per share	-0.093**	1.131E-5	0.062**	0.000	-0.033**	-4.112E-6	-0.053**	0.001**	-0.316**	-8.761E-5	-0.111**	6.167E-5
Emerging markets ETF share closing price	-0.926**	0.079**	-0.940**	0.055**	-0.888**	0.063**	-1.090**	0.130**	-1.037**	0.126**	-0.978**	0.090**
Emerging markets ETF NAV per share	-0.086**	3.122E-5	-0.059**	-0.002**	-0.033**	0.000	-0.054**	0.001	-0.321**	-0.006**	-0.108**	0.001

** Statistically significant at the 1% confidence level

5.5. Results of the analysis of the factors that influence the tracking error.

Table 13

Results of the regression of the tracking error on the factors that influence the tracking error using the regression equation:

$$\text{Tracking error}_{i,t} = \alpha_0 + \alpha_1 \text{Expense ratio}_{i,t} + \alpha_2 \text{Volatility}_{i,t} + \alpha_3 \text{Log (Trading Volume)}_{i,t} + \alpha_4 \text{Dividend yield}_{i,t} + \varepsilon_i \quad (4.3)$$

Tracking error for Type of ETF/ Estimate of return	Developed markets/ based on ETF share closing price	Developed markets/ based on NAV per share	Emerging markets/ based on ETF share closing price	Emerging markets/ based on NAV per share
Constant	2.452	1.370	1.168	0.939
Expense ratio	0.800	0.149	0.004	-0.660
Volatility	7.804**	5.776**	20.530**	14.233**
Log (Trading Volume)	-0.336	-0.156	0.005	-0.270
Dividend	-12.767**	-11.576**	-8.269**	-4.438**
Number of observations	329,792	329,792	60,292	60,292
R-square	0.310	0.171	0. 250	0.140

** Statistically significant at the 1% confidence level

Table 13 shows the results of the regression of the tracking errors on the dependent variables as in equation 4.3. In contrast to the results of Poterba and Shoven (2002), the results of table 13 indicate that the expense ratio is not statistically significantly related to tracking error for all 4 combinations (types of ETFs and methods of estimating return). 3 of 4 results show that expense ratio has a positive relationship with tracking error, except for ETFs in emerging markets when ETF returns are measured using NAV per share.

The coefficients of volatility are significantly positive for all combinations. The volatility shows how the daily market price changes affect tracking errors, ETFs with larger daily price changes, which could be influenced by higher market risks or market inefficiency, may have larger tracking errors. Based on the magnitude of the associated coefficients, the results also indicate that

volatility appears to have a greater influence on tracking error for ETFs in emerging markets than for ETFs in developed markets, besides volatility has a larger influence on tracking errors when ETF returns are calculated using closing share prices for ETFs in both developed markets and emerging markets.

In contrast to expectations, the influence of daily trading volume on tracking errors are all insignificant for ETFs from both developed markets and emerging markets. The coefficients of daily trading volume are negatively associated with tracking errors for all but one combination, which is that of emerging market ETFs when returns are estimated using share closing prices. Dividend yields are significantly negatively related to tracking errors for all combinations of ETFs and method of calculating returns as expected, dividend yields tend to have a larger influence on tracking errors for ETFs in developed markets than for ETFs in emerging markets. Dividend yields also have a larger influence on tracking errors when ETF returns are measured by share closing prices.

6. Conclusion

In my thesis, I examine the performance of exchange-traded funds (ETFs) over the period 2012-2016. I find that ETFs in developed markets and ETFs in emerging markets both underperform their corresponding benchmark indices. I measure the tracking error using both the absolute value of the difference between the return on the ETF and the return on its benchmark index and the standard error of a regression of the return (or excess return) of the ETF on the return (or excess return) of its benchmark index. I find that the tracking errors are significantly different from zero in all cases, so there is no convincing evidence that these ETFs are ideal substitutes for their corresponding indices. I also compare the tracking error of ETFs in developed markets with those of ETFs in emerging markets, depending on the measure of tracking error used, the results vary.

Hence, the results do not consistently indicate that ETFs in developed markets perform better than ETFs in emerging markets.

My test of the influence of several factors on the tracking error of all ETFs indicates that daily volatility is positively related to tracking errors, that dividend yields are significantly negatively related to tracking errors for both ETFs in developed markets and emerging markets, but there is no evidence that expense ratios and daily trading volume affect tracking errors. Volatility tends to have a larger influence on tracking errors in emerging markets, in contrast, dividend yields have a larger influence on tracking errors in developed markets. In addition, volatility and dividend have a larger impact on tracking errors when ETF returns are calculated using closing share prices, for both markets.

My thesis still has some limitations. First, though I want to include all the available ETFs in my database, I am only able to include one third of the whole set of ETFs which focus on equity due to the research period and missing data. Second, I cannot conclude that ETFs in developed markets have a better performance than ETFs in emerging markets over the research period, since I obtain different results when I use different methods to calculate tracking errors. These results may be verified by using a different set of ETFs and different methods of estimating tracking errors. Third, with the development of financial markets, some ETFs in emerging markets may perform as well as others in developed markets, so a simple classification of ETFs into emerging market and ETFs into developed market may not be suitable any more.

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